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MACHINERY

SEPTEMBER, 1913

MACHINING AUTOMATIC CHUCKING MACHINE AND LATHE TURRETS

SPECIAL BORING AND PLANER FIXTURES FOR INSURING HIGHLY ACCURATE INDEXING

BY C. M. CONRADSON*

IN boring the spindle bearings of the turret for the automatic chucking machine shown in Figs. 1 and 2, it was necessary to attain a degree of accuracy seldom required in machine work of this size. The holes had to be perfectly round, accurately spaced tangentially and radially, and the axes of the holes had to be exactly parallel with the axis of the central bearing of the turret. When it is known that the limit of tolerance was 0.0005 inch, it will be readily understood that this job required more than ordinary care.

In order to index the work for boring the six bearings, a special fixture was constructed which, so far as the writer knows, operates on a new principle. Referring to the illustrations, it will be seen that this fixture is mounted on a surface plate, the work being carried on an arbor supported in V-blocks. The supports which carry these V-blocks are firmly bolted and doweled to the surface plate and carefully

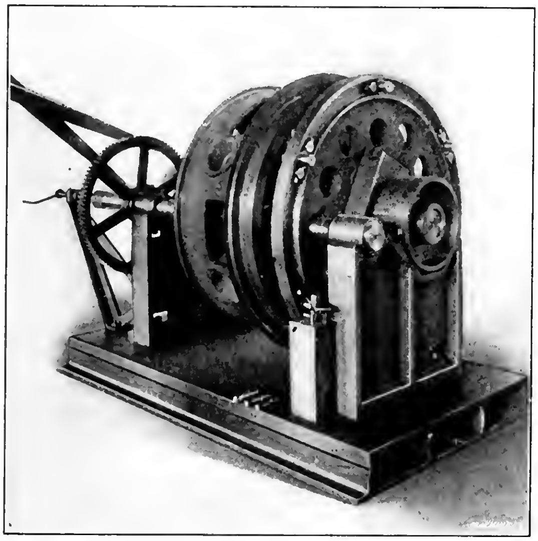


Fig. 1. End View of Fixture showing V-blocks and Indexing Mechanism

finished to bring the axis of the spindle carrier at exactly the required distance from the boring-bar which machines the six bearings.

The boring-bar is also supported in bushings which are carried in V-blocks, the bar being provided with double-ended boring cutters. The method of driving the boring-bar and feeding it up to the work is clearly shown.

The method of indexing used on this fixture constitutes the most interesting part of the work. The index wheel is a heavy plate casting which is clamped to the arbor by means of a split hub. It will be seen that there is an annular groove in the plate close to the periphery, and the index plugs are carried in holes bored through the casting in this groove. The plugs were very carefully ground and lapped after hardening and were brought to a perfect fit in the annular groove. A test-bar adapted to swing on one of the index plugs was equipped with a delicate test indicator at the opposite end. This indicator was used for adjusting the plugs until each plug was located at exactly the same distance from adjacent plugs. Similar tests were made to prove that the distance of each plug from the center of the fixture was exactly the same. The method of indexing is rudimentary in its simplicity, but it possesses the valuable feature of eliminating lost motion entirely. The index plug is strapped down on a hardened and ground steel plate which is carried on the top of a cast-iron block fastened to the surface plate. The operation of the fixture and the resulting accuracy of the work produced on it left nothing to be desired. The total time required for boring the piece was sixteen hours, and as this was the first piece to be machined in this fixture, it is felt that subsequent pieces can be machined in a much shorter time. Five of the bearings were located in exactly the required position, while the sixth one was 0.0005 inch out of the way.

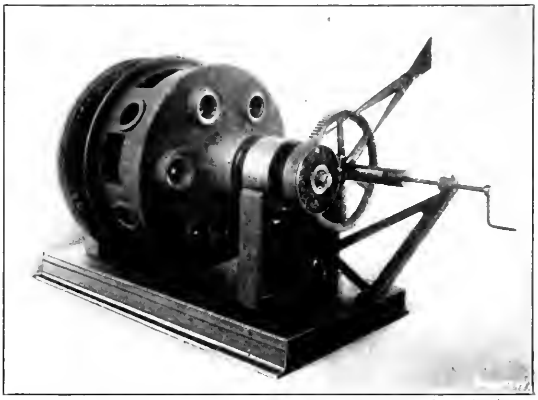


Fig. 2. Opposite End of Fixture showing Drive and Feed Mechanism

Fig. 3. Final Test of Location of Index Plugs with Dial Test Indicator

The question has been asked why some simple form of power feed was not used instead of relying upon the rather crude hand feed. It was felt that a workman who was competent to do this work satisfactorily could produce the desired results with the hand feeding device shown in the illustrations, and experience has shown that this assumption was correct. The accuracy and rapidity with which the work was done entirely fulfilled expectations. The fixture was designed and built by the writer, with the assistance of Mr. C. F. Larzelere, superintendent of Giddings & Lewis Mfg. Co., Fond du Lac, Wis.

*Address: Madison, Wis.

Planing Turret and Slide of Semi-automatic Turret Lathe

Figs. 3 to 8 show the methods used in machining a turret and turret slide for a semi-automatic turret lathe which is being built for the writer by the Phoenix Mfg. Co., Eau Claire, Wis.

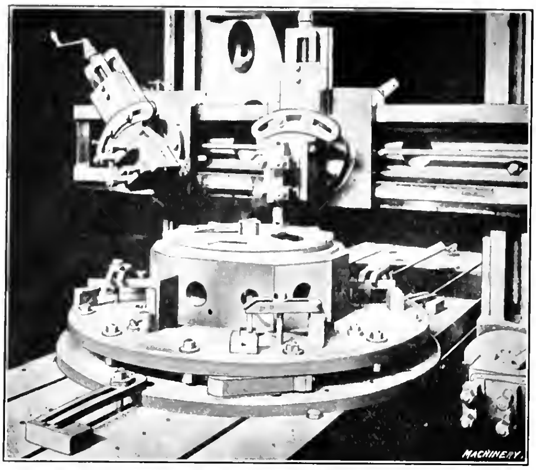


Fig. 4. Planing Teeth of Turret of Semi-automatic Lathe

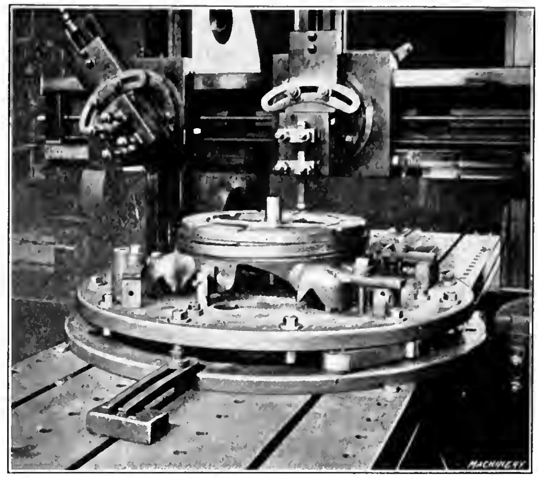


Fig. 5. Planing Spaces in Turret Slide to receive Turret Teeth

The turret of this semi-automatic turret lathe is provided with twelve holes and after it has been indexed to bring the required tool into the operating position, it is locked to the turret slide by means of the twelve teeth and spaces shown in the illustrations. The fixture shown in Fig. 6 was designed for indexing the work in order to plane these teeth and spaces. These operations are unusual, in that it is necessary to finish the work within very close limits in order to have the teeth on the turret engage properly with the spaces on the turret slide.

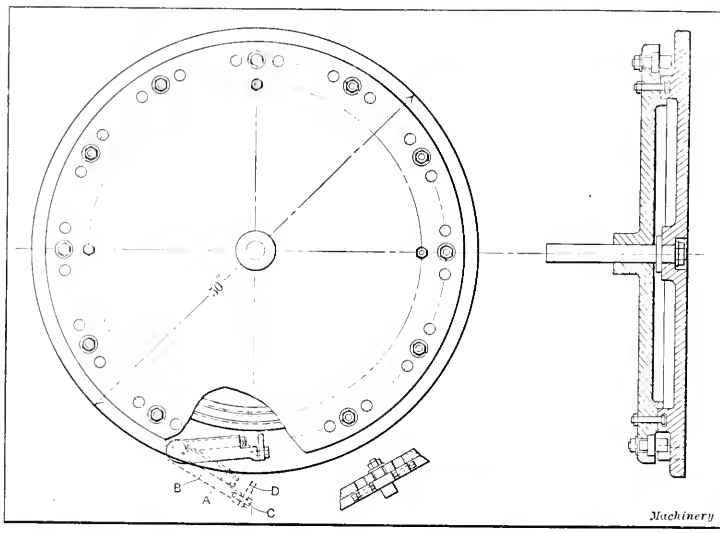


Fig. 6. Design of the Planer Indexing Fixture used to plane the Turret and Turret Slide

It will be seen that the fixture consists of two plates, the lower plate being bolted to the planer table, while the upper plate is carried on an arbor upon which it can be rotated in relation to the lower plate. The upper plate has twelve plugs mounted on its lower side. These plugs are made of steel and were ground and lapped after hardening to insure having them of exactly the same size; they were then carefully spaced around the diameter of the plate by means of a vernier caliper, the final adjustment being made with a dial test indicator as shown in Fig. 3.

In using this fixture to index for the twelve teeth on the turret or spaces on the turret slide, successive plugs on the index plate are brought up against the hardened steel plug *A* of the lock mechanism *B*. The bolt *C* is then tightened to clamp the plug *D* over the index plug. In this way the fixture is held securely in position and the planing operation can then be carried on. Fig. 4 shows the teeth being planed in the turret and Fig. 5 shows the operation of

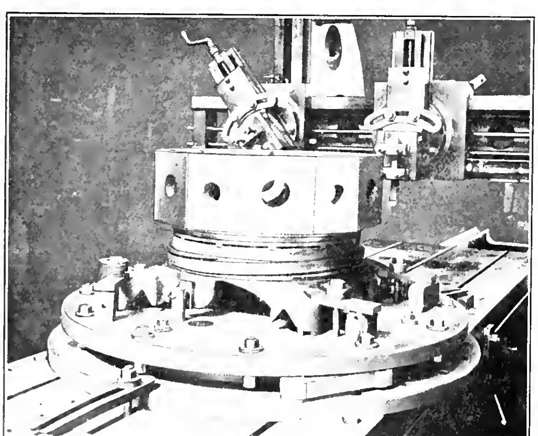


Fig. 7. Testing Accuracy of Teeth and Spaces of Turret and Slide

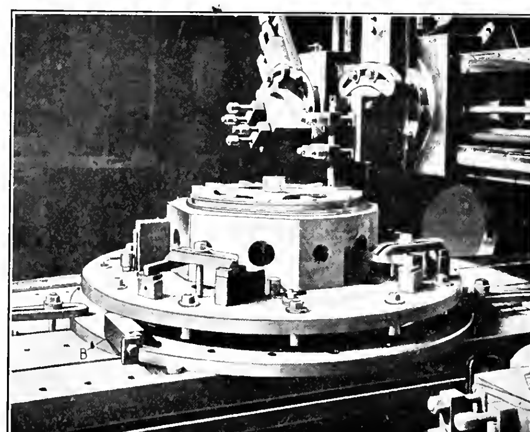


Fig. 8. Planer Indexing Fixture with the Lock Mechanism B swung back

planing the spaces in the turret slide. After these operations were completed, the table of the planer was run out sufficiently to allow the turret to be placed in position on the turret slide as shown in Fig. 7, in order to test the accuracy of the teeth and spaces.

This index plate was made in the shops of the Phoenix Mfg. Co., Eau Claire, Wis., under the direction of Mr. Neys, superintendent of the company. The operation of planing the turret and turret slide was also conducted in these shops and as previously stated, the work was finished within very close limits.

* * *

A CASE OF DEFLATION

BY GEORGE WILSON*

It is an idiosyncrasy of human nature to derive considerable satisfaction from the discomfiture of a performer who is putting on frills in an effort to aggrandize himself in the eyes of the audience—in plain English, "playing to the grandstand."

Bill and I were making the rounds of the machinery section of a state fair. A crowd that was gathered around the exhibit of a carriage-maker drew our attention, and on edging our way to the front we found the attraction to be several blacksmiths at their forges producing the various iron parts that went into that particular make of buggy. The *piece de resistance* of the exhibit proved to be a young fellow of perhaps twenty-five years of age, and it was quite evident that if there was any applause lying around loose he meant to have it.

He was a typical melodramatic smith, tall, broad-shouldered and a "good looker" generally. His hair was carefully arranged; his blue flannel shirt was open at the throat, disclosing a section of manly chest, and his sleeves were rolled rather higher than was necessary to give play to biceps that knotted and swelled just a little more than the job warranted. His get-up was one of "studied indifference" as the novelists say. But his action! Chesterfield and the Apollo rolled into one had nothing on him. Grace incarnate. The poetry of motion. The methodical plodding of the veterans at the other anvils was only cheap newspaper prose compared to his easy grace.

"My, ain't he grand!" breathed a callow damsel ecstatically through a mouthful of popcorn.

His pride was partly excusable, for he was really a good workman. With a few deft blows he would have a rod welded and bent into a graceful scroll. Then to prove the merit of the weld and the quality of the material he would bend and twist the cold piece over the anvil.

One of the duties of the smiths was to pass out souvenirs in the form of pewter facsimiles of a medal the carriage concern had won at some exhibition. This the Apollo did with a fine condescension.

"That guy is all right, but he ought to take something for his head," muttered Bill. Then to the Apollo, timidly, "Don't you ever get a bum weld?"

If a look could have killed, Bill's demise would have been swift and terrible. Chastened and contrite, Bill slunk back as Apollo flourished his irons from the fire and struck the uniting blow. Amazed he looked at the glowing ends. They had not stuck! Back to the fire. Another trial. Nothing doing. Some of the crowd tittered. The veterans at the other anvils grinned appreciatively and the Apollo's face got red. There were no flourishes when he grabbed some new irons and brought them to a heat. Biff! Bang! Swat! The pieces stuck about as nicely as a couple of pieces of brass would have done.

Apollo ceased his effort and mopped his classic brow. The hauteur had all oozed out. The snickers became general and included a few uncomplimentary remarks.

"Let's get out of here," muttered Bill. As we turned to leave the Apollo started to heave out his fire. Outside the crowd, Bill exploded and a suspicion dawned in my mind.

"Bill," I demanded, "what did you do to that fellow's fire?"

"Nothing much," grinned Bill, "just dropped a couple of his medals into it."

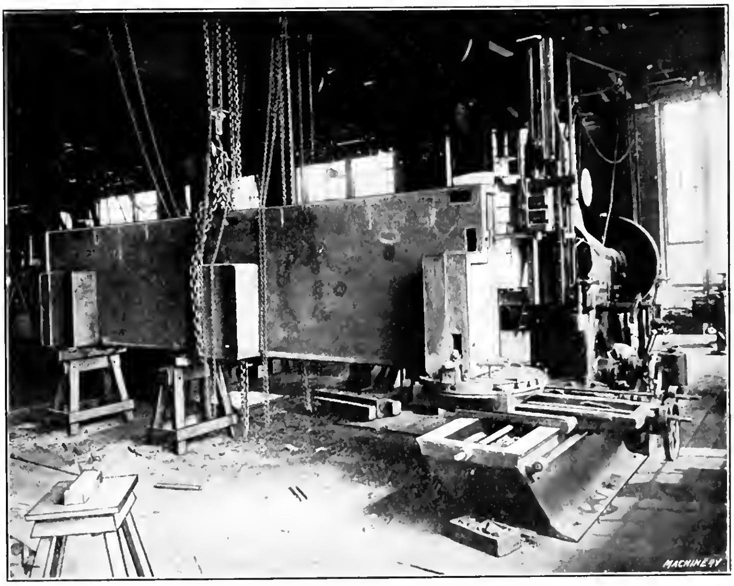
* Address: Madelia, Minn.

* * *

A LARGE SLOTTER JOB

In building a large special drilling machine at Edwin Harrington Son & Co.'s shops, at Philadelphia, Pa., the bed was constructed in quarter sections, and to join these sections properly it was necessary to machine the sides and ends. The sides were readily finished by planing, but the machining of the ends presented unusual difficulties because of the great size and weight of the work.

The halftone shows how the parts were machined on a Dill slotter. The casting was supported from a ten-ton crane and located with one end resting on the slotter table. As the length of the cut measured 51 inches and the full stroke of the slotter was only 20 inches, it is evident that the surface had to be finished in three cuts. In order to get up high enough to start the first cut a special offset slotting tool was forged, and this was clamped at the extreme top of the tool-holder. This tool being properly set, the casting was machined as far as the offset portion which is shown in the illustration. Of course the feeding across the work, which was a distance of twelve inches, was accomplished by using the traveling head, which is a distinguishing feature of the Dill slotter. After this section had been surfaced, a straight slotting tool was mounted in the tool-post and a second cut taken, leaving the stroke of the ram still at its highest position. The stroke was next transferred to the lower section of the work and the remaining part of the work thus completed. C. L. L.



Facing an 11,500-pound Casting on a Dill Slotter

* * *

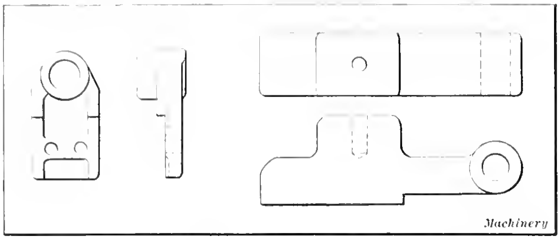
Reaming is commonly regarded as an internal cutting operation—that is, as enlarging a hole. But reaming is both internal and external. Box-tools are examples of external reamers. These usually ream or turn straight or cylindrical parts but they are also successfully used for taper work up to lengths of eighteen inches and diameters of 1½ inch or more. A prominent example is the locomotive taper turning tools used on special vertical machines in locomotive building and repair shops. The speed with which taper bolts are turned or reamed to exact sizes would astonish one not familiar with this work.

A UNIVERSAL DRILL JIG

A DESIGN PRIMARILY INTENDED TO HANDLE CASTINGS HAVING A ROUND BOSS ON ONE SIDE

BY CHRISTIAN F. MEYER*

The universal drill jig described and illustrated in the following was designed for drilling parts which are quite different in shape but which all have a round boss on one side.



Figs. 1 and 2. Two Classes of Work for which the Jig was designed

Figs. 1 and 2 show two typical examples of the class of work for which this jig was designed, and with slight modifications which will be explained later, the jig could be adapted for both drilling and boring operations on a great variety of work.

Referring to Figs. 3 to 6, it will be seen that the jig consists of a cast-iron baseplate *A*, which is provided with a dovetail slot in which three slides *D*, *G* and *K* are held, so that they may be moved longitudinally by screws and operating keys. A cast-iron guide piece *V* is also held in the dovetail slot in the base of the jig, and this guide carries the lower bushing *W*. This construction will be readily understood by referring to Figs. 4 and 5.

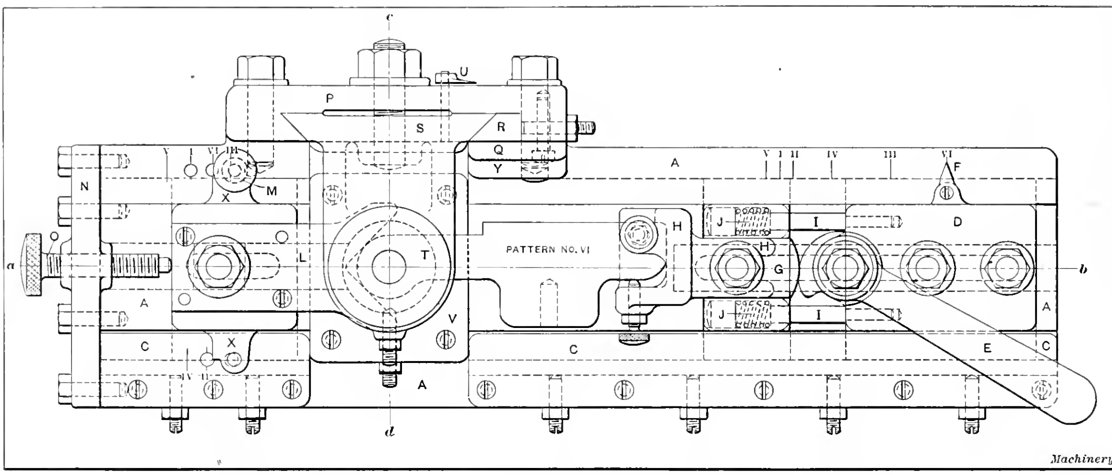


Fig. 3. Plan View of the Jig, showing Adjustable Slides for holding Different Kinds of Work

The slide *D* is provided with two bolts which slide with their heads in a suitable slot in the base *A*, and handle *E* is fastened to this slide, the hub of the handle being cam-shaped, as shown in Fig. 3. The cam forces the slide *G* forward when handle *E* is turned in the proper direction. Slide *G* is loose in the slot in casting *A*, and is connected to the slide *D* by means of two studs *I*. Each stud is provided with a spring *J* which draws slide *G* toward slide *D*. The top of slide *G* is cut away to receive the guide pieces *H*, a different form of guide piece being required for each class of work which is drilled in the jig. In order to explain the operation of this jig, it has been assumed that it was designed for drilling six classes of work, known as Patterns I to VI. Pattern No. VI is shown in detail in Fig. 2, and the same piece is shown mounted in the jig shown in the illustrations. It will be seen that the guide piece *H* for this particular piece is designed in such a way that the work is held by means of two screws with knurled heads. The guide piece is held on slide *G* by means of a washer and nut, which fit a stud in the slide. Slide *K* is also cut away for the V-block *L*, which receives the end of the piece to be drilled.

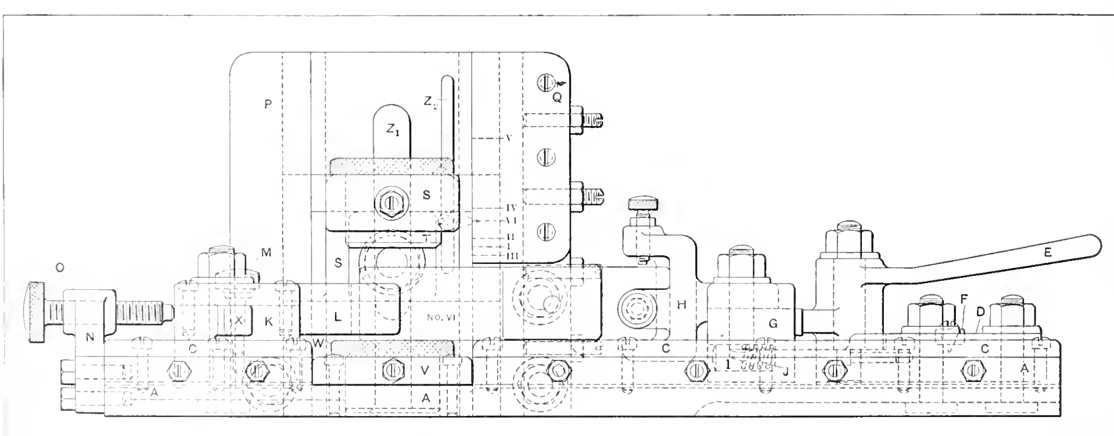


Fig. 4. Front View of the Jig showing Bushings and Drill Guide Supports

Referring to Fig. 3, it will be seen that slide *D* is provided with a pointer *F*. In adjusting the jig for any particular class of work, the bolts which hold the slide are loosened; the slide is then moved along the slot in the casting to bring the pointer

* Address: Wyomissing, Pa.

F to the graduation which indicates the class of work which is to be machined. The bolts are then tightened to secure the slide in this position. As shown, at the other end of the jig there are similar graduations which provide for setting slide *K* and V-block *L* in the required position, the method of adjustment being similar to that described for slide *D*. It will be seen that an adjusting screw *O*, carried by the piece *N*, provides for adjusting the position of slide *K*. This slide has a pointer *X*, which is brought up to the graduation that indicates the class of work to be drilled. A taper pin *M*, fitting into corresponding holes in the top of base *A* and cover *C*, serves to locate slide *K* and V-block *L* in exactly the required position, thus insuring an accurate location of the work.

The guide *V* is fastened to base *A* and receives a hardened steel bushing *W* which is held in place by a pointed set-screw. In a similar manner, the bushing *T* is held in the arm of the slide *S*. Both bushings are provided with a knurled flange and may be easily removed to be replaced by different bushings for another kind of work. The outside diameter of all of the bushings is made alike, however, so that they all fit the same holes.

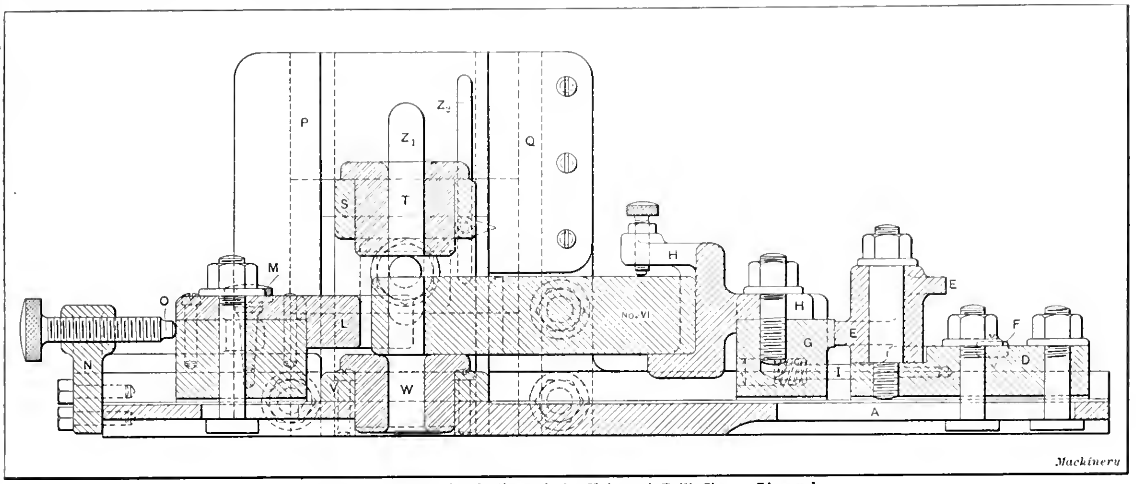


Fig. 5. Cross-sectional View of the Universal Drill Jig on Line a–b

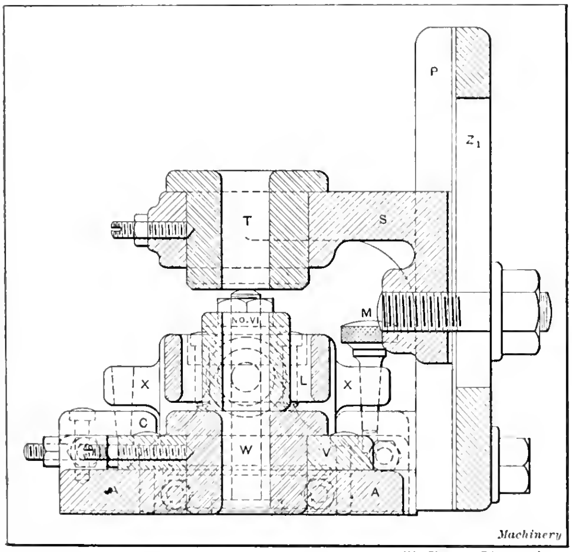


Fig. 6. Cross-sectional View of the Universal Drill Jig on Line c–d

The slide *S* is carried in a dovetail slot in the support *P*. The cover *Q* and key *R* are used to adjust the position of slide *S*. The support *P* is fastened to an extension on base *A* by means of bolts, the construction being clearly shown in Figs. 3 and 6. Slide *S* is held in the support *P* by a strong stud, washer and nut, and may be fastened in any desired position, the stud moving in the slot Z_1. A narrow slot Z_2 guides a smaller stud which has a pointer *U* fastened to it. This pointer slides over a scale graduated on the back of the support *P*, which indicates the correct position of slide *S* for different classes of work which are being drilled in the jig.

After the three slides *D*, *K* and *S* have been set, the jig is ready for use. The quick-acting cam lever *E*, in connection with the automatic releasing slide *G* and guide piece *H*, works very efficiently, and the guide pieces *H* and *L* locate the work with great accuracy. Although this jig was only constructed for work with a round boss—as shown in Figs. 1 and 2—it will be readily seen that it could be adapted for almost any shape of work by replacing the V-block *L* by a member somewhat similar to the guide piece *H* on the slide *G*. This jig might also be arranged upon the faceplate of a lathe or boring mill. The drill guide would then be unnecessary and the bushing *W* would be made in such a way that the pilot of the cutter would enter the bushing before the cutting operation began. This would provide for an accurate cut.

The operation of the jig is so simple that any boy can handle it. In addition, the jig is "fool-proof," as the special guide piece and setting of the slides will not suit any class of work except the one for which it is designed. The use of a universal jig of this kind saves the expense of making individual jigs for each class of work and also means a considerable saving of space in the tool-room.

* * *

USELESS LABOR IS THE ONLY UNPRODUCTIVE LABOR

"If a lot of capital is***spent in unproductive ways, there will be not only less for other uses, but the natural growth of capital will be arrested in proportion as the uses to which it is devoted are unproductive. When you put $10,000,000 of capital into an industry or a railroad it multiplies itself; when you put capital into armament, meaning warship and standing armies, as has been done on so vast a scale in Europe, or when you spend it on monuments which in themselves have no earning power, as has been done widely in this country, the capital is, in the economic sense, lost. It cannot multiply. The enormous expenditure of capital all over the world in unproductive ways is the fundamental explanation of the present scarcity of capital."—*New York Evening Sun.*

[The statement above would have been equally, or, perhaps, even more directly applicable and true if the writer had referred to labor spent in unproductive ways. In the last analysis, capital spent in unproductive ways is really labor thus spent, and the enormous expenditure of labor all over the world in unproductive ways is without question a fundamental reason for many of our financial, economic and social difficulties. EDITOR.]

* * *

A reliable aluminum solder, used by a large electrical concern, is composed of 75.5 parts, by weight, tin; 18 parts zinc; and 2.5 parts aluminum. No flux is needed.

PHOTOGRAPHIC DEPARTMENT OF THE NATIONAL-ACME MFG. CO.*

THE EQUIPMENT AND FUNCTIONS OF AN INDISPENSABLE FACTOR IN MODERN ADVERTISING AND SELLING

BY F. SLUKA, JR.†

The National-Acme Mfg. Co., of Cleveland, Ohio, in common with many other manufacturing companies, had a great deal of difficulty in getting suitable photographs from outside photographers, due to their lack of special training in photographing mechanical subjects, and to the fact that they were forced to work under difficulties, such as lack of a suitable place to take the pictures and conveniences for preparing the subjects to be photographed. The company therefore established its own photographic department, as a branch of the advertising department, during the month of August, 1910, as an experiment toward getting better photographs at less cost. In three years' time the photographic department has made itself practically self-sustaining, and it is doing so much better work in its line than the company was able to get previously that it has come to be regarded as a valuable adjunct to the advertising and sales divisions of the business.

The extent of the work carried on by the photographic department can be judged from the fact that during the past year the builders of the Acme automatic multiple-spindle screw machine used about 850 photographs per month for advertising and sales purposes, which means the use of over 10,000 photographic prints during the year. If outside photographers had been employed as required to get these pictures, a member of the sales or advertising force would have had to be with the photographer on each occasion, to see that he got the view of the machine desired, that the subject was prepared properly, and that the proper parts of the mechanism were brought out according to the requirements. An outside photographer, lacking familiarity with machinery in general and with the Acme automatic in particular, could not be expected to get this without supervision. With his own department, however, the advertising manager tells the head of the photography branch just what he wants, and then forgets about it until the photographic department shows him the finished prints that he ordered. The sales department puts in an emergency call at any time for any special photograph and the photographic department has it ready in a day or so without further attention from the sales department. This is a very great convenience to the heads of the sales and advertising departments, and it soon saves a lot of time and expense to the company. The National-Acme Mfg. Co. uses photographs in the following ways:

Fig. 1. Section of National-Acme Mfg. Co.'s Photographic Department

1. *For Records.*—The advertising department has all sorts of views of machines, parts, and tools taken at different times for many purposes. Every time a new photograph is made for any purpose whatever, the necessary working prints, for retouching, mailing, or other use, are made from the negative and at the same time one record print. The negative is then filed away in the racks provided for that purpose, the working prints are used or sent out as required, and the record print goes into one of the record binders, according to its classification. The record photographs are separated into twelve different classifications and each is kept in substantial binders and properly labeled for reference at any time. These record photographs are also listed in a card index, and the number on the negative also appears on the record print and on the

* For articles on shop photography previously published in MACHINERY see: "Shop Photography," January, 1910, and the other articles there referred to.
† Address: National Acme Mfg. Co., Cleveland, Ohio.

proper card in the card index. Needless to say, this library of record photographs is extremely useful and valuable. It is in many ways, a history of different experiments and developments in building the Acme automatic multiple-spindle screw machine during the period that the photographic department has been in existence.

2. *Photographs for answering Inquiries and for Sales Promotion Work.*—When inquiries about the machines, their work, their parts or their product are received, a very clear answer can be given the inquirer by sending him a photograph and a brief letter of explanation. The sales promotion department finds these photographs very effective as auxiliaries to the promotion letters. The photographs establish a bond of interest with the prospect and illustrate the truth of the points brought out in the letters. One of the big advantages of a photographic department for the business comes in right here. The men in the photographic department, through familiarity with the machines and their uses, develop the sense of mechanical values which is so necessary in order to get the real sales force into the photographs. By specializing, so to speak, on the Acme machines, they know how to bring out certain parts of the machines or features of their use, according to the requirements, and thus get pictures that have real educational and sales value, as well as artistic beauty. Some of these pictures are printed on black backgrounds with soft gray tones for the masses and high lights for the details of the machines. This treatment, besides being distinctively original, subdues the non-essentials and brings out the essential parts of the machines. Other pictures of machines have the background left in purposely, while on others it is painted out on the negative.

Fig. 2. Photographing Machine in Perspective for Line Drawing Copy

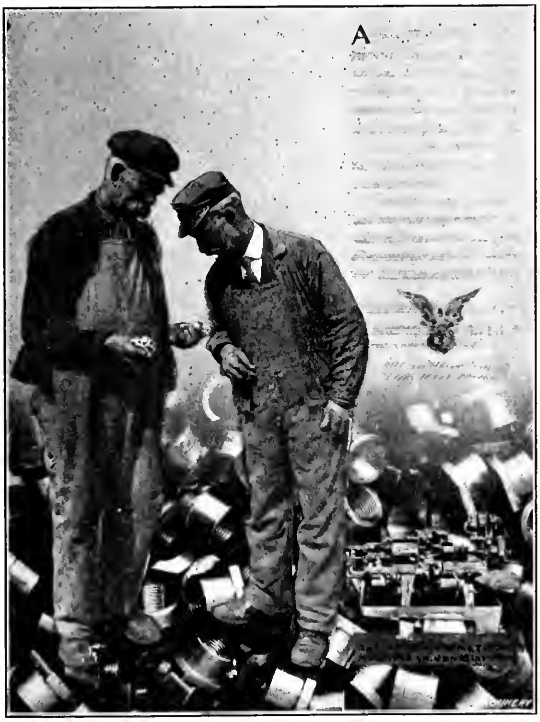


Fig. 3. Advertising Illustration composed from Shop Photograph

3. *Photographs for Retouching.*—Retouching photographs is at best an expensive process because it means hand painting by high-priced craftsmen. The cost of retouching can be minimized by the use of fine photographs, or magnified by the use of poor ones. It is a question of the amount of the artist's time required to fit the photograph for engraving. As a photograph of a simple object will cost only about $1.50 to $2.50, while the retouching necessary may cost anywhere from $5 to $50, according to the photograph, it seems wise to take more time for the photographing and save the more expensive time of retouching. The National-Acme idea is to spend a little more time and money on the photographs and save a lot on the retouching. The photographic department, in getting photographs which are later to be made into engravings, is very careful to get the clearest possible pictures to bring out the salient parts of the machine, which should be strong in the printing.

Fig. 4. The "Skyscraper" Camera photographing a Group of Screws

4. *Photographs for Line Drawing, or for Poses of Individuals for Advertising Purposes.*—Fig. 2 shows that when line drawings of machine parts are wanted, it is quite a simple matter to go into the shop and make a quick photograph from the proper angle, from which it is easy to make a pen-and-ink drawing. Such photographs do not need to have the light and shade contrast that the better photographs must have, but they should show as much detail as will be required in getting material for the artists to work on, so as not to waste the artists' time. A camera is often taken into the shop to get a quick photograph of a man or group of men in some characteristic pose to illustrate an idea for an advertisement. (See Fig. 3.) Sometimes line drawings for engravings are made from these pictures, and sometimes the photographs are used as copy for halftones with a background of machines or some other effect sketched in.

5. *Photographs to be enlarged for Advertisements or for Framing.* Magazine pages are in some cases larger than 8 by 10 inches the usual size of the photograph and in making the engravings for printing, as it is always advisable to reduce from the photograph, they are frequently thrown up to a much larger size, retouched if necessary, or perhaps lettered, and then sent to the engraver, who photographs them in reduced size to the proper size for the plate. This gives more detail in the finished cut. Enlargements of the Acme automatic machine and views of the factory are also made for framing. These pictures are sent to the branch offices and to other companies interested in having them on their office walls. These pictures are often made with the black background treatment referred to above.

The National-Acme photographic department has a well-equipped studio for taking pictures, a section of which is shown in Fig. 1. It is located on the top floor of one of the three bridges which connect two wings of the plant—an ideal place for photographic work, as an abundance of light is available from both sides and above, and the vibration common to large manufacturing plants is not felt in the suspended bridge. The studio is equipped with two 8 by 10 Century cameras, one for copying work and enlarging, and the other for general photographing; one 11 by 14 Century camera which is chiefly used for catalogue work; and a 5 by 7 Graflex which is used on special work. Four lenses are in use, *viz.*, one 19-inch, one 12-inch, one 8-inch Dagor, and one Bausch & Lomb Zeiss-Protor, Series V for extremely wide angle work.

When one of the Acme automatics is to be photographed it is brought into the studio from the elevator on a portable crane, and placed on a turntable by means of which the photographer can turn the machine easily to get any view desired. This is shown in Fig. 5. The turntable allows him to take advantage of the best lighting available at the time, and this is a particularly important feature in obtaining the best results. Artificial light is often used in photographing sections of the machines where the daylight fails to penetrate, and for this purpose a Cooper-Hewitt light is used as an auxiliary to the daylight in the studio.

Before photographing the machine, it is usually prepared by painting to avoid excessive retouching and to get a smooth effect in the engraving. The paint used by most photographers is made of lampblack and gasoline. The objection to this is that it is very quick-drying and requires care to apply it without getting a streaky effect. The lampblack must then be scraped off before finish-painting the machine for shipment. The National-Acme Mfg. Co. prepares the machines by wiping off all oil and grease, and then applying an oil paint that is a flat but not a dead black. (See Fig. 6.) This paint dries smoothly and with just enough luster to give the image a little snap. A picture of the machine prepared for photographing in this way will reproduce much better than one treated with the lampblack coating. The oil paint will not rub off, and a finishing coat of gloss paint, applied after photographing, makes the machine ready for shipment.

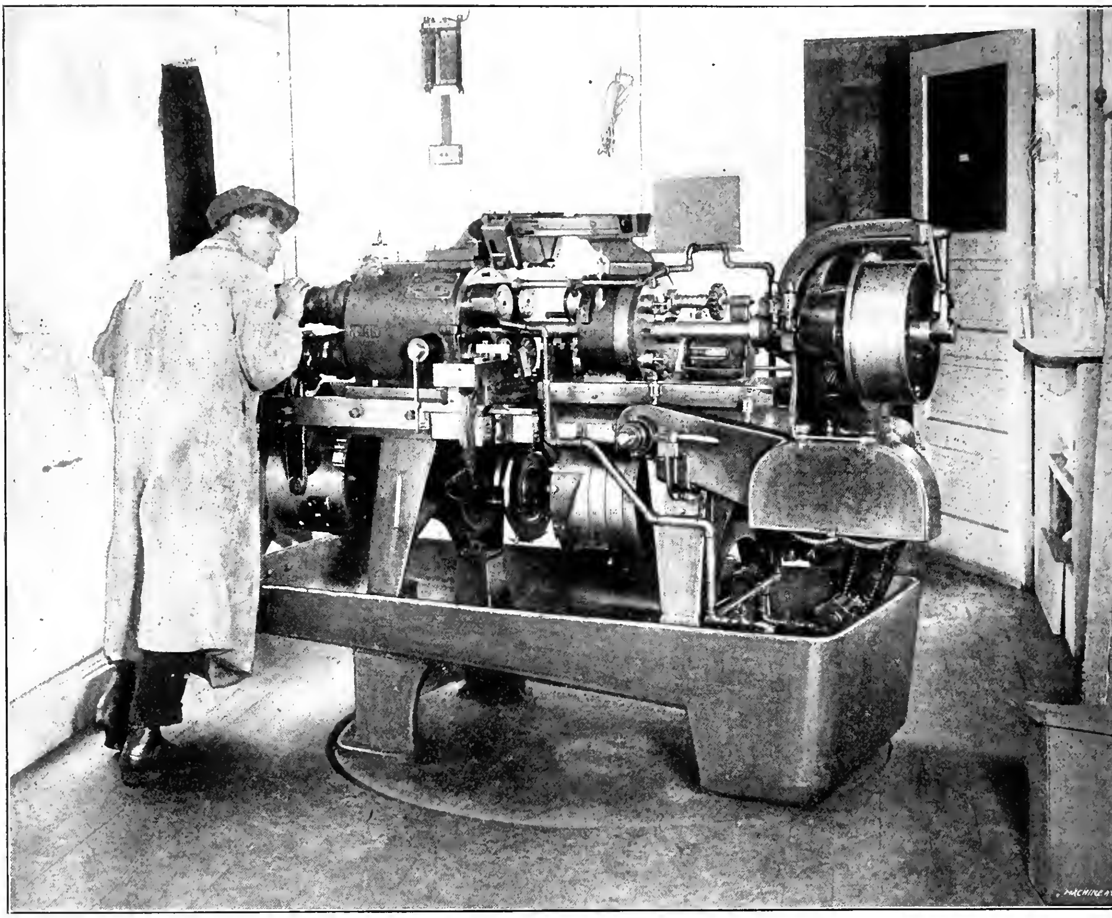


Fig. 5. Acme Screw Machine being posed on Turntable for photographing

A large part of the work of the photograph department consists of making pictures of screws and small parts which are the product of the machines. It has been found desirable to photograph these groups of parts in a horizontal position to avoid the trouble of nailing or wiring them to a board. Such photographs are taken with what is called the "skyscraper" camera, which is shown in Fig. 4, and this method is particularly advantageous when the parts are being photographed for reproduction, as no time is lost in working out the nails or wires from the print. The skyscraper camera, as arranged to take objects at an angle or straight down, is bolted to the top of the stand, and as one end is hinged it is

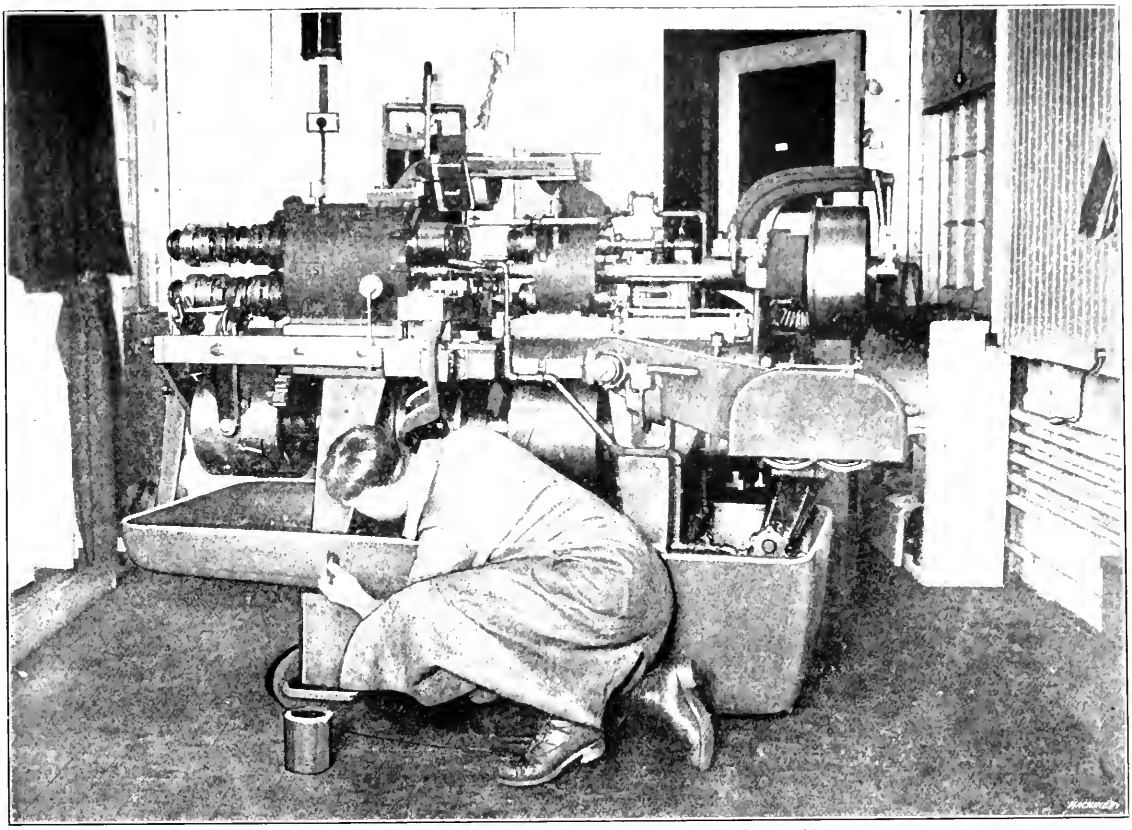


Fig. 6. Painting a Machine with a Flat Oil Paint before photographing

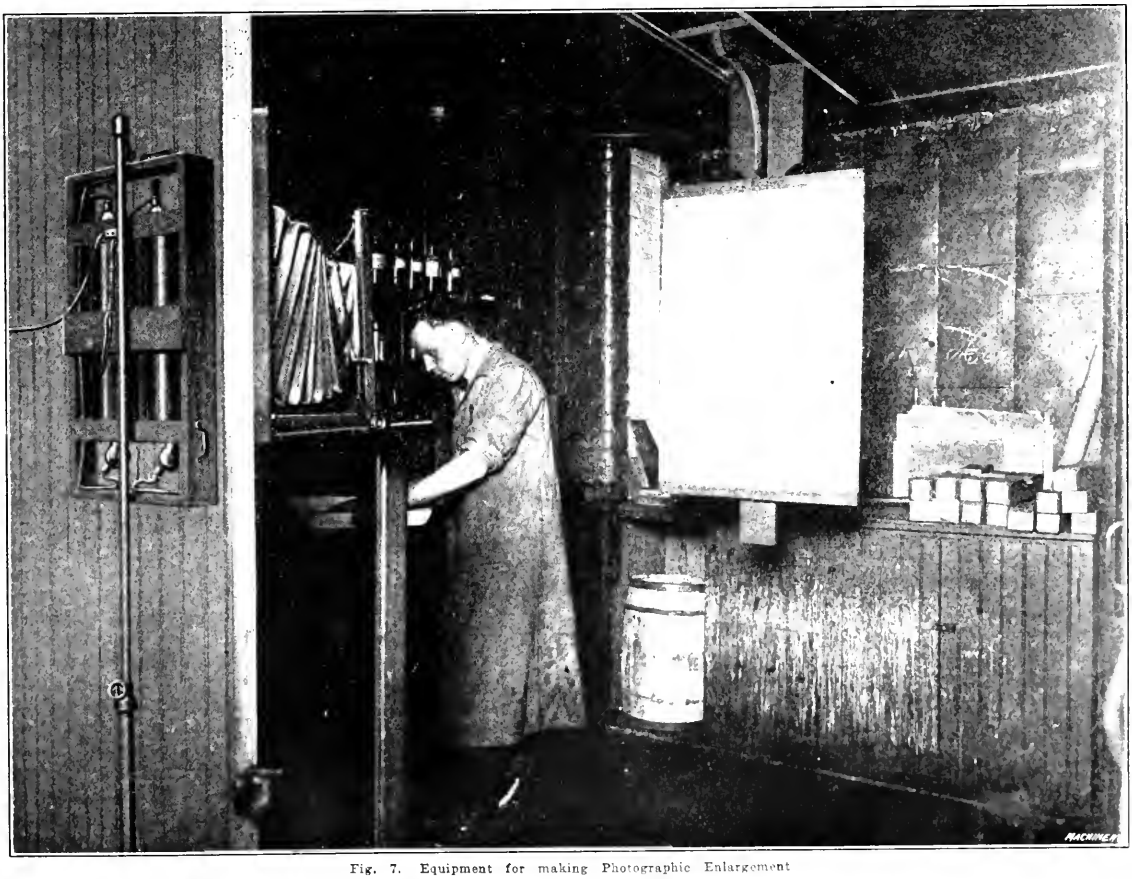


Fig. 7. Equipment for making Photographic Enlargement

possible to tilt the camera to any desired angle. The top is held in position by means of braces which are clearly shown in Fig. 4. In photographing screws or small parts when it is desirable to have the pieces cast a shadow for a natural effect, the group is laid on a sheet of clean white paper and the lighting arranged to strike the group at an angle of 45 degrees. When a pure white surface is desired, to show that the pieces are accurate, a piece of glass is used upon which the pieces are placed as is shown in Fig. 4. The objection that photographers have to using glass for this purpose is that it is impossible to hold the pieces in the position desired. This can be overcome by the use of small pieces of putty, which are placed under the parts to hold them firmly in position. This putty is prepared by heating beeswax and mixing it with vaseline, two parts of wax being mixed with one part of vaseline.

The National-Acme Mfg. Co. uses quite a good many enlargements. These are made in a dark room by means of a Cooper-Hewitt light and the regular 8 by 10 Century camera. One of the walls in the dark room has an opening about twenty inches square, through which the light enters. (See Fig. 7.) Over this opening, inside the dark room, a frame is built in which the plate to be enlarged is held. The Century camera, with the ground glass carrier detached, is fastened to this frame in front of the plate. Then the Cooper-Hewitt light is placed outside and close to the opening in the dark room wall and the light is thrown through the plate and lens onto a board. This board is fastened to a sliding frame suspended from the track in the ceiling. The overhead track runs the full length of the room, and the board can be adjusted toward or from the camera, according to the degree of enlargement required. (Fig. 7 shows this arrangement clearly.) Of course, the farther the board is from the camera the larger the image.

For developing plates, different kinds of developers are used to get different effects—usually metol-pyro for soft effects and hydroquinone for contrasting effects. The standard formulas published by plate and paper makers are used in this department because they have been found to give the best results claimed from the use of the different plates and papers. For most purposes metol-pyro is found to be a very good universal developer, as it produces soft effects and good transparent blacks. Wooden trays, about three feet by four feet, lined with oilcloth, are used for developing the enlargements. Separate rooms are provided in the advertising department for developing and printing from the negatives taken in the studio in the factory bridge. An unusually complete filing system is intact for both negatives and record prints for reference.

* * *

What is to be done with the fresh-air crank in the drafting-room and the equally absurd creature who is afraid of death if a whiff of fresh air touches him? Many disagreeable scenes are enacted in offices and other quarters where men and women work. Some are constitutionally unable to work unless the air is cool and fresh while others thrive best, in their own opinions at least, with all windows closed in winter and the temperature at 75 degrees F. The remedy is to provide in modern structures a heating and ventilating system that insures an equable temperature and air condition in all parts of an office or work room without requiring local ventilation by windows, doors or registers. Then control is removed from individuals who must perforce be contented with the conditions, or get out.

* * *

Up to the present some $7,000,000 has been earned by the United States Patent Office by fees, and turned into the treasury of the United States. The present fees provide more than enough income to pay for the cost of examining patent cases. Nevertheless, a bill has been introduced into Congress proposing an increase in the fees for patent applications from $15 to $20. We see no good reason for this increase as long as the letters patent remains merely a license to sue for infringement. The aspect would be different, of course, if the government undertook to protect an inventor directly in his patent rights after a patent had once been granted to him.

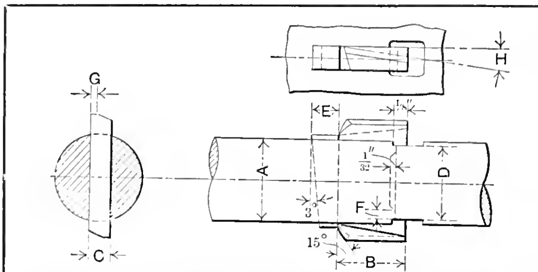
FLAT CUTTERS FOR BORING HEADS

BY FRANK H. MAYOH*

Although boring bars with inserted double-edge flat cutters are in general use, few attempts have been made to standardize the dimensions, shapes and angles. The accompanying table gives the dimensions of flat cutters for boring bars that have given satisfaction in use. While the range of 3/8 inch to 2 1/2 inches diameter of bar is perhaps wider in the direction of the smaller sizes than will be generally required, the extent of the table will be helpful in plotting larger sizes than 2 1/8 inches, if required.

The cutter is of the dependable type, fixed in a slot and secured by a wedge, and has ledges that overhang the sides of the bar at one end of the slot. The ledges locate the cutter centrally and prevent change of position. If cutters for bars of intermediate diameters are wanted, use the cutter dimensions of the bar for the next larger diameter. For example, the dimensions of the cutter and parts required for a bar

FLAT CUTTERS FOR BORING BARS



A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
3/8	7/16	3/32	11/32	1/8	1/16	1/32	5°	2 1/4	1 1/2	7/16	2 3/16	5/16	1/4	1/16	8°
1/2	5/8	1/8	15/32	1/8	1/16	1/32	5°	2 3/8	1 1/2	1/2	2 5/16	5/16	1/4	1/16	10°
5/8	5/8	5/32	19/32	5/32	1/8	1/32	6°	2 1/2	1 1/2	1/2	2 7/16	5/16	5/16	3/32	10°
3/4	3/4	3/16	11/16	5/32	1/8	1/32	7°	2 5/8	1 1/2	1/2	2 9/16	5/16	5/16	3/32	10°
7/8	13/16	7/32	13/16	1/4	1/8	1/32	7°	2 3/4	1 1/2	1/2	2 11/16	5/16	5/16	3/32	10°
1	7/8	1/4	15/16	1/4	5/32	1/32	8°	2 7/8	1 1/2	1/2	2 13/16	5/16	5/16	3/32	10°
1 1/8	1	5/16	1 1/16	1/4	5/32	1/32	9°	3	1 1/2	1/2	2 15/16	7/16	3/8	1/8	10°
1 1/4	1 3/16	5/16	1 3/16	1/4	5/32	3/64	7°	3 1/8	1 11/16	5/8	3 1/32	7/16	3/8	1/8	10°
1 3/8	1 3/16	5/16	1 5/16	1/4	5/32	3/64	7°	3 1/4	1 11/16	5/8	3 5/32	7/16	1/2	1/8	10°
1 1/2	1 1/4	5/16	1 7/16	1/4	3/16	3/64	7°	3 1/2	1 11/16	5/8	3 13/32	7/16	1/2	1/8	10°
1 5/8	1 1/4	5/16	1 9/16	1/4	3/16	3/64	7°	3 3/4	1 11/16	5/8	3 21/32	7/16	1/2	1/8	10°
1 3/4	1 1/2	3/8	1 11/16	5/16	3/16	3/64	7°	4	2	3/4	3 29/32	1/2	1/2	1/8	10°
1 7/8	1 1/2	3/8	1 13/16	5/16	3/16	3/64	7°	4 1/2	2	3/4	4 3/8	1/2	1/2	1/8	10°
2	1 1/2	7/16	1 15/16	5/16	1/4	1/16	8°	5	2	3/4	4 7/8	5/8	1/2	1/8	10°
2 1/8	1 1/2	7/16	2 1/16	5/16	1/4	1/16	8°	..	...	..	..	..	..	..	...

Machinery

Intermediate sizes made like nearest size above.

1 15/16 inch diameter should be made the same as the dimensions given for a 2-inch bar.

The table includes the desirable rake angles for the sides of the cutter, the angle of inclination of the cutter lips from the vertical, the width of land and other data on cutter characteristics not generally available. The cutting angles recommended apply to cast iron and mild steel.

* * *

PEAT POWDER AS A LOCOMOTIVE FUEL

Peat powder has been successfully applied as a locomotive fuel on one of the private railroads in Sweden. About 1 1/2 ton of peat powder is equivalent in steam rising value to one ton of coal. Peat powder is used with a mixture of about 5 per cent of coal. The powder is fed into the furnace by an automatic stoker. No change need be made in the boiler and in the fire-box, except for the mounting and application of the automatic stoker. An incidental advantage of the use of the peat powder is that no cold air can get into the fire-box and no smoke or sparks escape from the smokestack. As Sweden is very rich in peat bogs and has practically no coal deposits the success of the apparatus, which has been worked upon for years by eminent engineers, is of considerable importance. It has been estimated that the cost of peat powder would be only about one-half that of coal.

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MACHINE FORGING—5*

DIES AND METHODS EMPLOYED IN THE FORMING, WELDING AND UPSETTING OF MACHINE AND ENGINE PARTS

BY DOUGLAS T. HAMILTON†

The production of the Ford front axle by forging machine methods is an excellent example of the general adaptability of the upsetting and forging machine to the manufacture of miscellaneous parts from carbon and alloy steels. When used in conjunction with a steam hammer or bulldozer, there is practically no limit to the range of work which can be successfully handled. One of the most recent developments in forging-machine methods which should be of unusual interest to many manufacturers is the application of forging machines to the welding of machine and engine parts. This in many cases permits the utilization of scrap metal, thus converting practically valueless material into expensive machine parts. Some interesting forging operations employed in the production of the Ford front axle and other parts, will be described in the following.

Forging the Ford Front Axle

In Fig. 59 is shown a series of interesting operations performed in the 3½-inch "National" forging machine shown in Fig. 60, the work being the front axle for the Ford automobile. In its preliminary stages of production this front axle is made from a vanadium steel bar 1⅝ inch in diameter by 67¾ inches long, as shown at *a* in Fig. 59. The first forging operation consists in forming the two bulges *a* and *b*. Both ends of the bar are formed in this manner, but in separate heats. This operation, which is also indicated at *B* in Fig. 61, shortens up the ends of the bar from a length of 16⅛ inches to 13½ inches, which means that 2⅝ inches of stock is put into the bulges. The forging machine dies for performing this operation are shown in Fig. 62, the bulging being accomplished in the top members. In order to form both bulges at once it is necessary to have the top members of these dies constructed in such a manner that the blocks carrying the impressions are free to slide forward when acted upon by the plunger held in the ram of the machine.

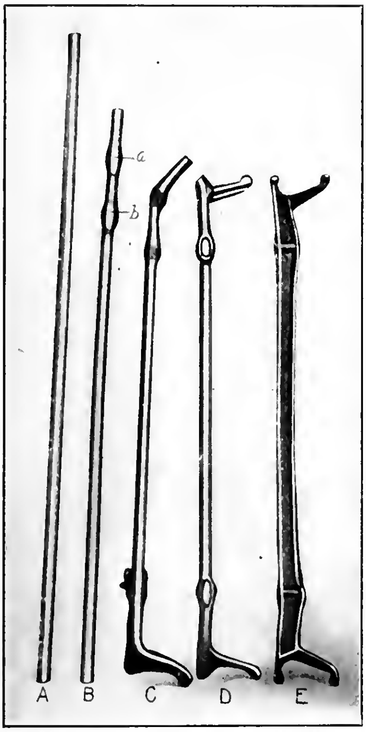

Fig. 59. Sequence of Forging Operations on the Ford Front Axle

As will be seen by referring to this illustration, one-half of the larger bulge is carried in the block *A*, while the other half of the impression is carried in the sliding block *B*. In the opposite end of the sliding block *B* is provided one-half the impression for the smaller bulge, the other half being formed in the sliding block *C*. These sliding blocks *B* and *C* are held by tongue plates *D* to the main body of the top forging die in which they are free to slide, being held in their outward positions by coil springs *E* and *F*. Coil spring *E* is carried on a stud held in sliding block *B*, while coil spring *F* is carried on a stud screwed into block *B* and fitting in a clearance hole in the sliding block *C*. The stock, when heated to the correct temperature, is located in the proper position

Fig. 60. "National" 3½-inch Forging Machine used in accomplishing the Preliminary Operations on the Ford Front Axle

in the dies by the block *G*, which is fastened by cap-screws to the block *C*, and covers the hole in the dies as indicated in the end view. The block *C* is located in its proper "out" position by means of the adjusting screw *H*, which is held in the block *I*, fastened to the top member of the forging die.

In operation, the stock which has been heated for a distance of about 18 or 20 inches is placed in the impressions in the upper members of the stationary gripping dies. The machine is then operated; the gripping dies hold the work rigidly, while plunger *K* advances and forces sliding block *C* forward until it contacts with block *B*. The forward movement of the ram continues until block *B* is forced up against block *A*, when the ram recedes, the dies open, and the forging is removed. It is evident that as the work is held rigidly between the opposing faces of the gripping dies, the advance of these sliding members can only accomplish one result, which is to upset the excess metal allowed and expand it into the impressions provided in the dies, thus forming the bulges.

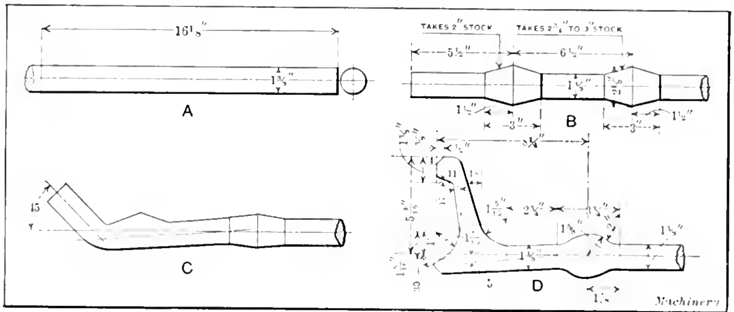

Fig. 61. Sequence of Operations on Ford Front Axle accomplished in "National" 3½-inch Forging Machine

The next operation on the front axle, which is indicated on the top of the axle at *C* in Fig. 59, and also at *C* in Fig. 61, consists in bending the end around in order to locate the material in the required position for forming the knuckles of

* The fourth installment of this series appeared in the July issue.
†Associate Editor of MACHINERY.

the axle. This operation is handled in the dies shown in Fig. 62, that member which accomplishes the work being formed on the top face of the top members of the dies. The bar, which is still in its initial heat, is laid on top of the dies and in contact with the stop gage *L*. The machine is then operated, and as the dies close, the impressions formed on the projection of the top die twist the end of the bar around and form it to the desired shape, offsetting it to an angle of 45 degrees in one direction and 5 degrees in the other.

The bar in this condition is now placed in the furnace and again heated to the proper temperature. Then it is brought to the forging machine and placed in the lower impression in the gripping die shown in Fig. 62. The forging machine is then operated, and as plunger *M* advances, it upsets and forces the work into the impressions in the lower gripping dies *N*, forming the front axle to the shape shown at *D* in Figs. 59 and 61. This completes the operations on the front axle which are handled in the forging machine. After one end of the bars has been formed to the desired shape, the other end of the bars is heated and passed through the operations previously described. Before the front axles are passed on to the final drop-forging operations, the burrs and fins formed in the forging machine dies are removed.

The final forming of the front axles is accomplished under a steam hammer of the type shown in Fig. 63, the dies illustrated in Fig. 64 being used. As was mentioned in regard to the forging machine operations on this axle, only one end is completed at a time; this will be seen by referring to the dies shown in Fig. 64. The axle is heated for a little over one-half its length and is placed on the lower die in the steam hammer. The operator is careful to locate the end of the bar so that the stock to form the knuckles is in the proper position in relation to the impression in the die before the first blow is struck; then ten successive blows are struck and the axle is removed and taken to a punch press holding a shearing die which removes the fins. The axle is then brought back to the steam hammer, given a final blow and laid down to cool off in the sand.

After one end of a batch of front axles has been finished in this manner, the other end is heated and carried through the operations described. The axles are again taken to the furnaces, heated and placed in a fixture held in a punch press, where they are stretched to the exact length—52½ inches. The manner in which work of a similar character—drop-forging of crankshafts—was handled under the steam hammer was illustrated and described in an article entitled "Shop Practice of the Willys-Overland Plant," published in the March, 1913, number of MACHINERY.

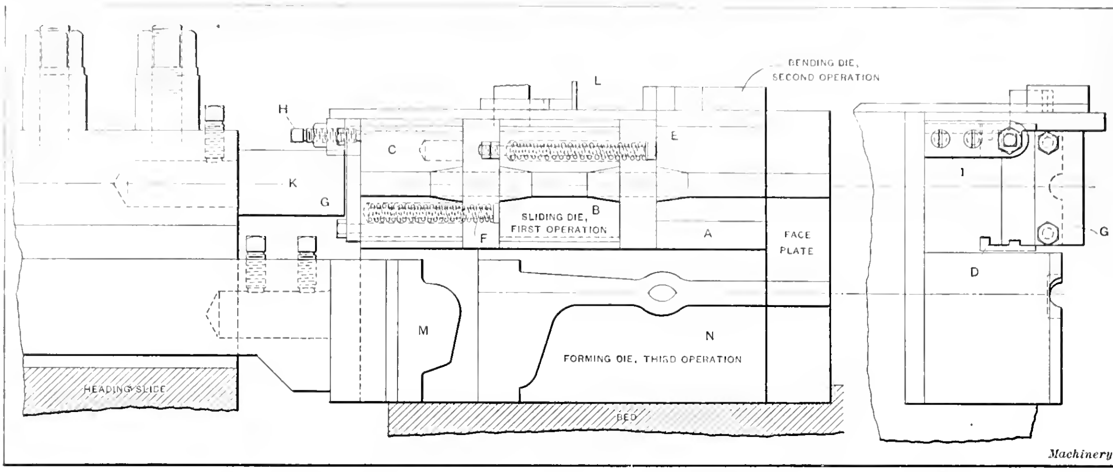

Fig. 62. Construction of Dies and Tools used in the "National" Forging Machine for making Ford Front Axle

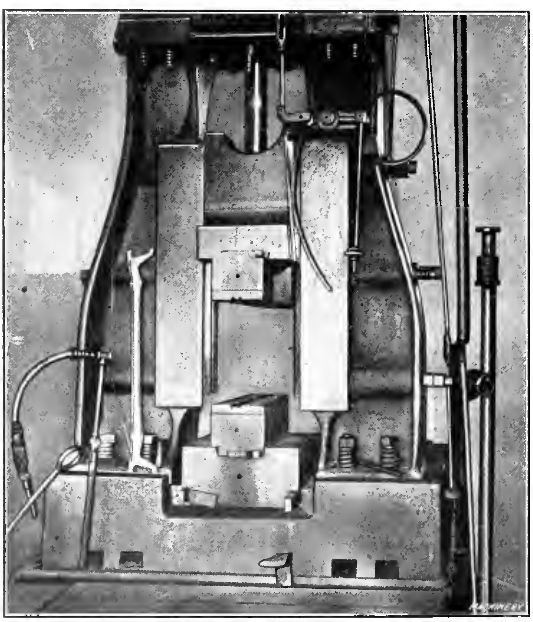

Fig. 63. "Massillon" Steam Hammer used for bringing the Ford Front Axle to Final Shape

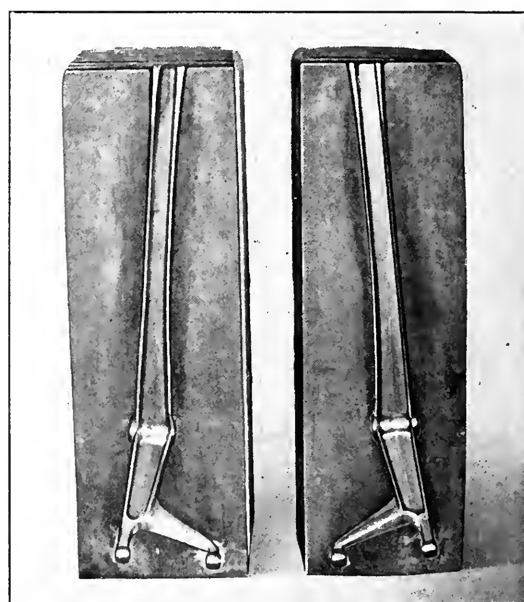

Fig. 64. Upper and Lower Dies used in Steam Hammer shown in Fig. 63 for finish-forming the Ford Front Axle

Methods used in Welding Parts in the Forging Machine

There are three methods in general use for welding or joining pieces together in a forging machine, the one employed depending largely on the shape of the work and other requirements. The most common method in general use is lap-welding, of which there are several applications. The next method of importance is pin-welding, butt-welding

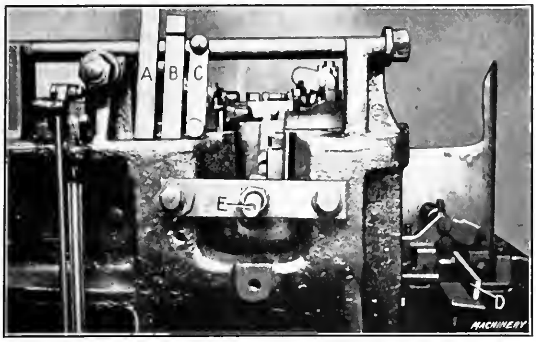

Fig. 65. Making Draw-bar Hangers in a 3-inch Ajax Forging Machine

as a rule being used only where it is impracticable to handle the work in any other way. An example will be given in a future article, however, of this class of welding, which is accomplished in an interesting and satisfactory manner.

In regard to the materials that can be handled, wrought iron can be very readily welded in the forging machine, and when proper care is taken this can be successfully done without resorting to the use of fluxes except in unusual cases. Machine steel does not weld as readily as wrought iron, and usually it is advisable to use a welding compound on the faces of the parts it is intended to join. The following ingredients make a satisfactory flux for steel welds: To one part of salammoniac add twelve parts of crushed borax. Heat slowly in an iron pot until the mixture starts to boil, then remove and reduce to a powder. Then apply the powder to the welding faces of the work shortly before removing from the furnace, putting the work back in the furnace for a short period after applying the flux. Alloy steels, while they can be worked successfully in a forging machine, cannot be welded, especially when great strength of parts is desired. As a rule, parts made from alloy steels can only be worked into shape by upsetting and forming.

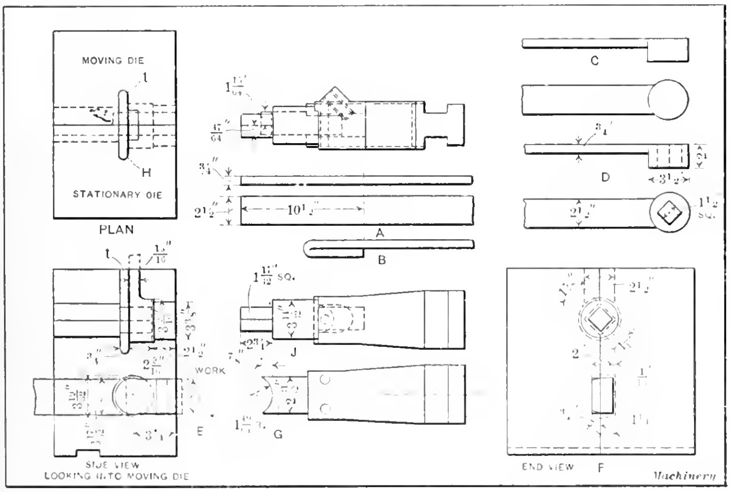

Fig. 66. Dies and Tools used in making a Locomotive Ash-pan Handle

Lap-welding and Forming Operations

A simple example of lap-welding in conjunction with a forming operation is shown in Fig. 65 where the various steps in the production of this part—known as a draw-bar hanger—are illustrated at *A*, *B* and *C*, respectively. The first operation consists in cutting a $2\frac{1}{4}$ by $\frac{3}{4}$-inch bar of wrought iron to a length of $19\frac{3}{4}$ inches—this allowing a sufficient amount of excess material to form the two bosses, one on each end. The bar is then heated in the furnace and placed in the side shear of the machine as shown at *D*. The forging machine is now operated and the tools held on the side shear arrangement partly cut off the bar and bend the nicked end around about one-quarter turn. It is then removed from the machine, placed on an anvil, and the bent end lapped over as shown at *B*, after which it is again put in the furnace and heated to the proper temperature; it is then removed and placed in the lower impressions in the gripping dies, being properly located for length by the back stop *E*. The machine is then operated, completing the weld and forming the upset square boss on one end of the bar in one blow. After performing the operations described on all of the bars, the other end is handled in practically the same manner, using the upper

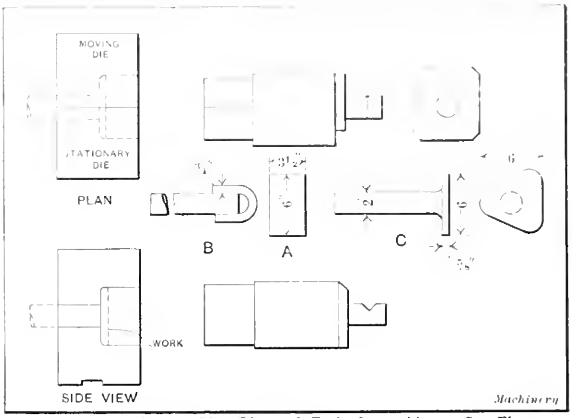

Fig. 67. Forging Machine Dies and Tools for making a Car Float Stanchion Foot

impressions in the gripping dies and subjecting the bar to three heats instead of two.

Dies and Tools for making Locomotive Ash-pan Handle

Fig. 66 shows a steam locomotive part known as an ash-pan handle that is produced in a similar manner to the draw-bar hanger shown in Fig. 65, the operations on this piece being indicated at *A*, *B*, *C* and *D*, respectively. The first operation is to cut off a bar *A* of the required length, as before mentioned, and bend one end over into the shape shown at *B*, putting it into the required condition for welding, forming and piercing in the forging machine. The welding and forming operations which are indicated at *C* are handled in the lower impression of the dies shown to the left of the illustration, the position of the work before forming being indicated by the heavy dotted lines *E*. The lower impression is formed as shown in the end view of the dies at *F*, being provided with a draft in the impression of 1/16 inch on the diameter in order to facilitate the "flow" of the metal and the removal of the forging from the dies. The punch *G* is made with a concave end which forms a portion of the boss and upsets the material into the desired shape at the same time.

After being welded and formed, the work is removed from the lower impressions and placed in a vertical position in the upper impressions in the dies. Here the square hole, as indicated at *D*, is punched. As the gripping dies are made from steel castings, they would not stand up satisfactorily for a piercing operation, so in order to punch a clean hole two steel plates *H* and *I* are inserted in the movable and stationary members of the dies. These are so shaped that a square hole is formed when the dies come together. The hole is pierced by the punch *J*, the construction of which is clearly shown in the illustration. Both punches *G* and *J* are made from steel forgings and hardened.

Dies and Tools for making Car Float Stanchion Foot

Another interesting example of lap-welding which is used for the purpose of enlarging a 2-inch bar to 6 inches in diameter to form the head on a car float stanchion foot is illustrated in Fig. 67. This car part in the initial stages of manufacture as indicated at *A* and *B* is made from a wrought-iron bar 2 inches in diameter, to which a rectangular block *A* 6 by 3½ by ¾ inch is welded. The block *A* is first cut to the required length, and bent into a U-shape in the bulldozer. Then it is placed on the round bar as indicated at *B*, and the two parts are put in the furnace, where they are heated to a welding temperature. The parts are now quickly removed, given a tap to stick them together, placed in the forging machine, and with one blow are formed to the shape shown at *C*. The dies and tools used for this operation, which are also shown in the illustration, are of simple construction, consisting only of two gripping dies and one plunger.

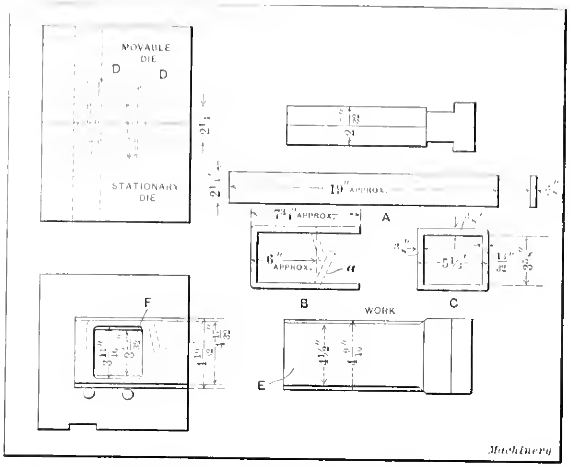

Fig. 68. Forging Machine Dies and Tools for making Locomotive Spring Bands

Dies and Tools for making Locomotive Spring Bands

A lap-welding operation which is handled in a different manner from those previously described is shown in Fig. 68. This piece, which is a spring band for a steam locomotive, is made from a rectangular wrought iron bar 2¼ by ⅜ inch by approximately 19 inches long. It is first bent into a U-shape as indicated by the full lines at *B* in a bulldozer. This part, after being bent in the bulldozer, is again put in the furnace and heated to the proper temperature. It is then removed from the furnace, and by means of bending dies held in the side shear of the forging machine, the ends are bent into the shape shown by the dotted lines *a*—partly overlapping each other. After this operation, the piece is again placed in the furnace, heated to a welding temperature, and quickly removed and placed between the gripping dies shown to the left in Fig. 68. The stationary gripping die, as illustrated, carries two pins *D*, which serve as a means for supporting the work before the dies close on it. The welding and forming operation is accomplished by the plunger *E*, which forms the work around the square impressions *F* in the dies, and at the same time welds the two ends together, forming the spring band into one piece. A particularly interesting feature about this job is the fact that the excess amount of stock formed by the overlapped ends is distributed equally along the front side of the forging, making it 1/32 inch thicker than the original rectangular bar, and thereby increasing its strength at this point.

Dies and Tools for making Extension Handle for Grate Shaking Lever

An interesting example of lap-welding is illustrated in Fig. 69, where the dies and tools used for forming an extension handle for a grate shaking lever are illustrated. This part, as shown at *A* and *B*, is made from two pieces—a rectangular bar of wrought iron 2½ by ¼ inch, which has been sheared to an angular shape on one end—and a loop *B* formed from a piece of ⅝-inch rectangular bar iron bent into a U-shape in the dies illustrated to the left. The trimming of the piece *A* and the bending of the piece *B* is carried on at the same time with special shaped formers held to the top faces of the gripping dies. To do this the operator first places a piece of rectangular stock of the required length in the impressions in the rear member *D* of the stationary gripping die; he then takes the bar *A*, which has been previously cut to the required length, and places it in the impression at the front end of the gripping die. Upon operating the machine, the moving die advances and as it carries a plunger *E* it forces the bar *B* into the suitably shaped impression in the stationary gripping die. At the same time that this operation is being accomplished the shearing plates *F* and *G* carried in the stationary and movable gripping dies, respectively, shear off the end of the bar *A*.

The welding of these two parts is accomplished in the lower impression in the gripping dies which hold the pieces in position while the punch *H* advances and upsets and welds the parts together. The manner in which this operation is accomplished is as follows: The two pieces are placed together and put in the furnace, heated to a welding temperature, then removed and given a tap, so that they are stuck together. They are then put in the lower impression of the gripping dies and the machine operated. Then as the plunger *H* advances it enters the loop in the part *B* expanding it into

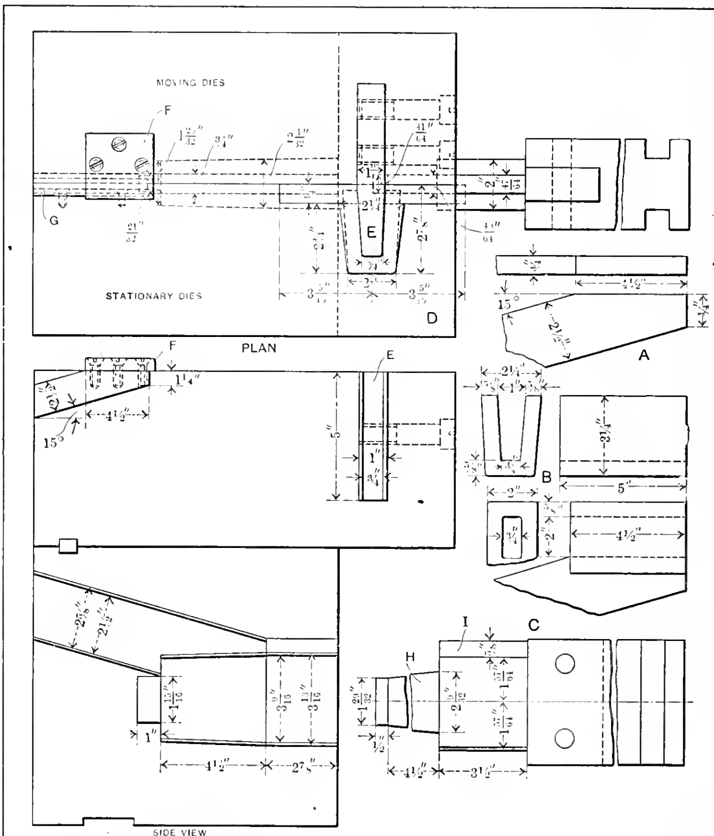

Fig. 69. Forging Machine Dies and Tools for making Extension Handles for Grate Shaking Levers

the impressions in the gripping dies, and at the same time by means of the shoulder on the punch carrying forward the excess stock and distributing it equally throughout the forging, thus joining the two parts and producing a perfectly welded joint. The punch *H* is guided when in operation on the work by a tongue *I*, which slides in a corresponding groove in the gripping dies, and thus prevents any side movement of the punch.

* * *

DON'TS FOR DRAFTSMEN*

BY MAURICE W. FOX†

Don't buy opaque triangles or curves.

Don't try to economize by buying thin tracing paper.

Don't work in an office where you are learning nothing.

Don't use a knife on tracing cloth except for a rough job.

Don't tap into a heavy casting when you can use a through bolt.

Don't draw outlines before you have laid out the center lines.

Don't waste money on cheap drawing instruments—they soon wear out.

Don't use irregular curves when arcs and straight lines will answer.

Don't always ask your neighbor to sharpen your pens—learn how yourself.

Don't design long, light parts that may be broken in shipment or handling.

Don't connect a straight line to a curve except at the point of tangency.

Don't use too hard a pencil—the tracer will have trouble finding the lines.

Don't expose heavy castings to friction—use renewable pieces to take the wear.

Don't use first-angle projection—third-angle projection is now almost universal.

Don't buy a T-square that is not equipped with an adjustable head and transparent edges.

Don't work in an office where you consider yourself superior in ability to the men over you.

Don't buy an irregular curve that does not have a fairly long portion that is almost straight.

Don't put light projections on heavy castings where they are likely to be broken off by accident.

Don't get sore because somebody offers a criticism, or destroy his friendship by an impatient remark.

Don't get mad when asked to make changes—very few drawings are approved in their original form.

Don't make anything elliptical when two halves of circles connected by straight lines will do as well.

Don't think that the concern has employed all the fools or all the experts there are in the business.

Don't detail a lot of special stuff when standard goods can be ordered as well out of a supply catalogue.

Don't make the small gears stronger than the large ones—it is cheaper to replace small ones if they break.

Don't forget elementary principles—they hold good in the greatest structures and most complex machinery.

Don't forget, if you roll up a tracing, it will have an annoying curl in it when you want to lay it out flat again.

Don't draw castings too large or complicated to be easily made or handled—consider dividing the piece and using bolts.

Don't think the chief draftsman incompetent because he does not possess the combined knowledge of all the men under him.

Don't forget that light sections will rust through faster, and cost more to paint, per unit of weight, than heavy sections.

Don't forget that the present tendency is to use nothing but capitals—also to cross-hatch all materials with simple parallel lines.

Don't bear on too hard, or rub too vigorously, or use a sandy eraser in removing ink—with due care the original surface of the cloth can be restored.

* For Don'ts previously published in MACHINERY, see "Don'ts for Drill Grinders," July, 1913, and "Don'ts" there referred to.
† Address: Culebra, Canal Zone, Panama.

Don't think you are an expert just because you once worked for some famous firm—every concern employs men of varying abilities.

Don't tell every newcomer what a dub you are working for—he cannot do his best work without confidence in his employer.

Don't think the professors in your college are the greatest engineers on earth, nor that their books are standards in every nation.

Don't forget that tracing paper is more easily torn and split than tracing cloth, but is cheaper, and lines are more easily erased from it.

Don't think a man is wholly useless because some other man is knocking him—reserve your opinion till you know both sides of the case.

Don't try to design complicated or highly standardized machinery unless you have had wide experience which fully equips you for the task.

Don't try to draw with the point of your ruling pen too close to the triangle—hold the pen vertical, or inclined in the direction of the line you are drawing.

Don't forget you can convert a "right hand" into a "left hand" by tracing the design and the lettering on opposite sides of the cloth or tracing paper.

Don't think that this or that expert produces nothing but perfect designs—check his work with what data you have and don't be afraid to look for improvements.

Don't think you have to have a row with the boss before you resign—leave every job with the good will of the concern and the chance to come back if you wish.

Don't think you are a "draftsman de luxe" because you have a lot of useless drawing instruments and curves or a stack of text-books that you never get time to read.

Don't think that every good designer came from your "neck of the woods"—able men have originated in every part of this country and in every foreign country as well.

Don't forget that nominal diameters and actual diameters of wrought iron pipe are entirely different, and that the actual dimensions can easily be found in catalogues and handbooks.

Don't start extensive erasing on a tracing without considering the method of making a negative and painting out a part with India ink—new lines can be drawn on the positive which is made from the negative.

* * *

POWER FROM DAM BUILT FOR IRRIGATION

The great Assuan Dam in Egypt was begun in 1898 and was completed, as originally planned, in 1902. It was built to impound the waters of the Nile and make them available for irrigation. The original dam impounded 980,000,000 cubic meters. The benefits of the extensive irrigation water supply made available by the dam were so great that in 1905 the government authorities decided to increase the storage capacity by making the dam higher and thicker, thus increasing the storage capacity to 2,500,000,000 cubic meters. The thickening and heightening of the dam was begun in 1907 and was completed in 1912. Plans are now being made for the utilization of power from the waste water flowing through the sluices. This power will be used in part for producing nitrates for fertilizer and will thus additionally contribute in restoring the fertility of the arid fields of ancient Egypt.

* * *

SPEED OF EARLY RAILWAY TRAINS

A locomotive steam engine, constructed by Davis and Garther, of York, Pa., commenced her operation on the Baltimore & Ohio Railroad under the most favorable auspices on Tuesday. It started from the Pratt street depot for Ellicott's Mills, with the entire train destined for that place, consisting of 14 loaded cars, carrying, together with the engine tender, a gross weight of 50 tons. The whole went off in fine style and was soon out of sight. A gentleman present says it was out of sight of the depot in about six minutes, and the rapid gliding of the immense train was one of the most imposing and most beautiful spectacles he ever witnessed.—*Extract from the National Gazette, published in the American Railroad Journal of July 28, 1832.*

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GRINDING FORMED CUTTERS

Joseph Brown's invention of the formed milling cutter, which can be ground without changing its shape, was a great advance in milling machine practice, and it is safe to state that the milling machine as a factor in interchangeable manufacture would never have become as important as it now is if all formed cutters were to lose their original shape when sharpened. The cost of maintaining cutters would be prohibitive for many classes of work on which they are freely used. The most important of the formed milling cutters are those used for cutting gears, and it is very essential that the original shape be maintained throughout their working life, because slight deviations from the original shape that would pass unnoticed with other formed cutters become very apparent in cut gears. Inaccurate tooth shapes and lack of concentricity of the pitch circle with the mounting shaft are the two chief causes of unsatisfactory action of gears cut with the common gear cutter.

To grind a gear cutter so as to preserve the original shape is not an easy matter unless better means are provided than are found in most machine shops. In the first place the cutting face must be ground truly radial; a pitching of the face ahead or back of the radial line changes the projected shape, and as it is that which defines the outline of the cut, the result, of course, is a departure from the established tooth shape. To grind radial faces with a cutter grinder is comparatively easy, and if this were the only requirement to produce perfect working cutters the problem were easily solved, but the heights of the teeth must be equal. This, too, could be readily accomplished by using an indexing fixture if the cutters were truly round and evenly spaced. These conditions are seldom realized, however. Changes of shape in hardening throw the teeth out of even spacing, and if ground on an accurate indexing fixture some of the teeth will be so short that only a few do the cutting. The result is rough work and heating of the cutter which reduces the quality and quantity of gears cut.

A cutter grinder recently put on the market employs a new principle of indexing—new in the sense that it is unknown to most mechanics. The teeth are indexed by a finger resting on the *back* of the formed part, an indicator being provided which enables the operator to gage the position of each tooth with reference to its own shape as well as to the axis of the cutter, within a thousandth inch or less. Each tooth face is ground truly radial and all the teeth are ground to the same height.

In the operation of this machine, the curious fact has developed that few machinists or toolmakers apparently understand the machine, although it is simple, because they have never taken the trouble to study the fundamental principles of efficient formed cutter action. This condition is hardly creditable to American mechanics, who pride themselves generally on being quick to grasp machine principles and apply them.

* * *

IMPROVED MACHINERY AND THE WORKMAN

The boilermakers' union in England is engaged at the present time in a campaign opposing the use of the oxy-acetylene blow-pipe for cutting boiler and ship plates. The union has passed resolutions limiting the number of machines used in proportion to the number of men employed, and forbidding the use of the machines when working over-time. Fortunately, the opposition to improved methods and machinery on the part of the men that are to use them is not as frequently met with in this country as in England; but there are enough instances on record to justify a word on the subject.

The idea that the introduction of machines for performing work which has previously been carried out by manual labor is detrimental to the best interests of the worker at a trade, is deeply rooted in the minds of a great many people. They apparently believe that there is just so much work to be done in the world at any given time, and no more. This attitude of men who work mainly with their hands was in evidence at the time when the earliest types of machines were introduced. The weavers in England fought the introduction of the mechanical loom; the sewing machine was opposed by the tailors; the molding machine, by the foundry workers. Of course, examples can be cited where the introduction of machinery has temporarily thrown a number of men out of work, but in the long run the community in general and these men as well have benefited. Taking a familiar example, it is beyond question that thousands of men who could have been employed on the farms in the United States are now displaced by our modern agricultural machinery; but is it reasonable to expect that the average standard of living would be as high as it is if all the farm labor were performed in the manner of a century ago? Improved machinery makes it possible to produce more quickly and cheaper, and, hence, should be a benefit to all. If it can be shown that in spite of the improved machinery the products are not sold any cheaper to the ultimate consumer, then the system of distribution and some other economic problems yet unsolved are responsible. Improved machinery is not at fault.

* * *

FAILURES THAT BECOME SUCCESSES

The fact that a method or machine is unsuccessful is not necessarily a proof that the principles involved are wrong. A new material or a new process of manufacture may so change conditions that an unsuccessful device becomes commercially practicable. The aeroplane, for example, became a possibility only after the internal combustion engine had been highly developed. The wish to navigate the air has been a dominant impulse of man in all ages, but although numerous models had been made, all were doomed to failure because of the lack of a practicable motive power. With a modern gasoline engine, Darius Green's "experiment" might not have ended so disastrously.

A common fault of tubular magazine rifles was the danger of explosion of the cartridges in the magazine from the impact of the bullet point of one cartridge on the primer of the cartridge ahead of it. Numerous schemes had been devised to obviate the defect, but none were considered successful. Magazine tubes having an internal spiral or thread to throw the cartridges out of line, had been tried but found faulty when used with the old form of military cartridge having a rimmed head. But with the rimless cartridge, the scheme works successfully. Shaving dies operate badly on some materials—drill rod, for example; when pressure is applied steadily, the metal is torn and left rough, but when the impelling force is applied as a series of blows, smooth cutting action results. Hence, the use of the pneumatic hammer to perform a shaving operation on drill rod that was found to be impossible when the power was applied by a press.

Many of us are cursed with the knowledge of things that are not so. We believe that experience has demonstrated that certain processes are impossible, whereas they are simply impossible when all the conditions are as they were in the original experiment. Modify one or more of those conditions and the impossible may become not only possible, but practicable. The progressive man has to learn to profit by the experiences of others, but he must also be a doubter of the accuracy of some recorded work to the extent of being willing to repeat it under new conditions with faith that different results may be obtained.

* * *

CHATTER IN MACHINE TOOLS

Given ample driving power, the efficiency of a machine tool in cutting metal may be said to be inversely proportional to its lack of rigidity. Logically, this should be stated as directly proportional to rigidity; but as no mechanism has a rigidity of one hundred per cent—that is absolute rigidity—we cannot draw a comparison between present realization and the ideal. The ideal in rigidity does not exist, and no one knows what the conditions would be if absolute rigidity of tool and work support could be realized. We simply know that weakness of the tool support and driving train causes excessive chatter. The stiffer these are, the smoother the cut, but in the best designs the tendency to chatter is likely to develop with heavy cuts and high speeds.

The purpose of machine tools is to force cutting tools through metal. The machinery and tool supports are solely for holding the tool against the work and driving the tool or work so as to take a progressive cut. When that object is accomplished in accordance with the requirements of the case, the designer's work is done, except that convenience of attendance, appearance, etc., must also be considered. These, however, are minor in comparison to the prime essential—presenting the work and tool in opposition, with ample driving power and the maximum rigidity of support that can be attained.

But a great difference may exist between two machines of the same weight and driving power as regards rigidity and tendency to chatter. This difference is due to friction of bearings and proportions of parts, which brings us to a consideration of the laws of vibration. A lathe, for instance, may chatter excessively when turning a piece of a certain diameter and using a tool ground to a certain shape. A change of cutting angle, lowering or raising the tool, running with open belt instead of back-gears, or other changes of the several factors involved, may promote smooth cutting.

Here is an opportunity for profitable investigation to determine what are the conditions of weights, torsional strength, cutting angles, hardness, etc., that tend to cause excessive chatter, or better, what proportions and arrangement of driving parts tend to produce the least vibration. Taking the typical engine lathe as an example, mechanics know that the smoothest and most accurate turning work is produced when running with an open belt. Chatter marks are more likely to show when the back-gears are in action. The difference is commonly attributed to irregularity of gear tooth action, but is it not largely due to lack of torsional rigidity of the back-gear quill? Tests have demonstrated that placing the two back-gears close together causes a great difference in the stiffness of drive. This probably is only one of the weaknesses not commonly known that could be eliminated in the engine lathe or milling machine.

* * *

After the recent floods in Ohio had subsided, a well-known machine tool builder received a request to overhaul some boring mills of his make, installed in a rubber plant. The workman sent found that the bearings were excessively worn and that new bushings were required for all the principal bearings. The wear was so abnormal that he made inquiries regarding the lubrication and discovered that the men were not allowed to use mineral or animal oils for lubricating their machines but could use linseed or cottonseed oils only. The lubricating properties of linseed and cottonseed oils are practically nil and the wonder is that the bearings were not worn worse than they were. Situations which demand the use of vegetable oils exclusively, would seem to require, for efficient up-keep, the use of ball bearings.

COST ESTIMATING IN MACHINE CONSTRUCTION

BY A. C. JEWETT*

Cost estimating varies in difficulty according to the nature of the work for which the cost is to be determined. In the larger engineering contracting and construction work, considerable data are available in the form of published records of work done and of bids submitted. Such data are not available for estimating manufacturing costs and it is doubtful if data collected in one plant could be utilized with safety in another, inasmuch as operations are far from being standardized and the elements of cost vary so greatly in different plants. In the course of time scientific management may bring about a standardization of machine operations and the establishment for such operations of unit times which may be of direct value in making estimates, but as yet nothing of this sort is available for factories in general. In most manufacturing concerns it is customary to keep careful records of all costs for various purposes. These data are analyzed and tabulated for use in estimating the probable cost of a new machine. For certain classes of work unit prices can be established, such as a pound price for castings, but in a larger part of the work it is hardly possible to fix a unit price. In such cases the probable cost, of machining for example, is estimated by finding what it has cost in the past to make some similar detail.

The factors affecting the cost of a machine are labor, material, and overhead expense. In producing a machine of new design the costs may divide themselves into the following classes: (1) Patterns; (2) Castings; (3) Machining; (4) Assembling. The cost of patterns depends upon the amount of lumber used and the time consumed, which will vary with the size and intricacy of the part. The cost of castings depends upon the difficulty of molding, the kind of metal and the number of castings to be made. The cost of machining depends upon the kind of material, the superficial area to be machined, the quantity of stock to be removed, the nature and accuracy of finish required, the intricacy of the work and number of pieces to be finished. The cost of assembling depends upon the size and intricacy of the machine and the accuracy of the workmanship upon its parts, which determines the amount of time which must be consumed.

The methods of estimating cost of manufacture may be based upon: (1) A straight pound price, or curve of comparisons; (2) The shop foremen's estimate of time and material, with burden added; (3) The bill of material, time records and machine rates determined from other work performed, plus burden. The following examples of these methods are taken from statements supplied by some of the larger manufacturers and may be considered typical of the practice in many concerns:

(1) The cost of machines of various sizes and known weight, which have already been built, is taken from the regular shop cost records. The costs per pound are computed and plotted as one coordinate and the total weights of the machines as the other. When enough data are available to establish the curve from various sizes of machines previously built, it may be used with considerable accuracy in predicting the cost of a similar machine of any estimated weight. If the machine has a certain degree of resemblance to established types, the established cost is taken and modified to suit the new features by an amount which these may seem to warrant.

(2) When a machine of new design is contemplated, drawings and specifications of which have been completed, a conference is held at which the works superintendent, the machine shop superintendent, the foundry superintendent, the superintendent of the pattern shop, and the chief engineer are present. The drawings and specifications are examined, and the superintendent of the foundry expresses his views regarding the molding of the cast pieces in the design, indicates where the design may prove impracticable from his standpoint, and makes suggestions whereby the cost of molding can be reduced. It is considered that the foundrymen must necessarily be consulted on a large part of the work, as to

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the best method of constructing the pattern with reference to molding.

The superintendent of the pattern shop estimates the amount of lumber that will be cut up in constructing the pattern and the time required to build it. The cost of the pattern is then determined from the price of the lumber and the rate of the patternmaker. The cost of the castings is based upon a price per pound, which price has been determined from costs covering a considerable period. The engineering department furnishes estimated weights of the parts, so that the cost of the castings is obtained. The time of machining the work is estimated by the superintendent of the machine shop and, from previous cost records, the cost of machining is determined from the time. The assembling is also estimated by the superintendent of the shop or by one of his foremen, and the actual stock and labor cost of the product is obtained. Such parts as machine screws, that are purchased from other concerns, are easily figured from the purchasing department's records. The stock and labor costs are kept separate. It has been found in many plants that the labor cost should be increased by 100 per cent and the stock cost by 10 per cent to cover overhead charges. To the total is added 15 per cent for profit, to give the selling price. From the estimated weight and the estimated selling price, the price per pound is secured and compared with the price per pound of other machines on the market of a similar nature or design. By this method a check is made upon the estimated figures. If it is found that the price is going to be entirely out of reason with those of competitors, a revision in the design is made to reduce the cost.

A similar method, with certain variations, is followed in many other plants. In some the overhead charges are isolated for the separate shops. For instance, one plant adds twelve cents per hour-man to the material and labor cost to obtain the cost of patterns. In some cases the cost of patterns is considered a part of the overhead charge or expense. To the cost of molding, plus the pound price of iron, plus labor is added 80 per cent of the cost of labor and iron to obtain the cost of the castings, which is reduced to a pound price. This cost also includes the cost of special flasks or rigging. The machining time is figured at the actual price paid the men plus an overhead shop charge of twenty-two cents per hour. The cost of special tools, jigs or fixtures is figured in the same way and added in. The profit is commonly added by an executive officer. The amount of the profit to be added is determined by considering the various circumstances surrounding the particular job in hand, being varied by the probable competition, the risk of spoiling or losing any of the pieces handled, the payments and numerous other items.

(3) A consulting engineer who is an executive of a plant which has been very successful with the Taylor plan of management has said, in substance, the cost of manufacture of machines of new design may be determined by making a complete detailed analysis of the work to be done, basing the time upon elementary time units; in short, making up the time for each operation just as it is done in setting tasks on work that is to be done in the shop. Arrive at the cost of material by making careful estimates of the weight of the castings and other materials entering into the machine. Add a proper proportion for indirect expenses. The principal objection to so detailed an estimate is that it is rather expensive. Unit prices can only be developed where the line of machinery is of the same design and type of construction, the differences being chiefly in size. For work of this nature a unit price per pound of the machine's weight may be used where it is not necessary that an estimate should be very accurate. Such a unit is useless when applied to machines totally different in design and construction. The cost per square inch is also useless if accurate results are to be achieved, as the proportion of cost in relation to the number of square inches to be machined differs widely, depending upon the nature of the surface, the form of the part, difficulties encountered in setting, the number of pieces of each kind to be machined, etc. While many of these makeshift methods serve the purpose, it is only because a rather wild guess is good enough by reason of there being a comparatively wide margin, or because their application is restricted to estimating machinery of a very similar nature.

TURNING CAMS ON A LATHE

An ingenious method of turning cams on a lathe is used by the Carpenter-Tew Gear Co., Brooklyn, N. Y., and could be adopted by many shops which occasionally have to cut cams of the type shown in Fig. 1, but do not have enough work of this kind to warrant buying a cam machine or a cam cutting attachment for a milling machine.

The type of cam turned by this method is illustrated in Fig. 1, where it will be seen that the hub *A* is concentric with the surface *B* of the cam. The bore of the hub is also concentric with the surface *B* but the center of the surface *D* of the cam is 7/8 inch from the center about which the surface *B* is turned. These cams are made of 5-inch machine steel stock. Blanks for this purpose are sawed from the bar and set up in the

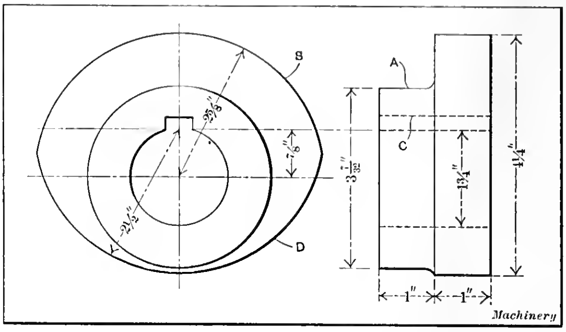

Fig. 1. Type of Cam to be turned

lathe, where the first operation consists of turning down the blank to form the hub *A*. The hub is then bored, after which the cam surface *B* is turned. After these operations have been completed on all of the blanks, the work is transferred to a slotter where the 1/2-inch taper keyway *C* is cut in each piece.

After the work has progressed to this stage, the final step consists of turning the cam surface *D*. For this purpose, the fixture shown in Fig. 2 is used. This consists of a plate which is bolted to the faceplate of the lathe by bolts fitting in the two slots. It was previously mentioned that the center of the surface *D* is 7/8 inch from the center about which the surface *B* was turned. Consequently the fixture is set 7/8 inch off center. The work is held on the stud *B*, the key *C* being provided to fit into the keyway which was machined in a

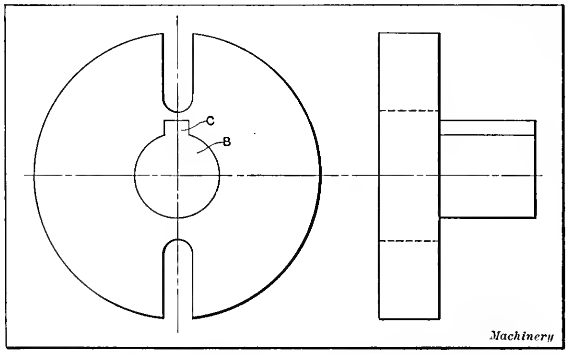

Fig. 2. Fixture used for turning Cams on a Lathe

previous operation and prevent the work from turning on the stud. The successive blanks are then mounted on this fixture, when it is an easy matter to turn the surface *D*. Referring to Fig. 1, it will be seen that there is an edge at the two points where the surfaces *B* and *D* meet. After the surface *D* has been machined, a file is applied to the work to reduce these two edges so that the roller will run smoothly when passing around the cam. These cams are used on a well-known printing press. E. K. H.

* * *

Curious incongruities are sometimes noted in plant management. Pattern lumber stored in the open air while chips and other metal refuse are kept under cover, is an example.

AN EARLY AUTOMATIC GEAR CUTTING MACHINE

A RECORD OF IMPROVEMENTS MADE IN GEAR CUTTING MACHINERY IN THE SHOPS OF R. HOE & CO., NEW YORK

BY DOUGLAS T. HAMILTON*

Little is known of the early development of automatic gear cutting machinery for the simple reason that no authentic records were kept, and no patents had been taken out before the early eighties. What is supposed to have been the first full automatic gear cutting machine was developed in the plant of R. Hoe & Co., New York City, makers of web printing presses. This first machine was evolved from a hand-operated gear cutting machine built by the Freeland Tool Works, New York City. The factory in which these early gear cutters were built was closed years ago; it was located on 34th St. between Tenth and Eleventh Aves. This first machine in its remodeled condition—converted into an automatic gear cutting machine—is shown in Fig. 1. When originally built it only had a down feed for the cutter slide, which had to be raised by hand, and the machine was indexed in a similar manner. The method of operating was to draw up the cutter slide with the left hand by means of the handwheel and ratchet at the top of the feed-screw, and index the work with the right hand.

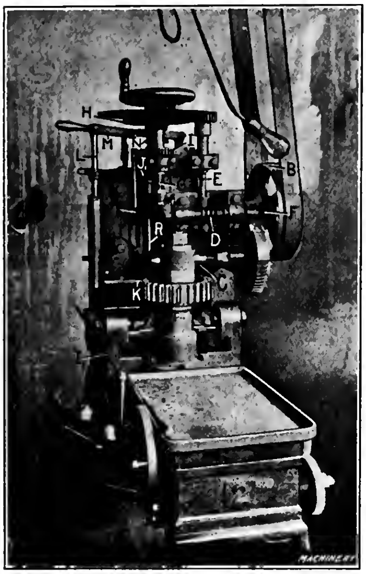

Fig. 1. Old Freeland Hand-operated Gear-cutting Machine, converted into an Automatic Gear-cutter

The Freeland gear cutting machine, as originally built, was supposed to be accurate as regards indexing, but after many tests were made of gears cut on this machine, it was found that the spacing of the teeth varied. As the work turned out was not of the required standard for the Hoe printing presses, Colonel Robert Hoe set about to develop this machine and make it much more accurate. The first step in this direction was to make an accurate dividing wheel, which is shown in Fig. 6. This dividing wheel was made from an iron casting of the shape shown, and was machined on its circumference providing a ledge as indicated in Fig. 7. Against this ledge 180 cast-iron blocks *B* are held by screws *C* and toe-clamps *D*. These blocks, which are slightly over one inch in length, were scraped to fit a gage, the sides of which were beveled to about 0.010 inch in the height of the block. When the 180 blocks had been finished to the desired size the cast-iron wheel was turned to approximately the required diameter and then the cast-iron blocks fitted to it. This procedure was followed until the circumference of the turned portion on the wheel was such that it exactly contained the 180 blocks. The diameter of the dividing wheel over the clamps is about 63 inches, and the separate sections or blocks are about 3/16 inch thick.

Obviously the making of this dividing wheel required the most painstaking work and consumed considerable time, as is evident from the statement that it took two years to complete this wheel, which was finished in 1879. After producing the master dividing wheel, the next step was to make the indexing or dividing wheels to be used on the Freeland gear cutter shown in Fig. 1, and also on others that were built later. These dividing wheels were cut on the old Whitworth machine shown in Fig. 5. The dividing wheel was placed on the rear end of the work arbor *A* and the wheel to be cut took the place of the work. The teeth were produced with a special shaped cutter, which was kept as sharp as possible.

The manner in which this dividing wheel was cut is as follows: The operator removed one of the blocks *B*, Fig. 7, from the master dividing wheel and located the indexing plunger in the space from which the block was removed. Then he cut one tooth space, using a very fine feed so as not to heat the work. When this was completed, the block was put in place and another block removed from a point on the circumference of the wheel diametrically opposite to the position from which the first block was removed. The wheel was then turned around and the locking plunger put in the place previously occupied by the block, whereupon the second tooth space was cut. Following this the wheel was divided into quarters, eighths, etc., until all the teeth were cut. In all cases the indexing was made from positions diametrically opposite in order to reduce to a minimum inaccuracies due to temperature conditions. After the teeth were roughly cut, the gear was put away to season and was then set up again and a light finishing cut taken. Some idea of the care taken in cutting these wheels may be gained from the fact that it required nine months to complete seven wheels. The room in which these wheels were cut was kept at a uniform temperature of 70 degrees F. by a fan. At the time that the master dividing wheel was made seven index wheels were completed, six of which were later used on machines built by R. Hoe & Co.

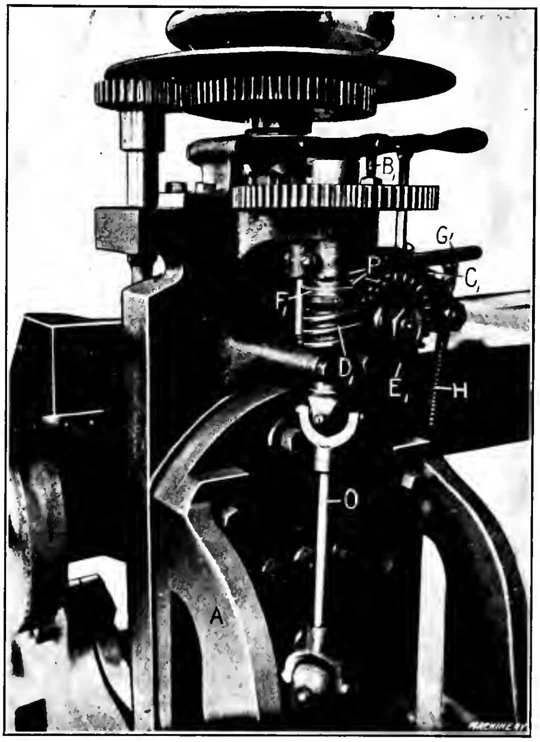

Fig. 2. Rear View of Machine shown in Fig. 1, showing Portion of Indexing Mechanism—an Improvement made by R. Hoe & Co.

The changing over of the Freeland hand-operated gear cutting machine into a fully automatic machine is credited to William Hall, who at that time had charge of the gear cutting department. The first improvement was made in 1880 by Mr. Hall and consisted of a device to provide an automatic stop and return for the gear cutter slide. Later he devised an attachment for indexing the work. The automatic stop and return for the cutter slide worked satisfactorily, but the indexing attachment did not. Trouble was caused by its fre-

*Associate Editor of MACHINERY.

quently failing to slip and preventing the work from indexing the full amount, thus of course, spoiling the gear. About the year 1882 Joseph Buckley, who was also employed in the gear cutting department, put on a safety device which stopped the down feed of the cutter slide when the indexing mechanism had not operated properly. This stopped the feeding down of the cutter slide, and prevented the gear from being spoiled.

The Whitworth Gear Cutting Machine

The gear cutting machine shown in Fig. 5, which was built by Joseph W. Whitworth & Co., Manchester, England, was the first machine to be employed in the shop of R. Hoe & Co. for cutting gears. This machine was used for several years before the Freeland machine was purchased, and as the Freeland machine was considered somewhat better as a manufacturing proposition, the same developments were not made on the Whitworth that were made on the former machine. This Whitworth machine stands today practically the same as it was when originally built. It is indexed by hand, by means of the handle *B* and shaft *C*, then through change gears *D* to a shaft at the rear, which carries a worm that meshes with the dividing wheel *E*. The handle *B* is rotated the required number of times and is then located in the disk *F* which has four notches. The dividing wheel *E* is keyed to the arbor *A* holding the work and in this way the work can be indexed for the cutting of each successive tooth. Considerable trouble was encountered in indexing this machine, owing to the fact that the operator had to depend only on the four notches in disk *F*, and when it was necessary to make an odd number of divisions the handle could not be locked and hence was not accurately located. To provide against improper indexing, Joseph Buckley put on a safety device which worked satisfactorily. A worm-wheel was fastened to shaft *C* and a bracket *T* was attached to the bed of the machine. This bracket carried a shaft on which a worm was held, meshing with the worm-wheel, and also three indexing cams having three, four and five grooves, respectively.

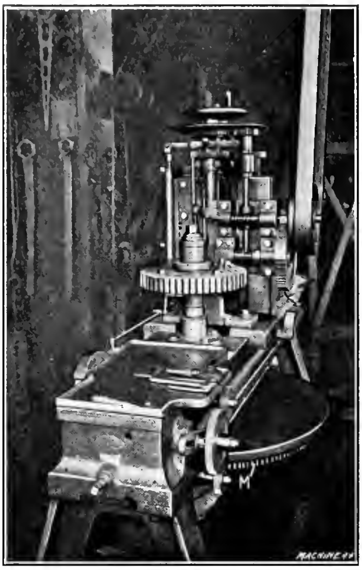

Fig. 3. One of the Six Automatic Gear-cutting Machines built by R. Hoe & Co., patterned after the Freeland Machine

Now when the operator rotates handle *B* it is necessary for these cams (only one of which is brought into use to give the desired number of divisions) to rotate into such a position that the rod *U* will drop into one of the notches. This allows the knob lever *N* to be pushed in, engaging the feed. If the lever *U* should not locate properly in the notch in the cam—owing to improper indexing—it would be impossible for the feed to be started, as the knob lever *N* is securely locked by rod *U*. The shaft on which the indexing cams are held is provided with notches in which a latch *S* fits, thus providing a means for bringing the proper cam into position to give the required number of indexings.

The gear cutter *G* is driven by a belt *H* which runs on a pulley *I* held on the top bracket *J*. This pulley, through a pinion and large bevel gear *K*, drives a vertical spindle which carries a spur gear, meshing with the gear *L* attached to the cutter arbor. The feeding of the cutter past the work is accomplished by a worm on the shaft carrying the large bevel gear which meshes with a spur gear located on the shaft *M*. This shaft, in turn, carries another spur gear that meshes with a larger gear on the screw operating the head carrying the cutter. When knob *N* is pushed in, it engages a clutch on the end of the feed-screw *M* thus throwing in the feed. An adjustable washer or dog held on the rod provided with the knob lifts up a finger and thus forces the clutch out of engagement at the end of each cut. This is accomplished by means of a compression spring.

The base *O* carrying the entire cutter slide mechanism can be swung around and set to any angle within a range of 90 degrees and is locked as indicated. This base is carried on a slide *P* which can be adjusted back and forth in relation to the work and thus greatly increases the capacity of the machine. The work arbor is held in a slide *Q*, which is adjustable along the bed by a screw and is locked in the desired position by the wrench shown. The rear shaft is splined so that the worm meshing with dividing wheel *E* can accommodate itself to the position of the wheel. The bracket carrying the cutter slide can be swung around to different angles, making the latitude of this machine practically unlimited. Bevel gears, spur gears, worm-wheels, etc., can be produced with equal facility, but, of course, not very rapidly. This old Whitworth machine is still in use for cutting worm-wheels having angular teeth—not helical.

The Freeland Gear Cutter

The Freeland gear cutter shown in Fig. 1, when originally built, was designed with the idea of cutting bevel gears, as well as spur gears. This is clearly indicated by referring to Fig. 1, where it can be seen that the cutter slide is held by trunnions to a bracket on the base of the machine. The work arbor remains in a vertical position and for the cutting of various bevel gears the entire head carrying the cutter slide is set over to the desired angle. When converted into an automatic machine, this feature was eliminated and a bracket *A* as shown in Fig. 2 was provided, being fastened to the cutter slide bracket and also to the bed of the machine. The mechanism which was added to this Freeland machine to convert it into an automatic gear cutter is extremely complicated and also very ingenious. In order to make the following description clear, it probably will be advisable to take up the additions in the sequence in which they were made.

Automatic Return for the Cutter Slide

By referring to Fig. 1 it will be seen that power is transmitted to this machine through a pulley *B* which, through the spur gears, drives the cutter arbor *C*. On the shaft directly in line with the pulley is a worm *D* that meshes with a helical gear on the vertical shaft *E*. This shaft is connected by spur gears to the feed-screw operating the cutter slide. On the extreme end of shaft *F* is held a bevel gear, meshing with another bevel gear mounted on the shaft *G*. This shaft, through spur gears, also connects with the feed-screw operating the cutter slide. The feed-screw carries a double sliding clutch *N* which is brought into engagement with the upper and lower clutches, and thus provides a means for moving the cutter slide up and down. The downward movement of the cutter slide is accomplished with the top clutch directly under spur gear *H*, while the lifting of the cutter slide is accomplished with the clutch located directly behind the spur gear *I*.

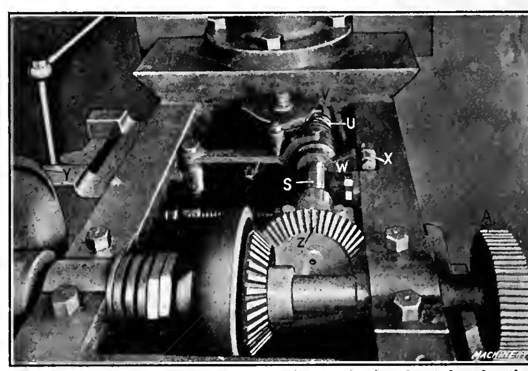

Fig. 4. Close View showing the Indexing Mechanism located under the Table which has been removed

The Automatic Stop

A further development in the Freeland gear cutting machine in connection with the automatic return was the automatic stop or trip. This stopped the downward feeding of the cutter slide and allowed it to be returned. The automatic stop consists of an adjustable dog *J* which is held in a slot in the cutter slide. This dog is so adjusted that it comes in contact with the lever *K* when the cutter slide has reached its lowest predetermined position. As the fulcrum lever *K* on which the rod *L* is resting is forced out by the adjustable dog, the support is withdrawn from the rod *L* allowing it to be forced down by a compression spring. Now rod *L* is pivoted to the yoke lever *M*, which is fastened to the double sliding clutch *N* carried on the feed-screw, and as the support is withdrawn from this rod, the sliding clutch is brought into engagement with the lower clutch, which is rotated as previously described to return the cutter slide to its "up" position. As the cutter slide ascends adjustable block *T* lifts lever *M*, disengages the clutch, and holds lever *M* in an intermediate position. At this point in the operation the indexing is accomplished by hand, after which the sliding clutch *N* is engaged with the upper clutch and the cycle of operations repeated.

The Automatic Indexing Mechanism

The automatic indexing mechanism added to the Freeland gear cutter by William Hall, while having been changed slightly from its original design, still works on practically the same principle as when first completed. As can be seen by referring to Fig. 2, the indexing mechanism is operated by a universal jointed shaft *O* at the rear of the machine. This is driven from the gear on the feed-screw through a spur gear and clutches *P*, the lower one being fastened to the top part of the knuckle jointed shaft. On the lower member of the knuckle jointed shaft is held a spur gear meshing with another spur gear on shaft *S*, see Fig. 4. This view shows the mechanism of the machine, the top guard or table being removed. Shaft *S* carries a worm *U* that meshes with a worm-wheel held to the shaft on which the four-lobe cam *V* is mounted. Shaft *S* rotates continually—when clutch *P* is engaged—in the correct relation to the operation of the cutter slide, allowing the required travel of the slide to one-quarter turn of the shaft carrying the cam.

As one of the lobes on this cam comes into contact with the roll on lever *Q*, it forces the cam *W* over, bringing it in contact with roller *X*. This roller, in turn, is connected to the indexing plunger that fits in a notch in the index wheel *Y*. Now as cam *W* comes in contact with the roller, it withdraws the indexing plunger and allows the index disk to be rotated through bevel gears *Z*, and also the dividing wheel *M* under the machine, see Fig. 3, to be rotated by the change gears A_1, the proportioning of the teeth in which, are such as to give the required space indexing. This indexing mechanism just outlined was that devised by Mr. Hall, and while the idea as arranged was practical, it did not always work successfully and considerable work was spoiled owing to the failure of the locking plunger to engage with the notch in the indexing disk and thus secure the correct indexing.

When the indexing mechanism just described was added, the automatic trip for returning the sliding clutch into engagement with the top clutch to feed the slide down, was also provided. This automatic trip works as follows: When the cutter slide rises and sliding clutch *N* is brought into an intermediate position by lever *M*, the link B_1 (see Fig. 2) transmits a movement to lever C_1, bringing the clutch *P* into engagement, and starts the indexing mechanism operating. The vertical shaft on which clutch *P* is held carries a worm D_1 which meshes with the spur gear E_1. The shaft carrying this spur gear also holds a cam similar in shape to that shown at *V* in Fig. 4. This cam guards against improper indexing in the same manner as the device put on the Whitworth machine shown in Fig. 5.

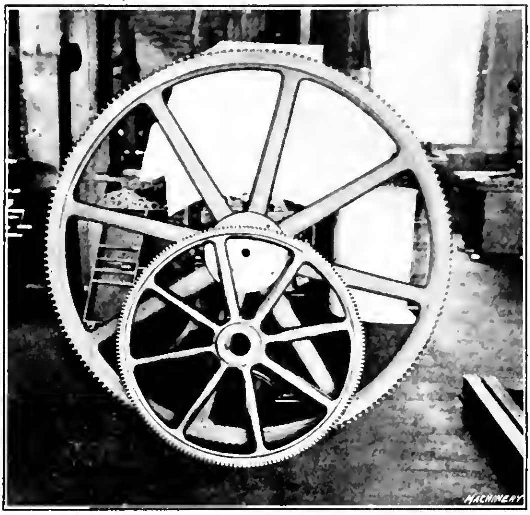

Fig. 6. Master Dividing Wheel and One of the Dividing Wheels reproduced from it on the Whitworth Machine shown in Fig. 5

As the indexing operation nears completion, cam F_1 held on the vertical shaft comes in contact with a bell-crank lever, not shown. This lever lifts a latch supporting lever G_1, allowing the latter to be pulled down by the spring *H*, and thus disengages clutch *P*. At this instant the cam at the rear of spur gear E_1 comes into position and raises the lever *M*, engaging the sliding clutch *N* with the top clutch to feed the cutter slide down again.

Automatic Safety Device

In order to provide against improper indexing of the work, Joseph Buckley put on a safety device that automatically stops the downward feed of the cutter slide, should the indexing mechanism fail to operate properly. This safety device is indicated in Fig. 1, and consists of a rod *I*, which is held to the slide carrying the indexing locking plunger. This rod through a bell-crank lever operates rod *R*, which carries a tooth clutch on its upper end. Now when the locking plunger fails to locate properly in the indexing disk, rod *I*, is forced back, transmitting an upward movement to the rod *R* and engaging the tooth clutch with the gear J_1. Gear J_1 is rotated by a gear held on the feed-screw, when the latter is being operated, and as the clutch is engaged the rod *R* is revolved. On the lower end of rod *R* is a one-lobe cam which comes in contact with lever *K*, forcing it out and withdrawing the support from rod

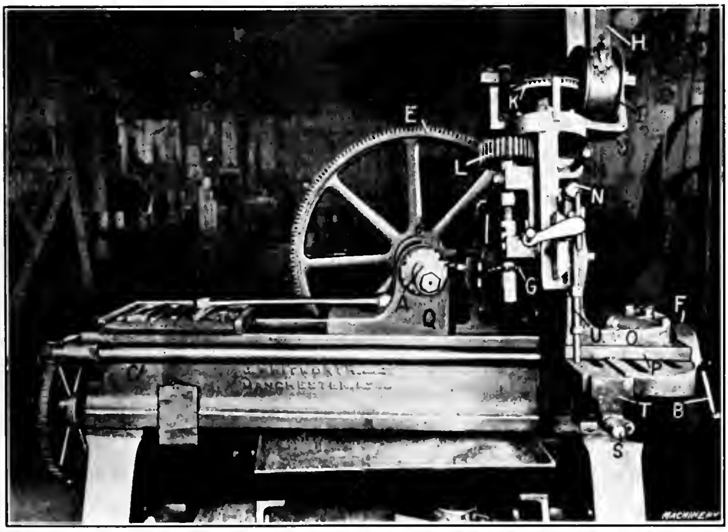

Fig. 5. Gear-cutting Machine built by J. W. Whitworth & Co., Manchester, England
This was the First Gear-cutting Machine purchased by R. Hoe & Co.

L, thus disengaging the clutch *N* and stopping the downward movement of the cutter slide. As lever *M* drops, the clutch *N* is held in an intermediate position by the adjustable rod *T*, which comes in contact with the projection on the lever.

The Remodeled Freeland Gear Cutter

In 1883 and 1884 R. Hoe & Co. built six machines patterned after the Freeland machine, improved upon by William Hall and Joseph Buckley. One of these improved machines is shown in Fig. 3, and as can be seen upon reference to it and that shown in Fig. 1, very little change has been made except in a slight remodeling of the automatic safety device, to provide against improper indexing. Six of the seven index wheels cut as previously described were used on these machines, one wheel being kept as a reference wheel. The driving belt is kept in contact with the pulley by means of an adjustable countershaft operated by a weight fastened to wire ropes that run over pulleys attached to a post. These remodeled machines are still doing good work in R. Hoe & Co.'s shops, and while they are not such rapid producers as machines of present-day design, they show to a remarkable extent the ingenuity of those instrumental in their development. As an

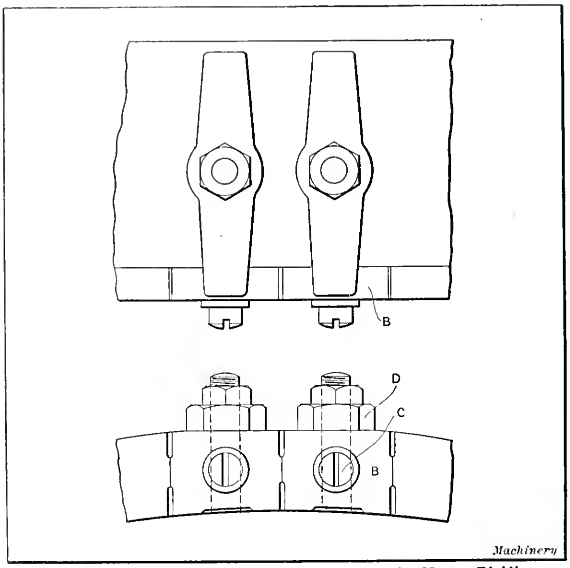

Fig. 7. Illustration showing how the Blocks on the Master Dividing Wheel shown in Fig. 6 were made and held in Place

indication of the desire of this company to keep in step with the progress made in gear cutting, it might be mentioned that the present equipment for this work includes Lees-Bradner hobbing machines, Gleason two-tool bevel gear generators, and Brown & Sharpe automatic gear cutters.

In closing the writer wishes to think Mr. Edwin J. Peirce, production manager, for permission to take the photographs presented, and also Mr. James D. Lamond, tool-room foreman, for the details concerning the interesting development of these automatic gear cutting machines.

* * *

KNURLS FOR KNURLING IN THE LATHE

The knurls commonly used for lathe work have spiral teeth and ordinarily there are three classes known as coarse, medium and fine. The medium pitch is generally used. The teeth of coarse knurls have a spiral angle of 36 degrees and the pitch of the knurled cut (measured parallel to the axis of the work) should be about 8 per inch. For medium knurls, the spiral angle is 29 degrees, 30 minutes and the pitch measured as before, is 12 per inch. For fine knurls, the spiral angle is 25 degrees, 45 minutes, and the pitch, 20 per inch. The knurls should be about 3/4 inch in diameter and 3/8 inch wide; when made to these dimensions, coarse knurls have 34 teeth, medium, 50 teeth, and fine knurls, 80 teeth. To prevent forming a double set of projections when knurling, feed the knurl in with considerable pressure at the start, and then partially relieve the pressure before engaging the power feed. Use oil when knurling.

CUTTING INTERNAL GEAR TEETH ON A VERTICAL SHAPER

An internal gear cutting proposition that would puzzle many machinists is the one illustrated in Fig. 1, which shows a brass casting, approximately five inches internal diameter, within which ninety gear teeth of twenty pitch were required to be cut. This work could easily be handled on a Fellows gear shaper if it were not for the fact that a projecting boss extended into the ring, thus preventing the

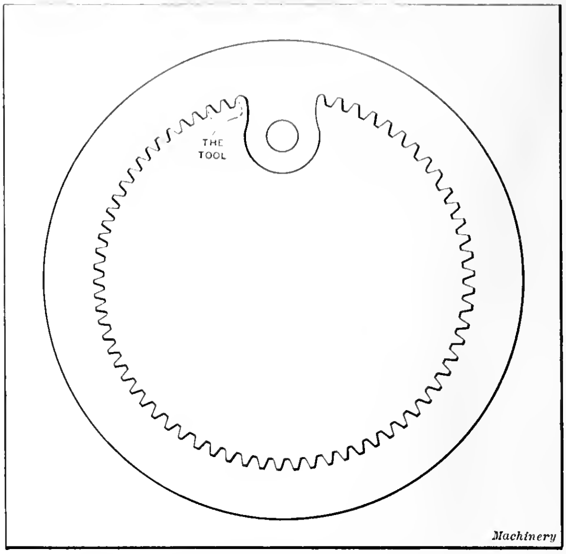

Fig. 1. The Ring in which the Internal Teeth were cut

use of a circular gear cutter. At the Rhodes Mfg. Co.'s shop in Hartford, Conn., where this job was handled, the work was done upon a Rhodes vertical shaper. The shaper with the work on it is illustrated in Fig. 2, from which it will be seen that the casting was mounted upon the circular table with the work centrally located. The tool used was of the shape indicated by the dotted lines extending around

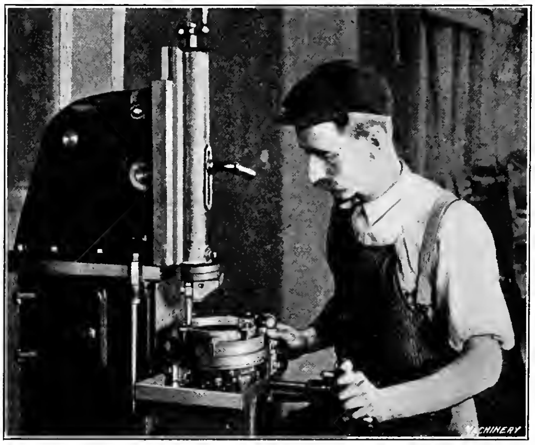

Fig. 2. Cutting the Teeth on a Rhodes Vertical Shaper

the first two teeth at the left of the boss shown in Fig. 1. The tool was first set so as to cut the first two teeth from the boss. The complete depth of cut was not taken with one stroke, but the work was fed out gradually to the tool by means of the hand cross-feed. After the first two teeth were cut the work was withdrawn from the tool, the circular table indexed to the correct pitch and the work fed in again to cut the third tooth. This operation was repeated, finishing one tooth at a time until the entire ninety teeth were finished. The second tooth on the cutting tool acted as a spacer and prevented the tool from springing away. The handling of a job of this kind is quite novel. C. L. L.

STRESS COEFFICIENTS FOR ROOF TRUSSES*

DATA ON THE DESIGN OF ROOF TRUSSES ARRANGED IN CONVENIENT FORM FOR THE DESIGNER

BY CARL E. SCHIRMER†

The current Data Sheet Supplement gives stress coefficients for various types of roof trusses and for different numbers of panels for each type of truss. The term "panel" means one of the spaces into which the upper chord of the truss is divided. In all cases the loading is assumed to be uniform and the stress in any member of a roof truss is obtained by multiplying the panel load by the coefficient for the member in question. These coefficients were obtained by graphical analysis. This method has the double advantage of being rapid and at the same time showing any error which may have been made, as the stress diagram must close if it has been properly drawn.

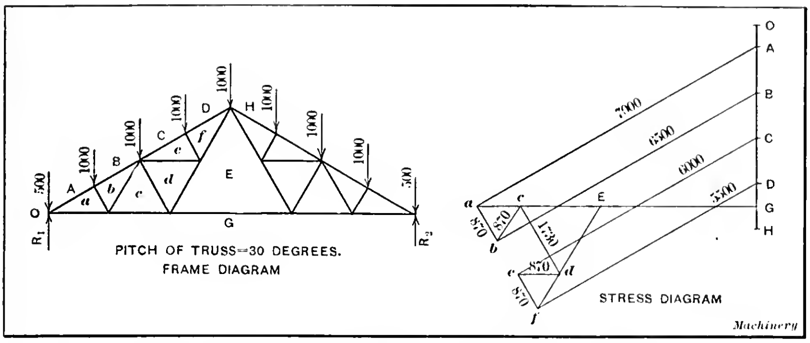

Fig. 1. Frame and Stress Diagrams for Eight-panel Fink Roof Truss

It is not the intention of this article to explain the principles of graphical statics but merely to present data on the design of roof trusses in a convenient form for use by a designer who is not frequently called upon to handle work of this kind. In order to give a brief description of the method by which these Data Sheets were computed, a frame diagram and a stress diagram are presented for three characteristic cases, *i. e.*, for a roof truss uniformly loaded but where the wind load is not considered; for a roof truss uniformly loaded and also carrying a uniform wind load; for the saw-tooth type of roof truss uniformly loaded.

Fig. 1 shows the frame diagram for an eight-panel Fink roof truss in which the distribution of the load is indicated, and also the stress diagram for this truss which is drawn to a scale equal to 1 inch = 1000 pounds. The stress diagram is drawn for one-half the truss, the other half being similar owing to the uniform loading of the truss. The stress diagrams which were drawn to derive the results presented in the Data Sheets, were laid out for the whole truss. The system of notation or lettering is such that any member lies between two letters. Thus *Aa* signifies the top chord member in the first panel on the left-hand end of the truss as shown in Fig. 1.

After drawing the stress diagrams, the results were scaled off and these results were pointed off to three decimal places (divided by 1000), thus obtaining the stress in any member for a panel load of one pound. For example, in the stress diagram shown in Fig. 1, *Aa* represents 7000 pounds for a panel load of 1000 pounds. The stress for a panel load of one pound is therefore 7000 divided by 1000 = 7.000. This value will be found in the table for the eight-panel Fink roof truss in the column for 30 degree pitch. It follows that for any panel load the stress in a given member can be found by multiplying the panel load by the coefficient for that member. The character of the stress (whether tension or compression) will be found in the second column of the Data Sheets. It should be thoroughly understood that in deriving these results, all of the panel loads were regarded as being equal and acting simultaneously.

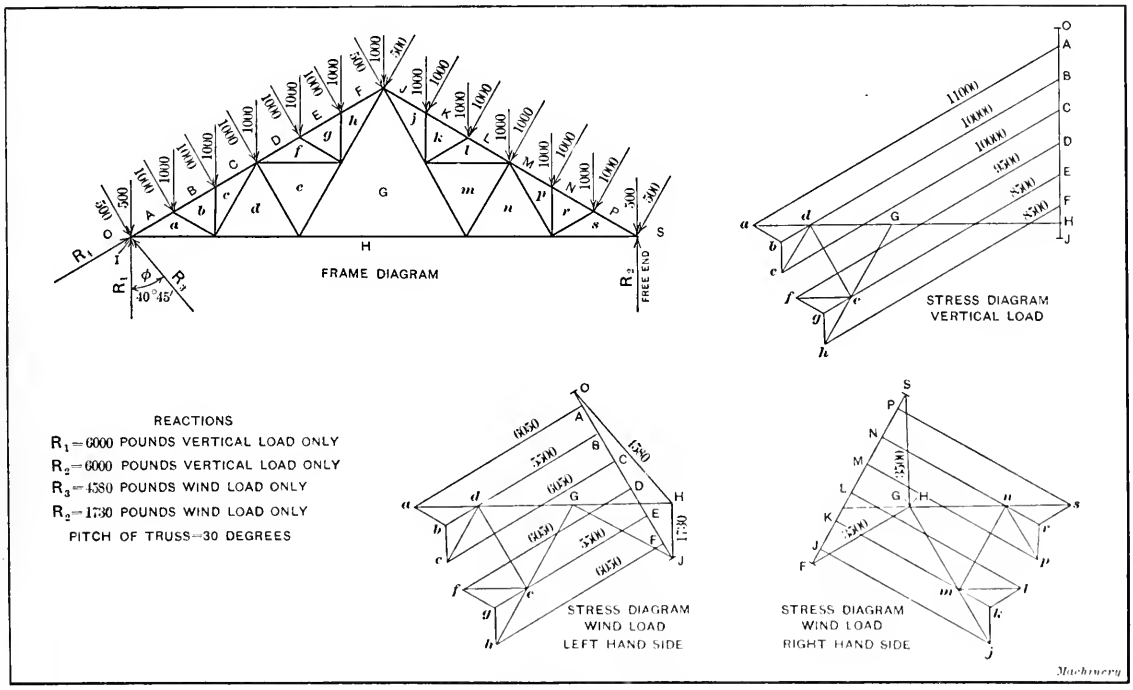

Fig. 2. Frame and Stress Diagrams for Twelve-panel Fan Roof Truss

Fig. 2 shows the frame diagram for a twelve-panel fan type

* With Data Sheet Supplement.
† Address: 1552 Indiana Ave., Toledo, Ohio.

roof truss carrying a uniformly distributed vertical load and a uniform wind load. It should be remembered that all of these loads do not act at the same time, but they are shown in this way in the diagram to save space. The same statement applies to the reactions. R_1 is only for vertical loads; R_2 is of a different amount for the vertical and the wind loads, but is always in the same direction; R_3 is the reaction for the left hand wind load only; and R_4 is the amount of the fixed-end reaction for the wind load on the free end side of the truss. A typical stress diagram for the vertical load is shown in this illustration, and it will be remembered that the method of constructing such a diagram was discussed in connection with the eight-panel Fink type of roof truss.

Referring to Table 1 it will be seen that two tables are given one for the wind load and the other for the vertical load. The results set forth in these tables are for the wind on the left-hand side of the truss which is considered fixed or stationary while the opposite end is considered free. Stress diagrams for the wind load on the fixed end side and on the free end side are also given in Fig. 2. The reaction R_2 for the free end is always vertical, whereas reaction R_3, which is for the wind load on the left-hand side of the truss, is at an angle. The direction of this reaction is determined from the stress diagram for the wind load on the left-hand side of the truss and corresponds to the direction of the line OH. The reaction R_2 due to the left-hand wind load is shown by the vertical line HJ both in direction and magnitude. The fixed end reaction R_4, due to the right-hand wind load, is given by the line FH in the stress diagram for wind load on the right-hand side.

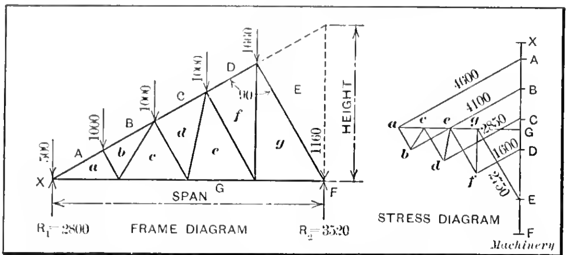

Fig. 3. Frame and Stress Diagrams for Four-panel Sawtooth Roof Truss

By comparing the respective diagrams for the wind loads on the two sides of the truss, it will be seen that the stress in the lower chord members is greater with the wind blowing on the fixed end or left-hand side. With the wind load on the fixed end, the members Gj, Gm, jk, kl, lm, mn, np, pr, and rs are not subjected to stress and consequently take no part in carrying the load—that is theoretically. The same members on the opposite side of the truss and in the same relative position, are inactive when the wind acts upon the right-hand or free end. The members Gh, dH and aH are likewise found to be without stress as far as right-hand wind load is concerned. As the truss must be proportioned for the maximum stresses and as the stresses due to wind load are greater with the wind acting upon the fixed end (in this case the left-hand end) the coefficients given in the Data Sheets are for the maximum stress. Many engineers assume an equivalent vertical load to take care of the wind load and add such a load to the loads due to the weight of the roof, to snow on the roof and to the weight of the truss itself.

In explaining the design of trusses for the sawtooth type of roof, the four-panel, 30-degree truss is taken as an example. Fig. 3 shows the frame diagram for this truss, in which it will be seen that uniform loading is assumed. The panels A, B, C and D are equal; hence the loads at AB, BC and CD represent the load carried by one panel, *i. e.*, 1000 pounds. The load XA at the left-hand end is equal to one-half of the panel load. It will be seen that the panel E is longer than the other panels and hence it carries a larger load; the load DE was assumed to be made up of one-half the panels D and E which amounts to 1660 pounds. The load EF at the right-hand end of the truss is equal to one-half the panel load E or 1160 pounds. It should be noted that the coefficients given for these loads are 1.66 and 1.16 respectively, from which it will be seen that with a given load at AB, BC or CD, which are equal, the load at DE or EF can be easily obtained by multiplying their respective coefficients by that load.

The height of the truss is taken as the vertical distance from the bottom chord to a projection of the top chord and the member gE makes an angle of 90 degrees with the top chord. The reactions are calculated by the method of moments. The left-hand reaction R_1 is 2800 pounds, and the right-hand reaction R_2 is 3520 pounds. It will be well to note that the coefficients given in the Data Sheet are 2.8 for R_1 and 3.52 for R_2. Multiplying these factors by the load at either AB, BC or CD, gives the respective reactions.

A stress diagram for this type of roof truss is illustrated in Fig. 3. Referring to the Data Sheet it will be seen that the stress coefficient for the member Aa in the 30-degree pitch column is 4.60. Multiplying the load at AB, which is 1000 pounds in this case, by this factor gives a stress of 4600 pounds, the member being under compression. The angle θ is the inclination of the top chord to the bottom chord.

In all types of roof trusses, except the sawtooth, the pitch is obtained from the following formula:

$$\text{Pitch} = \frac{\text{height}}{\text{span}}$$

In the case of the sawtooth type of roof truss the pitch is as follows:

$$\text{Pitch} = \frac{\text{height}}{2 \times \text{span}}$$

Therefore, the height of the truss is obtained by multiplying the pitch by the span or by twice the span, according to the type of truss under consideration. The height can be readily found by means of the preceding formulas for pitches of 1/3, 1/4, and 1/5 but for the 30-degree pitch this is not the case. To find the height of a 30-degree pitch truss, the following formula is used:

$$\text{Height} = \frac{\text{span}}{2} \times \tan 30 \text{ degrees.}$$

The use of this Data Sheet Supplement should prove of particular value in starting upon the design of a new building when it is desirable to compare the relative economy of several different types of roof trusses.

* * *

DRILLING HOLES IN GLASS

There are several methods of drilling holes in glass. For holes of medium and large size, use brass or copper tubing, having an outside diameter equal to the size of hole required. Revolve the tube at a peripheral speed of about 100 feet per minute, and use carborundum (80 to 100 grit) and light machine oil between the end of the pipe and the glass. Insert the abrasive under the drill with a thin piece of soft wood to avoid scratching the glass. The glass should be supported by a felt or rubber cushion, not much larger than the hole to be drilled. If practicable, it is well to drill about half way through and then turn the glass over and drill down to meet the first cut. Any fin that may be left in the hole can be removed readily with a round second-cut file wet with turpentine. For comparatively small holes, a solid drill is often used. Use steel rod or an old three-cornered file, grinding the end to a long tapering triangular shaped point. Grip the drill in a chuck and rotate rapidly. Use a mixture of turpentine and camphor as a lubricant. Holes up to about ½ inch diameter can readily be drilled in glass with a flat drill which has been hardened in sulphurous acid, a mixture of turpentine and camphor being used as a lubricant.

* * *

The year 1912 was a record one as respects German export and import trade. During that year, the value of the exports amounted to about $2,250,000,000 and the imports to about $2,675,000,000, so that the sum total of imports and exports came close to five billions. In many other respects, 1912 was a record year in German industries. The tonnage of merchant vessels constructed in German shipbuilding yards was over 375,000 tons, an increase of nearly 50 per cent over that in 1911. In the export trade, the United Kingdom was the greatest customer of Germany.

THE HOLLERITH TABULATING MACHINE IN THE BUSINESS OFFICE

A RAPID MEANS OF COMPILING AND TABULATING STATISTICS

BY S. G. KOON*

Statistics essential to the intelligent consideration of every manufacturing or selling proposition must be compiled quickly and tabulated promptly if they are to be of value. Information of value today is often valueless next week.

The president of a large steel company called suddenly for an analysis of the sales for the preceding five years. The next morning he had the complete analysis for the three most recent years. But as it would have taken a whole month, with a considerable increase in the accounting force, to give him the other two years, he accepted the three years then instead of five years a month later. The reason for this is simple. Hollerith tabulating machines and cards had been used for three years; prior to that reports were all in loose-leaf form, and the work of compiling the special report would have involved going to original sources and working over every piece of information from start to finish. By the Hollerith system, punched cards are used which sort, classify, and aggregate the amounts recorded, in any manner desired and practically automatically. This method of transferring records to cards, and

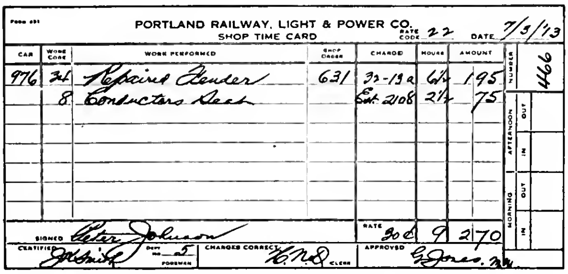

Fig. 1. Time Card for Two Operations from which Statistical Cards are punched

then analyzing the records, is capable of positive proof for correctness. It gives results which are available for reports immediately after closing business daily, weekly or monthly, as required. Figures may be obtained by this means within a few hours, where formerly weeks were needed. They may be obtained in much greater detail and at an expense far less than that of getting such complete results in any other way.

The system is used in factories of all sorts, in steel mills, by insurance companies, by electric light and traction and telephone companies, by wholesale merchandise establishments and department stores, by textile mills, automobile companies, numerous railroads, municipalities and state governments. It is used for compiling labor costs, efficiency records, distribution of sales, internal requisitions for supplies and materials,

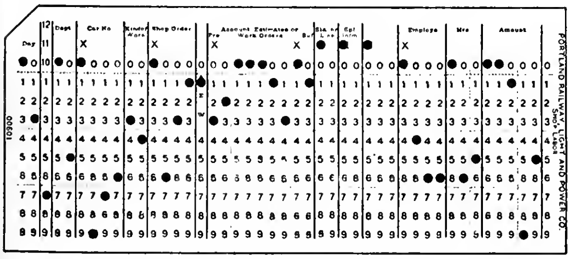

Fig. 2. Statistical Card punched for First Operation on Time Card

production statistics, day and piece work. It is used for analyzing risks in life, fire and casualty insurance, for plant expenditures and sales of service, by public service corporations, for distributing sales and cost figures as to salesman, department, customer, location, commodity, method of sale, and in numerous other ways. The cards, besides furnishing the basis for regular current reports, provide also for all special reports and make it possible to obtain them in a mere fraction of the time otherwise required.

The analyses and reports are obtained by means of cards, punched according to a code representing certain fundamental facts, and then run through two automatic machines. These first assort the cards according to a predetermined arrangement; then having obtained the grouping desired, they record details and totals on counters from which they are taken off to blanks suitably prepared. Electric contacts, made when a

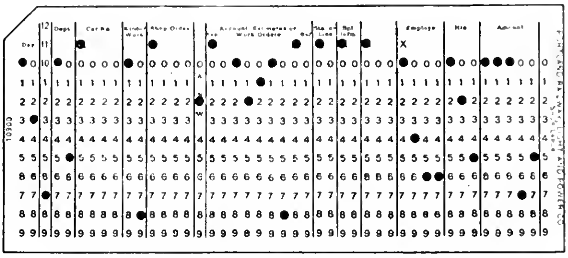

Fig. 3. Statistical Card punched for Second Operation on Time Card

punched hole in the card passes over a brush terminal in the apparatus, produce the action of either machine in so certain and positive a manner that far fewer errors are made than by any method of hand analysis. The cards can be grouped to give any possible result, and can be resorted and tabulated any number of times. The ability of these machines to handle this sort of analysis satisfactorily lies in their power to count combined facts. Each counter adds a different set of figures.

One machine tool builder uses this system for compiling costs, analyzing payroll, sales and shipments, keeping track of materials, and hence, compiling a perpetual inventory. The possibilities of its use are said to be almost untold. An electric service company, by adjusting the sorting machines to sort cards by car numbers, obtains the aggregate shop cost in

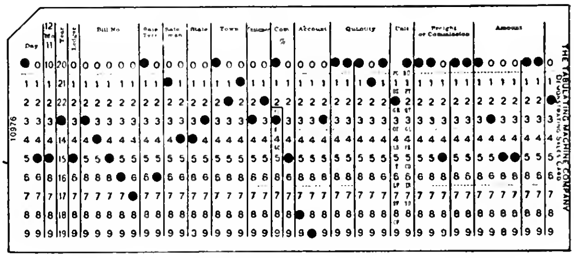

Fig. 4. Another Statistical Card punched from a Different Set of Specifications

labor and material during any given time and for each car automatically and quickly. Fig. 1 shows a shop time card made out for two operations, and Figs. 2 and 3 show the statistical cards punched from this record at the end of the week or month for distributing costs, etc. Following through the punching of the card in Fig. 2 from the information given on the time card for the first operation, Fig. 1, it will be seen that the day has been punched as 3, the month as 7, the department as 5, the car number as 976, kind of work as 34 (work code), shop order as 631, work order as 32-13, the employe as 466, hours as 6.5 and amount as 195 ($1.95). In the same way information for the second operation is punched on the card shown in Fig. 3. Fig. 4 shows a card punched from a different set of specifications. If the cost of any special kind of work, such as winding field coils, is desired, this can be obtained in the same way by running the cards through the machine again after setting it to catch and record that item. Set in still another way, the time spent by any employe upon any particular class of work or upon all kinds of work can be obtained.

The auditor of the Board of Education of New York City recently prepared his budget, covering an expenditure for 1913 of forty million dollars, from Hollerith cards which had been punched as a record of previous disbursements. One of the

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transcontinental railroads finds it necessary to refer repeatedly to traffic statistics in connection with rate litigation and kindred subjects. The volume of traffic is such that complete reports could not be obtained without enormous cost in both time and money, except for the fact that all traffic statistics are analyzed regularly by means of the tabulating system. This road estimates that present results in routine work without the aid of the machines would cost from 50 to 75 per cent more than at present.

In any shop, by punching cards direct from employes' time tickets, payrolls can be made up quickly and shop costs compiled easily, which must agree absolutely with the payrolls. From these cards, job costs to the finest detail can be figured promptly, and comparisons of men and work made. For every classification, whether part of the current analysis or of a subsequent special report, one and the same batch of cards is used over and over again, without any recopying of original

Fig. 5. Southern Pacific R. R. Co., San Francisco. Twelve tabulating machines are required to perform the traffic and other analyses on this railway system

entries. There is thus no possibility of repeated errors or transposition of figures; nor can any figure be used twice.

The cards are made in two sizes, each with two widths of column spacing. As the location of the column on the card determines the location of the column in the counter upon which the result is finally recorded, the machines are necessarily arranged to fit the card adopted. The long or full sized card will accommodate 37 wide-spaced or 45 narrow-spaced columns; the smaller card will take 27 or 34 columns. In the actual application to the card it is not simply a question of the

Fig. 6. Southern Pacific R. R. Co.'s Card Punching Department. The extent of the use of this system by a railroad is indicated by the number of girls employed in punching cards

notation of numbers and figures on the card, but of the indication of those symbols by means of perforations at measured distances from the top, bottom and ends of the card. The key punch used to perforate the cards accords with the card dimensions and the column spacing. It may be considered the writing instrument. The rate of punching varies materially with the amount of information carried. It is more rapid than ordinary card writing or the usual speed of journalizers or entry clerks. Depending upon the number of holes punched, cards are prepared by seasoned operators at the rate of 1500 to 4000 per day, the average output being not far from 2500. Many items are repeated from one card to the next. This is particularly true of dates, departments, classes of transaction, origin of business, etc. To avoid punching these individually,

Fig. 7. Carnegie Steel Co., Pittsburg. Two sorting machines at work sorting cards at the rate of 250 per minute each

a gang punch is used for multiple punching. This will punch a dozen or fifteen cards at once and covers nine or ten items on each card.

In nearly all cases, mechanical sorting is necessary before the cards can be used in the tabulator to obtain the required analysis. The sorting machine is used for the arrangement

Fig. 8. Cleveland Electric Illuminating Co. A complete statistical unit —two key punches at left, sorting machine in corner, tabulator in center, and gang punch at right in front of card cabinet

and rearrangement of the cards into orderly groups, such as by states, by agencies, by style of job or color of the product under analysis. The cards are sorted at a speed of about 250 per minute into pockets or boxes in the machine, each corresponding to one row on the cards. This is done for a single column at a time. Owing to the necessity of handling the cards, this rate of speed is cut down markedly in a day's run.

When the sorting has once been done, the cards are run through for tabulation, obtaining such totals as are necessary. If any further sorting is required the same set of cards which has been run through the tabulator is again put into the sorting machine, resorted in accordance with some other classification, and again run through the tabulator. The tabulator carries from two to five counters, each having from one to seven magnets. Each counter may therefore add numbers with from one to seven digits.

The tabulating machine, electrically controlled and mechanically operated, adds the numerical amounts up to a maximum of thirty-five columns at a time. The operating speed is 150 cards per minute. In the five-counter machine, 750 individual items may be added in one minute.

COLORING NON-FERROUS METALS AND ALLOYS*

CLEANING WORK—RECEIPTS FOR PRODUCING DIFFERENT COLORS—OXIDIZING—MOTTLING

BY E. F. LAKE†

Man is so much a product of nature that mere light and shade, or white and black, are only pleasing for a time. To fully satisfy his natural desires, man's vision must be stimulated by views of different colors and various combinations thereof. To look upon one color continuously is one of the most tiresome things he can do, as it affects his entire nervous system. This has led to the coloring of metals, and to producing many beautiful effects in place of the natural color of the metal which may become repulsive from being seen too frequently.

In thickly inhabited sections a great deal of coal gas is burned. More or less of the products of combustion together with the gases arising from the manufacture of other materials stay in the atmosphere and give to brass and bronze objects a dark, dirty color by attacking their surfaces. The oxygen and moisture in the atmosphere also give these metals or alloys a disagreeable color. Hence coloring or coating is also resorted to for the purpose of enhancing and preserving the original beauty of the metal. Sometimes rich and beautiful browns and greens are produced on copper alloys that have been subjected to atmospheric conditions for years. Therefore these conditions have been studied and chemical means have been found for producing the colors quickly and on a commercial scale.

Copper is more susceptible to coloring processes and materials than any of the other metals, and hence the alloys containing large percentages of copper are readily given various shades of the yellow, brown, red, blue and purple colors and also black. Alloys with smaller percentages of copper, or none at all, can be given various colors, but not as easily as if copper were the principal ingredient, and the higher the copper content, the more readily can the alloy be colored. The shades, and even the colors, can be altered by varying the density of the solution, its temperature and the length of time the object is immersed. They can also be altered by finishing the work in different ways. If a cotton buff is used one shade will be produced; a scratch brush will produce another, etc. Thus to color work the same shade as that of a former lot all the data in connection with these operations must be preserved so they can be repeated with exactness.

Many different kinds of salts are made into solutions for the coloring processes. When capable of producing the desired results it is always best to use the simple salts. It is often necessary to combine two or more salts in the solution to get the required color, but these deteriorate in strength much more rapidly than the simple salt solutions and hence the last piece immersed will have a lighter color than the first one. When adding salts to bring back the original strength of the bath, they should first be dissolved in a small amount of water to prevent their settling to the bottom where they might become covered with an insoluble mud that would prevent them from being dissolved. In making the solutions it should be remembered that a strong solution will produce the color quickly and a weak solution more slowly. When a uniform coating can be produced the strong solution is always the best owing to the time factor. The most effective and lasting results, however, are obtained with the weaker solutions, and hence they are used for high-grade work. While these solutions are often used cold, there are many cases where better results can be obtained when they are heated. Raising the bath to the boiling point will insure a complete solubility of the salt.

Cleaning Work to be Colored

Cleaning the work is of the utmost importance before attempting to give it any kind of color. A greenish or brownish film forms on copper, brass, bronze, etc., when they stand, as they are attacked by the moisture in the air and the simultaneous presence of carbonic acid which gradually changes into carbonates. This film is a mixture of carbonate of copper and oxide. Often sulphur compounds are formed when the atmosphere is impregnated with the products of combustion arising from the coal gas burned in cities and towns. This is nearly always stronger in rooms than in the open. If these films are not removed before coloring they show up as stains and the work will be streaked or spotted. Touching the work with the bare hands after it is cleaned will also leave a slight film that will make the work spotted, and hence it should be strung on wires or handled in other ways that will prevent it from being touched with the hands.

Several acid dips can be made that will remove these films and leave the bright clean metal with its original smooth surface. Work that will stand heating can be heated to a dull red and then plunged into dilute sulphuric acid, after which it should be soaked in old aquafortis and then thoroughly rinsed. It should be soaked long enough to have a uniform metallic appearance, and the bath should be large enough in volume to prevent its heating up from the hot work. The best results are obtained with straw-colored aquafortis, as the white is too weak and the red too strong. In diluting the sulphuric acid it should always be poured into the water slowly, as heat is generated, and too rapid mixing generates so much heat that the containing vessel is liable to crack and the escaping liquid to cause burns. To pour water into sulphuric acid will cause an explosion that is almost sure to result in serious, if not fatal, burns from the flying liquid.

A good method of removing these films, without heat, is to soak the work in a pickle composed of spent aquafortis until a black scale is formed and then dip it for a few minutes into a solution composed of 64 parts water, 64 parts commercial sulphuric acid, 32 parts aquafortis and 1 part hydrochloric acid. After that the work should be thoroughly rinsed several times with distilled water. If the strong aquafortis is used for the pickle in which the work is soaked it will cause a too rapid corrosion of the copper during the time of the solution of the protoxide. Hence the spent aquafortis is better on account of its slower action and it also saves the cost of new. A dip that is useful for removing the sand, etc., that sticks to castings is composed of 1 part spent aquafortis, 2 parts water and 6 parts hydrochloric acid. A few minutes will suffice for small pieces, but large castings can remain in the bath for thirty minutes. They become coated with a black mud and when this is thoroughly washed off they should be bright.

If a further whitening of the work is desired a solution may be made by mixing 3 pounds nitric acid, 4 pounds sulphuric acid and 40 grains sodium chloride (table salt), combining this with 40 times its bulk of water and allowing it to cool before using. If a dead surface is desired the following mixture can be added to the bath: 2 pounds nitric acid, 1 pound sulphuric acid, 10 grains sodium chloride and 40 grains zinc sulphate. The degree of deadness is determined by the length of time the work is left in the bath. As with all other solutions, the work should be well rinsed after leaving the bath and then thoroughly dried. Another dead dipping bath can be made from one part of a concentrated solution of potassium bichromate and two parts of concentrated hydrochloric acid. Many other combinations of chemicals may also be made for cleaning or whitening the work or giving a dead finish after it has been colored, but those given above will suffice for the present.

Bright Castings

The bright clean color sometimes seen on bronze castings has been thought by many to be the result of an acid dip. This has been produced, however, by plunging the castings into water while they are still red-hot. It is seldom that brass castings can be given this color as they usually contain too much lead. Likewise the bronze castings must be free

* For previous articles published in MACHINERY on coloring metals see "Coloring Iron and Steel Products," June, 1913, and other articles there referred to.

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from lead as well as iron, antimony or other impurities, and the water into which they are plunged must be clean, or a dirty, unpleasant color will be the result. The castings must also be as hot as possible when quenched. If too hot the metal will be brittle and hence the highness of the temperature is governed by the toughness that is desired in the casting, but if quenched after they have cooled too much the color will be dull. Copper ingots can be given a beautiful rose-red color by this method.

To Produce Yellow to Orange Colors

From a golden yellow to orange color can be given polished brass pieces by immersing them for the correct length of time in a solution composed of 5 parts caustic soda to 50 parts water, by weight, and 10 parts copper carbonate. When the desired shade is reached the work must be well washed with water and dried in sawdust. Golden yellow may be produced with the following: Dissolve 100 grains lead acetate in 1 pint water and add a solution of sodium hydrate until the precipitate which first forms is redissolved, and then add 300 grains red potassium ferricyanide. With the solution at ordinary temperatures the work will assume a golden yellow, but heating the solution darkens the color until at 125 degrees F. it has changed to a brown. A pale copper color can be given brass by heating it over a charcoal fire, with no smoke, until it turns a blackish brown, then immersing in a solution of zinc chloride that is gently boiling, and finally washing thoroughly in water. Dark yellow can be obtained by immersing for five minutes in a saturated solution of common salt containing some free hydrochloric acid and which has as much ammonium sulphide added as the solution will dissolve.

To Produce a Rich Gold Color

A rich gold color can be given brass by boiling it in a solution composed of 2 parts saltpeter, 1 part common salt, 1 part alum, 24 parts water, by weight, and 1 part hydrochloric acid. Another method is to apply to the work a mixture of 3 parts alum, 6 parts saltpeter, 3 parts sulphate of zinc and 3 parts common salt. The work is then heated over a hot plate until it becomes black and then washed with water, rubbed with vinegar and again washed and dried. Still another solution is made by dissolving 150 grains sodium thiosulphate in 300 grains water and adding 100 grains of an antimony chloride solution. After boiling for some time the red-colored precipitate must be filtered off, well washed with water and added to 4 pints of hot water. Then add a saturated solution of sodium hydrate and heat until the precipitate is dissolved. Immerse the brass articles in the latter solution until they have attained the correct shade. If left in too long they will be given a gray color.

To Produce White Colors or Coatings

The white color or coating that is given to such brass articles as pins, hooks and eyes, buttons, etc., can be produced by dipping them in a solution that is made up as follows: Dissolve 2 ounces fine grain silver in nitric acid, then add 1 gallon distilled water and put into a strong solution of sodium chloride. The silver will precipitate in the form of chloride and this must be washed until all traces of acid are removed. Testing the last rinse water with litmus paper will show when the acid has disappeared. Then mix this chloride of silver with an equal amount of potassium bitartrate (cream of tartar) and add enough water to give it the consistency of cream. The work is then immersed in this and stirred around until properly coated, after which it is rinsed in hot water and dried in sawdust.

Silvering

Another method of silvering that is applicable to such work as gage or clock dials, etc., consists of grinding together in a mortar 1 ounce very dry chloride of silver, 2 ounces cream of tartar and 3 ounces common salt. Then add enough water to make it of the desired consistency and rub it on the work with a soft cloth. This will give brass or bronze surfaces a dead white thin silver coating, but it will tarnish and wear if not given a coat of lacquer. The ordinary silver lacquers that can be applied cold are the best. Before adding the water, the mixture as it leaves the mortar can be kept a long time if put in very dark colored bottles, but if left where it will be attacked by light it will decompose.

Assorted Colors

Some very interesting results in coloring brass can be obtained by dissolving 200 grains sodium thiosulphate and 200 grains lead acetate in 1 pint water and heating it to from 190 to 195 degrees F. Immersing the work in this for five seconds will make it pale gold; fifteen seconds, brown gold; twenty-five seconds, crimson; thirty seconds, purple; forty-five seconds, an iridescent bluish crimson green; sixty seconds, pale blue; sixty-five seconds, mottled purple; eighty seconds, nickel color; eighty-five seconds, mottled blue and pink; one hundred and ten seconds, mottled purple and yellow; two and one-half minutes, pale purple; four minutes, mottled pink and yellow; five minutes, mottled pink and gray; ten minutes, mottled pink and light blue. Other combinations of colors can also be obtained, but some of these fade and change color unless protected by a coat of lacquer. By using one-quarter ounce of sulphuric acid in place of the lead acetate a variety of colors can also be produced, but they will not be as good a quality as those made with the above solution. Nitrate of iron can be used with equally good results.

To Produce Gray Colors

A solution of 1 ounce of arsenic chloride in 1 pint of water will produce a gray color on brass, but if the work is left in too long it will become black. The brass objects are left in the bath until they have assumed the correct shade and then are washed in clean warm water, dried in sawdust and finally in warm air. A dark gray color that can be made lighter by scratch brushing can be obtained by immersing the work in the following solution: 2 ounces white arsenic oxide, 4 ounces commercially pure (c. p) hydrochloric acid, 1 ounce sulphuric acid and 24 ounces water. A steel gray can be produced with the following: 20 ounces arsenious oxide, 10 ounces powdered copper sulphate, 2 ounces ammonium chloride and 1 gallon common hydrochloric acid. After mixing, this should stand for one day. A 5 per cent solution of platinum chloride in 95 per cent water will also produce a dark gray color if it is painted on and the brass is warmed. Weaker solutions will make the color lighter. Copper can also be colored, but the platinum does not adhere as firmly to the surface as it does on brass. A coating of lacquer is required to make it permanent. By smearing the work with a mixture of 1 part copper sulphate and 1 part zinc chloride in 2 parts water and drying this mixture on the brass, with heat, a dark brownish color is obtained. If desirous of immersing the work a weaker solution could be used. The color is changed very little by exposure to light.

To Produce Lilac Blue and Violet Colors

The lilac shades can be produced on yellow brass by immersing the work in the following solution when heated to between 160 and 180 degrees F. Thoroughly mix 1 ounce chloride, or butter, of antimony in 2 quarts muriatic acid, and then add 1 gallon water.

To give brass a blue color dissolve 1 ounce antimony chloride in 20 ounces water, and add 3 ounces hydrochloric acid. Then warm the work and immerse it in this solution until the desired blue is obtained. After that, wash it in clean water and dry in sawdust. A permanent and beautiful blue-black can be obtained by using just enough water to dissolve 2 ounces copper sulphate and then adding enough ammonia to neutralize and make it slightly alkaline. The work must be heated before immersion. Copper nitrate, water and ammonia will also yield this rich blue-black, but if the brass is very highly heated after immersion it changes to a dull steely black. On copper or work that is copper-plated this latter produces a crimson color.

A beautiful violet color can be produced on polished brass with a mixture of two solutions. First, 4 ounces sodium hyposulphite is dissolved in 1 quart water, then 1 ounce sugar of lead is dissolved in another quart of water and the two are well stirred together. By heating this to 175 degrees F. and immersing the work the correct length of time, it takes on the violet color. The work first turns a golden yellow and this

gradually turns to violet. If left a longer time the violet will turn to blue and then to green. Thus this same preparation can be used for all of these colors by correctly limiting the time that the work is immersed.

To Produce Green Colors

When left to the natural action of the atmosphere, or ageing, most of the brasses and bronzes first turn green, and very decidedly so if near the ocean where the moisture from the salt water attacks the metal. This green color gradually darkens and then turns brown and finally black. Some of the shades it assumes are very beautiful and hence they have been produced by chemical means, as nature is too slow in its action. So many different chemical combinations are used for this purpose that it would require a book to enumerate them all and hence only a few can be mentioned. Some of the green colors can be produced by the solutions given above, but the antique, or rust, greens require different mixtures.

One solution that will produce the verde antique, or rust green, is composed of 3 ounces crystallized chloride of iron, 1 pound ammonium chloride, 8 ounces verdigris, 10 ounces common salt, 4 ounces potassium bitartrate and 1 gallon water. If the objects to be colored are large, this can be put on with a brush and several applications may be required to give the desired depth of color. Small work should be immersed and the length of time it is immersed will govern the lightness or darkness of the color. After immersion, stippling the surface with a soft round brush, dampened with the solution, will give it the variegated appearance of the naturally aged brass or bronze. Another solution that will give practically the same results is composed of 2 ounces ammonium chloride, 2 ounces common salt, 4 ounces aqua-ammonia and 1 gallon water. The work may have to be immersed or painted several times to give it the desired coating, and after washing and drying it should be lacquered or waxed. The Flemish finish can be given brass with a solution composed of 1/4 ounce sulphuret of potassium, 1 to 2 ounces white arsenic, 1 quart muriatic acid and 10 gallons of water. The arsenic should be dissolved in a part of the acid by heating and then mixed with the balance of the acid and water. Two ounces sulphuret of potassium in a gallon of water may also be used if it is heated to 160 degrees F. One ounce sulphuric or muriatic acid in a gallon of water darkens the color produced by this last mixture.

To Produce Brown Colors

Many different shades of brown can be produced and many different chemicals are used to form solutions or pastes for this purpose. In these liver of sulphur, either potassium sulphide or sodium sulphide, is one of the most commonly used chemicals. One-fourth ounce liver of sulphur in 1 gallon water will give bronze a brown color when used cold but if heated it is more effective. The depth of the color is governed by the length of time that the work is immersed. If left in too long, however, it becomes black and if too much liver of sulphur is used the color will be black. Copper is turned black even with the weak solutions. To set the color it should afterwards be immersed in water containing a small amount of sulphuric or nitric acid. Brass is not attacked by this solution but if caustic potash is added it causes the liver of sulphur to color the brass. Then 2 ounces liver of sulphur should be added to 1 gallon water and from 2 to 8 ounces caustic potash, according to the shade of brown that is desired; the more potash the darker will be the color. A solution composed of 1/2 ounce potassium sulphide in 1 gallon of water will produce a gray or greenish color on brass when cold but when heated to 100 degrees F. it produces a light brown; at 120 degrees, a reddish brown; at 140 degrees, a dark brown; and at 180 degrees, a black color.

The barbedienne bronze, or brown, color can be produced on cast brass or bronze by immersing in a solution made by dissolving 2 ounces golden sulphuret of antimony and 8 ounces caustic soda in 1 gallon water. The work must be properly cleaned beforehand and afterwards scratch-brushed wet, with a little pumice stone applied when brushing. It must then be well washed and dried in sawdust. A second immersion in a solution of one-half the above strength will have a toning effect, and the work must again be washed and dried. The high light can be made to show relief by rubbing the object with pumice stone paste on a soft rag. A dead effect can be produced by immersing in a hot sulphuret of antimony solution for ten or fifteen seconds, then rewashing and immersing in hot water for a few seconds and drying in sawdust. The work should be lacquered to preserve the tones and waxed when the lacquer has become dry and hard. This brown color can be darkened by a five-seconds immersion in a cold solution of 8 ounces sulphate of copper in 1 gallon water. Some other processes use two solutions, the first of which is heated and the second used cold, after which the work is rinsed in boiling water.

To Produce Black

There are as many different processes and solutions for blackening brass as there are for browning, and consequently only a few can be given. Trioxide of arsenic, white arsenic or arsenious acid are different names for the chemical that is most commonly used. Its use can be traced back to the fifth century and it is the cheapest chemical for producing black on brass, copper, nickel, German silver, etc. It has a tendency to fade and a much greater tendency if not properly applied, but a coat of lacquer will preserve it a long time. A good black can be produced by immersing work in a solution composed of 2 ounces white arsenic and 5 ounces cyanide of potassium in 1 gallon water. This should be boiled on a gas stove, in an enamel or agate vessel and used hot. Another cheap solution is composed of 8 ounces sugar of lead, 8 ounces hyposulphite of soda and 1 gallon water. This must also be used hot and the work afterwards lacquered to prevent fading. When immersed the brass first turns yellow, then blue and then black, the latter being a deposit of sulphide of lead.

The ammonia-copper carbonate solution much used for medals, ornaments, etc., is made by taking the desired quantity of the strongest ammonia water and mixing it with an equal amount of distilled water, and dissolving carbonate of copper in it until it is thoroughly saturated and a little remains undissolved. This is placed in a stone crock and surrounded with water and then heated to from 150 to 170 degrees F. before the work is immersed. After immersing for a few seconds the brass will turn black and it is then removed and first rinsed in cold water and dried and then given a coat of dead, black lacquer.

A black that will withstand the wear of such articles as desk telephones can be given to brass with a solution that is made as follows: Mix 1 ounce nitrate of copper with 1 ounce water. Then mix 1 ounce nitrate of silver with 1 ounce water. Then combine 1 part of the nitrate of silver solution with 2 parts of the nitrate of copper solution and 3 parts water. Heat the brass, bronze or copper article to 250 degrees F., and give it two coats of this solution with set-in-rubber brushes. When the fluffy smut is brushed off with a stiff bristle brush, the work will be found to have a pleasing brownish black color that is tenacious. If it is desired to change this to a dead black the article can be immersed for 5 minutes in a cold solution made from 2 ounces liver of sulphur in 1 gallon water. It is then removed and heated until uniformly dead black and again brushed. It can then be given a coat of flat lacquer or waxed.

Oxidizing

Solutions that produce the green, brown or black colors are usually used when it is desired to oxidize copper, brass or bronze. A dark slate green can be produced with a solution composed of 8 ounces double nickel salts, 8 ounces sodium hyposulphite and 1 gallon water. The color is almost instantly produced when the temperature of the solution is above 150 degrees F., but below the boiling point, and the articles immersed. After removing and rinsing in water the relief is easily produced with pumice stone or other abrasives. This green color harmonizes well with the metal color.

The browns and blacks are coated on the metal in the same manner as described above under these headings; the solutions that are used hot give the best results, as the coating is more tenacious and better withstands the

buffing that is necessary when oxidizing the work. Many beautiful effects are produced by these combinations of colors, and while it is not difficult to relieve the rough surfaces of cast, stamped or pressed articles it requires considerable skill to properly relieve turned or polished surfaces.

Mottling

After properly buffing and cleaning the work, a handsome mottled effect can be produced by first immersing it in a boiling solution composed of 8 ounces sulphate of copper, 2 ounces salammoniac and 1 gallon water. This produces a light taffy color that soon changes to an olive green. The work should be removed when the taffy color appears and dipped in a second solution composed of 4 ounces sal-soda in 1 gallon water and that has the surface covered with a small amount of lard oil or gasoline. After that the work is again immersed in the first solution until the olive-green color is produced. The oil spreads over the surface and prevents the uniform action of the first solution, and hence the taffy and olive-green colors are mottled together with a pleasing effect. The same process might be used with different chemical solutions to mottle work with other combinations of colors.

Coloring Aluminum

Aluminum is the most difficult of metals to color. Heretofore aluminum parts have only been colored by coating them with lacquers of different colors, but a process has recently been patented by Salamon Axelrod in Germany that produces different metallic colors. Either a neutral or alkaline cobaltous nitrate is made into a water solution into which the articles are dipped, or it may be painted on pieces too large to dip. After that the work is heated and the degree of heat determines the color. A low temperature produces a steel gray color that changes to brown with a higher heat and to a durable and permanent dead black when the temperature is still higher. Zinc, tin and other white metals may also be colored with similar cobalt salt solutions.

The gun-metal finish can be given aluminum by immersing it for from six to ten seconds in a cold solution of 12 parts hydrochloric acid, 1 part chloride of antimony and 87 parts distilled water. After that, thoroughly wash it in running water for several minutes, dry with heat and lightly buff with a high-speed wheel. The color penetrates the metal and its depth is governed by the length of time it is immersed. If immersed longer than ten seconds the solution should be weakened, as hydrochloric acid eats the metal.

Nearly any color can be plated on any of the metals or alloys by electro deposition, but this is an art or trade that requires experienced platers. Electrochroma is the name given a new plating process that promises to revolutionize the older methods of plating on colors. It produces any desired shade of green, blue, red, violet or yellow and black and white by immersion in the electrolyte for from one-half minute to two minutes. The work is made the cathode. One of its special features is the coloring of leaded glass. The lead can be given any desired color, while the glass is not affected but is left clean and with a clear luster. Heretofore the lead has been painted by hand, which was a long, tedious job, often consuming a day or more for one piece. It is also easy to match colors with this plating process and they are permanent enough not to require lacquering or waxing. The plating processes, however, are separate and distinct from those given above, as these do not require an electric current nor the high degree of knowledge and skill that goes with the plater's profession.

NEW YORK CENTRAL LINES SAFETY EXHIBIT CAR

The safety exhibit car is a new feature that has just been introduced by the New York Central Lines. This car has been put into service in connection with the work of the safety department of the company. It is intended primarily as an instruction car for the purpose of teaching the 125,000 or more employes of the railroad, the principle of "safety first," although it is also an interesting exhibit for the general public. An interior view of the car is shown in the accompanying illustration. Along each side is a shelf about 3 feet from the floor, which carries models of various metal- and wood-working machines used in the locomotive repair and car shops. These models are equipped with guards and various safety appliances such as are used on the machines which they represent. Along the side walls of the car above the models there are rows of pictures which form an instructive feature of the exhibit. On one side of the car, the pictures are devoted entirely to unsafe practices, there being about 100 photographs showing the common practices of railroad employes which cause accidents resulting in injuries to themselves and others. Beside a picture showing the improper or unsafe method, there is another showing the safe and proper way. Another section of the picture gallery deals with the trespassing question, there being a number of pictures showing to what extent persons risk their lives, needlessly, by trespassing on railroad property. Above these pictures there is a statement calling attention to the fact that nearly 5300 people were killed and 5700 injured, while trespassing on the railroads of the United States during the year ending June 30, 1912. Attached to the exhibit car, there will be a coach equipped with a stereopticon so that illustrated lectures on safety can be given to employes at various points along the New York Central Lines.

Interior of New York Central Lines Safety Exhibit Car

* * *

AN INSTANCE OF RAPID GEAR-CUTTING

As an instance of the celerity with which up-to-date gear cutting concerns are required to work at times may be cited the making of a large special semi-steel gear by the Philadelphia Gear Works. This was a 56-inch, 3-inch circular pitch spur gear, with a 10-inch face, weighing 3340 pounds. The order came in on a Saturday morning and the pattern was made, sent to the foundry and the gear casting was returned on Wednesday morning. The gear blank was turned up Wednesday afternoon and Thursday morning, and the teeth were cut and finished by Friday morning. At the time this work was going through, a 15-inch mating pinion was carried through and shipped with the large gear on Friday afternoon.

STEAM POWER PLANT PIPING DETAILS—6

PROVIDING FOR EXPANSION AND CONTRACTION STRAINS IN PIPING SYSTEMS—(Continued)

BY WILLIAM F. FISCHER*

Exhaust mains as used in connection with condensing systems are known as vacuum exhaust mains, while those discharging the steam directly into the atmosphere are known as atmospheric exhaust mains. Atmospheric and vacuum exhaust mains expand and contract the same as do high-pressure steam mains, but not to the same extent, as the steam temperatures are lower. Exhaust mains are considerably larger than live-steam mains, however, and contain a much greater cross-sectional area of metal in the walls of the pipe; therefore they exert a greater thrust or pressure when expanding, which tends to strain the valves and fittings in the line, and even the machinery to which the exhaust piping is connected.

The thrust or pressure exerted by an exhaust main as it expands may be figured in exactly the same manner as described in the August number of MACHINERY. (See heading: "The Force of Expansion," page 959.) As exhaust mains are of greater diameter than live-steam mains, they will not bend, or buckle as easily when strained by expansion of the piping system, and this should be taken into account when making provision for expansion and contraction, even though the actual expansion be slight.

The materials commonly used in the construction of exhaust steam mains are steel, wrought iron and cast iron. Large vacuum exhaust mains are nearly always made of cast-iron pipe. Tables V, VI and VII are for use in figuring the expansion of atmospheric and vacuum exhaust mains. Table V is to be used for wrought iron pipe, Table VI for steel pipe and Table VII for cast-iron pipe. As the coefficients of expansion for the various metals vary slightly at different temperatures, this has been taken into account in preparing these tables. The values of the coefficients for different steam temperatures are given at the foot of each table.

Explanation of the Tables

The tables are to be used only for exhaust mains carrying steam at atmospheric pressure or lower. The temperature of exhaust steam at atmospheric pressure (14.7 pounds per square inch absolute pressure) is 212 degrees F. Steam at atmospheric pressure or lower will not be recorded on a steam gage, as the gage is so arranged that the pointer or hand registers zero at atmospheric pressure or lower. Steam pressures below atmospheric pressure are règistered either on a vacuum gage or mercury column. A column of mercury approximately 30 inches high exerts a pressure of 15 pounds per square inch at its base; therefore, two inches of mercury is equivalent to approximately one pound pressure per square inch. If a vacuum gage attached to a condenser registers 26 inches it means that the condenser is working under a 26-inch vacuum, or a pressure approximately equal to $26 \div 2 = 13$ pounds lower than atmospheric pressure, or $15 - 13 = 2$ pounds absolute pressure, approximately. Absolute pressure is the pressure reckoned from a complete vacuum; therefore atmospheric pressure (zero pressure as shown by a steam gage) is, in reality, approximately 14.7 pounds per square inch above vacuum.

The upper line of each table gives the vacuum in inches of mercury, as recorded on a vacuum gage connected either to the condenser or to the exhaust main. In the second line of each table is given the temperature of the exhaust steam, corresponding to the vacuum, in inches of mercury. The figures in the body of the table represent the expansion, in decimals of an inch, per lineal foot of pipe. In the first column of the table the initial temperature of the pipe is given (temperature before steam is turned into the piping system). The values given in the last column are for exhaust mains carrying steam at atmospheric pressure. To find the expansion, in inches, of an exhaust main of a given length in feet, multiply the constants as given in the table, by the length of pipe, in feet.

Example:—A cast-iron vacuum exhaust main 35 feet long discharges its steam to a surface condenser which operates under a vacuum of approximately 26 inches of mercury, as recorded on a vacuum gage attached to the condenser, or the exhaust main. The initial temperature of the pipe before steam is turned into it is 30 degrees F. How much will the pipe expand? The expansion in inches, per foot of length, is found in Table VII under 26-inch vacuum, and opposite 30 degrees initial temperature of pipe, to be 0.00685, which, multiplied by 35 (the length of the pipe in feet), gives $0.00685 \times 35 = 0.24$ inch, or approximately $\frac{1}{4}$ inch.

Allowing for Expansion and Contraction in Steam and Exhaust Mains

It is considered good practice when figuring for expansion, to allow one-half the calculated amount when cutting the pipe to length.

Example:—If, in a run of pipe 75 feet between connections, or points where the branch pipes are taken off from the header,

TABLE V. EXPANSION OF WROUGHT IRON PIPE—VACUUM EXHAUST MAINS

Initial Temperature of Pipe in Degrees F.	Vacuum, in Inches of Mercury														
	28	26	24	22	20	18	16	14	12	10	8	6	4	2	Atmos. Pressure
	Temperature of Steam, Degrees F.														
	100	125	140	152	162	169	176	182	187	192	197	201	205	209	212
	Expansion in Inches per Foot of Length														
0	0.00792	0.00990	0.01130	0.01230	0.01310	0.01365	0.01422	0.01500	0.01543	0.01585	0.01625	0.01680	0.01692	0.01725	0.01750
10	0.00712	0.00910	0.01050	0.01150	0.01230	0.01285	0.01340	0.01420	0.01460	0.01500	0.01543	0.01575	0.01610	0.01612	0.01670
20	0.00635	0.00832	0.00970	0.01067	0.01150	0.01205	0.01262	0.01340	0.01380	0.01420	0.01460	0.01495	0.01527	0.01560	0.01585
30	0.00555	0.00752	0.00890	0.00986	0.01067	0.01123	0.01180	0.01255	0.01295	0.01340	0.01380	0.01410	0.01445	0.01480	0.01500
35	0.00515	0.00712	0.00850	0.00947	0.01028	0.01082	0.01140	0.01213	0.01255	0.01295	0.01340	0.01370	0.01403	0.01437	0.01460
40	0.00475	0.00673	0.00808	0.00905	0.00986	0.01042	0.01100	0.01172	0.01213	0.01255	0.01295	0.01330	0.01362	0.01395	0.01420
45	0.00435	0.00635	0.00768	0.00865	0.00947	0.01000	0.01060	0.01130	0.01172	0.01213	0.01255	0.01290	0.01320	0.01355	0.01380
50	0.00396	0.00594	0.00728	0.00825	0.00905	0.00963	0.01020	0.01090	0.01130	0.01172	0.01213	0.01245	0.01280	0.01312	0.01340
55	0.00356	0.00555	0.00687	0.00784	0.00865	0.00922	0.00978	0.01050	0.01090	0.01130	0.01172	0.01201	0.01240	0.01272	0.01295
60	0.00316	0.00515	0.00647	0.00743	0.00825	0.00882	0.00938	0.01010	0.01050	0.01090	0.01130	0.01165	0.01197	0.01230	0.01255
65	0.00277	0.00475	0.00607	0.00703	0.00784	0.00840	0.00897	0.00965	0.01010	0.01050	0.01090	0.01120	0.01155	0.01190	0.01213
70	0.00238	0.00435	0.00567	0.00663	0.00743	0.00800	0.00857	0.00925	0.00965	0.01010	0.01050	0.01080	0.01115	0.01148	0.01172
75	0.00198	0.00936	0.00525	0.00623	0.00703	0.00760	0.00817	0.00885	0.00925	0.00965	0.01010	0.01040	0.01072	0.01108	0.01130
80	0.00158	0.00356	0.00485	0.00582	0.00663	0.00720	0.00776	0.00843	0.00885	0.00925	0.00965	0.01000	0.01030	0.01065	0.01090
90	0.00079	0.00277	0.00405	0.00502	0.00582	0.00638	0.00695	0.00760	0.00800	0.00843	0.00885	0.00917	0.00950	0.00983	0.01010
100	0	0.00198	0.00324	0.00420	0.00502	0.00558	0.00615	0.00677	0.00720	0.00760	0.00800	0.00835	0.00867	0.00900	0.00925

Machinery

Coefficients of expansion used in computing the above table: Steam temperatures 100 degrees to 125 degrees inclusive, 0.00000660; steam temperatures 140 degrees to 176 degrees inclusive, 0.00000673; steam temperatures 182 degrees to 212 degrees inclusive, 0.00000688.

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the expansion is calculated to be 2 inches, it would be good practice to allow one-half of this amount when cutting the pipe to length. In other words, the total length of pipe between connections should be 75 feet minus 1 inch. The steam-fitter takes up the other inch, putting a cold strain on the pipe and springing the bends sufficiently to make up the joints. to strain the piping sufficiently to make up the joints. If one-half, or any part, of the expansion is allowed for when cutting the pipe to length, the steam-fitter should be notified to that effect, as otherwise he is apt to find the pipe short and install a "Dutchman" in the line, not knowing that expansion had been allowed for in the shop.

TABLE VI. EXPANSION OF STEEL PIPE–VACUUM EXHAUST MAINS

Initial Temperature of Pipe in Degrees F.	Vacuum, in Inches of Mercury														
	28	26	24	22	20	18	16	14	12	10	8	6	4	2	Atmos. Pressure
	Temperature of Steam, Degrees F.														
	100	125	140	152	162	169	176	182	187	192	197	201	205	209	212
	Expansion in Inches per Foot of Length														
0	0.00678	0.00850	0.00968	0.01050	0.01120	0.01168	0.01215	0.01285	0.01320	0.01355	0.01400	0.01420	0.01450	0.01480	0.01500
10	0.00610	0.00780	0.00898	0.00980	0.01050	0.01100	0.01147	0.01215	0.01250	0.01285	0.01320	0.01350	0.01380	0.01400	0.01430
20	0 00542	0.00712	0.00830	0.00913	0.00980	0.01030	0.01078	0.01145	0.01180	0.01215	0.01250	0.01280	0.01310	0.01335	0.01355
30	0.00425	0.00645	0.00760	0.00893	0.00913	0.00960	0.01010	0.01073	0.01110	0.01145	0.01180	0.01210	0.01238	0.01265	0.01285
35	0.00440	0.00610	0.00725	0.00810	0.00878	0 00927	0.00975	0.01040	0.01073	0.01110	0.01145	0.01173	0.01200	0.01230	0.01250
40	0.00407	0.00575	0.00691	0.00775	0.00893	0.00892	0.00940	0.01002	0.01040	0.01073	0.01110	0.01140	0 01165	0.01195	0.01215
45	0.00373	0.00542	0 00655	0.00740	0.00810	0.00857	0.00905	0.00968	0.01002	0.01040	0.01073	0.01100	0 01130	0.01160	0.01180
50	0.00339	0 00518	0.00622	0.00705	0.00775	0.00823	0.00870	0.00933	0.00968	0.01002	0.01040	0.01067	0.01095	0.01123	0.01145
55	0.00305	0.00425	0.00587	0.00670	0.00740	0.00788	0.00835	0.00898	0.00933	0.00968	0.01002	0.01030	0.01060	0.01090	0.01110
60	0.00271	0.00440	0.00553	0.00635	0.00705	0.00753	0.00800	0.00863	0.00898	0.00933	0.00968	0.00997	0.01025	0.01052	0.01073
65	0.00237	0.00407	0 00518	0.00600	0.00670	0.00718	0.00767	0.00827	0.00863	0.00898	0.00933	0 00960	0.00990	0.01018	0 01040
70	0.00203	0.00373	0.00483	0.00567	0.00635	0.00685	0.00733	0.00792	0.00827	0.00863	0.00898	0.00926	0.00955	0.00983	0.01002
75	0.00169	0.00339	0.00450	0.00532	0.00600	0.00650	0.00698	0.00755	0.00792	0.00827	0.00863	0.00890	0.00920	0.00948	0.00968
80	0.00136	0.00305	0.00415	0 00497	0.00567	0.00615	0.00663	0.00720	0.00755	0.00792	0.00827	0.00855	0.00885	0.00912	0.00933
90	0.00068	0.00237	0.90345	0.00428	0.00497	0 00545	0.00594	0.00650	0.00685	0.00720	0.00755	0.00785	0.00815	0.00842	0.00863
100	0	0.00169	0.00276	0.00359	0.00428	0.00477	0.00525	0.00580	0.00615	0.00650	0.00685	0.00715	0.00742	0.00770	0.00792

Machinery

Coefficients of expansion used in computing the above table: Steam temperatures 100 degrees to 125 degrees inclusive, 0.00000565; steam temperatures 140 degrees to 176 degrees inclusive, 0.00000576; steam temperatures 182 degrees to 212 degrees, 0.00000590.

When steam is turned into the piping system, the elongation of the main, due to expansion, removes the cold strain, and in this way the fittings, valves and pipe joints are, at any time, strained only one-half as much as if none, or all, of the expansion were allowed for when cutting the pipe to length.

Most of the large concerns making a specialty of furnishing and erecting piping material have adopted this rule in their shops and it has proved to be satisfactory for conditions in general. When estimating the pipe length, some designers allow for all of the expansion in the line, with the result that when the steam-fitter comes to erect the piping system he finds it necessary, especially in long lines of piping, to install what is known as a "Dutchman" or filler piece (see Fig. 41) in order to make up the required length, as he finds it impossible

Anchoring Steam Mains

The method of anchoring steam main and branch pipes and the location of the anchors are very important details which should be given the proper attention when designing and erecting a piping system. If the anchors are not properly located the expansion of the piping may throw severe strains on the joints, resulting in loose gaskets and bolts and causing leakage. A steam main should never be anchored at two or more points in its length, unless an expansion bend or joint is provided at some point between the anchors; otherwise the anchors would be very apt to fail, or the pipe would bow or spring out of shape and strain the joints of the main header and branch pipes.

No special rules can be given for designing and anchoring

TABLE VII. EXPANSION OF CAST-IRON PIPE–VACUUM EXHAUST MAINS

Initial Temperature of Pipe in Degrees F.	Vacuum, in Inches of Mercury														
	28	26	24	22	20	18	16	14	12	10	8	6	4	2	Atmos. Pressure
	Temperature of Steam, Degrees F.														
	100	125	140	152	162	169	176	182	187	192	197	201	205	209	212
	Expansion in Inches per Foot of Length														
0	0.00720	0.00900	0.01028	0.01118	0.01190	0.01240	0.01292	0.01365	0.01402	0.01440	0.01480	0.01510	0.01547	0.01570	0.01590
10	0.00650	0.00830	0.00955	0.01042	0.01115	0.01168	0.01220	0.01290	0.01330	0.01365	0.01402	0.01432	0.01462	0.01492	0.01515
20	0.00576	0.00757	0 00882	0.00970	0.01042	0.01093	0.01145	0.01215	0.01253	0.01290	0.01330	0.01358	0.01388	0.01420	0.01440
30	0 00505	0.00685	0.00808	0.00897	0.00970	0.01020	0.01070	0.01140	0.01178	0.01215	0.01253	0.01282	0.01312	0.01342	0.01365
35	0.00468	0.00650	0.00772	0.00860	0.00933	0.00985	0.01035	0.01103	0.01140	0.01178	0.01215	0.01245	0.01275	0.01305	0.01330
40	0.00433	0.00613	0.00735	0.00823	0.00897	0.00948	0.01000	0.01065	0.01103	0.01140	0.01178	0.01208	0.01238	0.01267	0.01290
45	0 00396	0.00576	0.00698	0.00786	0.00860	0.00912	0.00963	0.01028	0.01065	0.01103	0.01140	0.01170	0.01200	0.01230	0.01253
50	0.00360	0.00540	0.00661	0.00750	0.00823	0.00875	0.00926	0.00990	0.01028	0.01065	0.01103	0.01132	0.01163	0.01192	0.01215
55	0 00324	0.00505	0.00625	0.00712	0.00786	0.00838	0.00890	0.00953	0.00990	0.01028	0.01065	0.01095	0.01125	0.01155	0.01178
60	0.00288	0.00468	0.00588	0.00675	0.00750	0.00800	0.00855	0.00915	0.00953	0.00990	0.01028	0.01058	0.01088	0.01118	0.01140
65	0.00252	0.00433	0.00550	0.00638	0.00712	0.00765	0.00815	0.00878	0.00915	0.00953	0 00990	0.01020	0.01050	0.01080	0.01103
70	0.00216	0.00396	0.00515	0.00602	0.00675	0.00727	0.00778	0.00840	0.00878	0.00915	0.00953	0.00983	0.01013	0.01042	0.01065
75	0.00180	0.00360	0.00477	0 00565	0.00638	0.00690	0.00742	0.00803	0.00840	0.00878	0.00915	0.00945	0.00975	0.01005	0.01028
80	0 00144	0.00324	0.00441	0 00528	0.00602	0.00653	0.00705	0.00765	0.00803	0.00840	0.00878	0.00908	0.00938	0.00968	0.00990
90	0.00072	0.00252	0.00367	0.00455	0.00528	0.00580	0.00632	0.00690	0.00728	0.00765	0.00803	0.00883	0.00863	0.00893	0.00915
100	0	0.00180	0.00294	0.00382	0.00455	0.00507	0.00558	0.00615	0.00653	0.00690	0.00728	0.00758	0.00788	0.00818	0.00840

Machinery

Coefficients of expansion used in computing the above table: Steam temperatures 100 degrees to 125 degrees inclusive, 0.00000600; steam temperatures 140 degrees to 176 degrees inclusive, 0.00000612; steam temperatures 182 degrees to 212 degrees inclusive, 0.00000626.

against expansion and contraction. The designer must depend more or less upon his own judgment in placing the expansion bends and anchors where they will do the most good. Pipe anchors should always be supported on rigid foundations, or steelwork, in order to resist the severe strains which they are subjected to. Any movement of a pipe anchor, or its foundation, defeats the purpose for which it was intended and is liable to cause the expansion strains to come on some member of the piping system where least desired, with subsequent damage to the steam main or machinery to which it is connected.

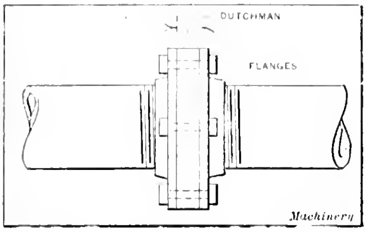


Fig. 41. "Dutchman" required when Pipes are cut Short enough to allow for All Expansion

As a guide in placing anchors and bends, see Fig. 39 (August number of MACHINERY) and also the following examples and illustrations showing several methods of caring for expansion and contraction.

Caring for Expansion and Contraction

Having determined the amount a steam pipe will expand in service, the next question that arises is how the expansion shall be taken care of so that the piping system can expand and contract freely without injury to the joints, valves and fittings in the line.

For steam mains of moderate length—say 50 to 100 feet—where flexible pipe connections are provided between the main header and the engines and boilers, the main header may be

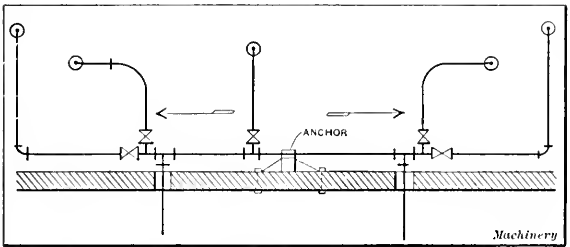


Fig. 42. Diagram showing Method of anchoring a Steam Line of Moderate Length

anchored rigidly at, or near the center of the line, thus allowing expansion in both directions, as indicated by the arrows in Fig. 42. In this case, the joints nearest the anchor are subjected to the least strain, the greatest strain falling on the joints near the end of the header. If the lines are very long it is usually better to install an expansion bend or loop in the header somewhere between the different branches, as shown in

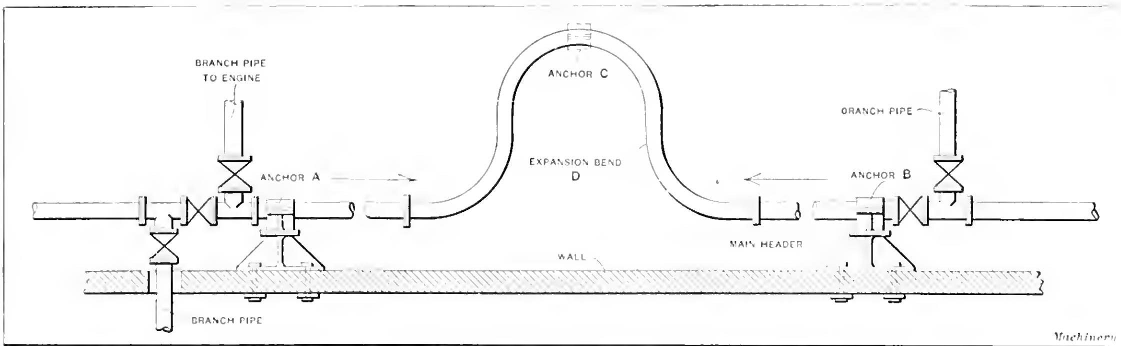


Fig. 43. Illustrating Method of compensating for Expansion and Contraction by the Use of an Expansion Bend

Fig. 43, provided the expansion in the line is sufficient to warrant the use of a loop. In Fig. 43, the main header is shown anchored close to the branch pipes at *A* and *B*, and an expansion bend is placed at any convenient point between the branch pipes, as shown at *D*. In very long pipe lines, it may be necessary to anchor the expansion bend at *C*, in order to prevent the main header from buckling sideways. When heated, the main header expands in the direction of the arrows, tending to close the bend; thus, in order to insure sufficient elasticity, the expansion bend should be designed to suit the elongation of the main header. If one-half of the expansion between points *A* and *B* is allowed for when cutting the pipe to length, expansion bend *D* would be sprung or stretched this amount during erection in order to make up the pipe joints, and would thus take care of approximately twice as much expansion as the same bend would if none of the expansion were allowed for when cutting the pipe. Rules for designing expansion bends will be given in a later installment.

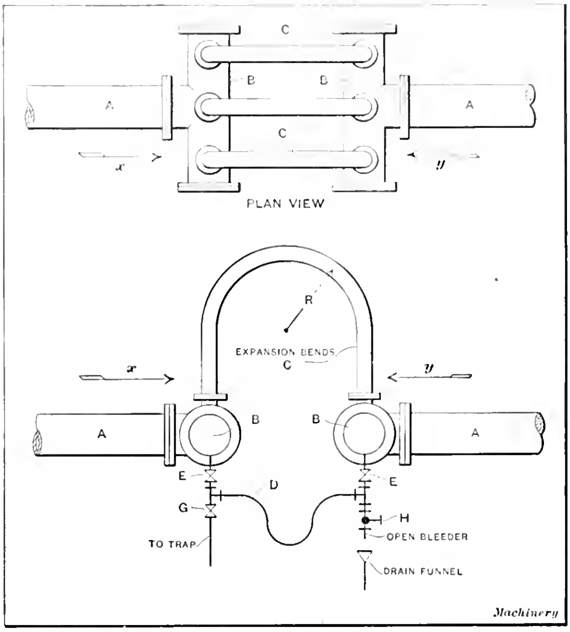
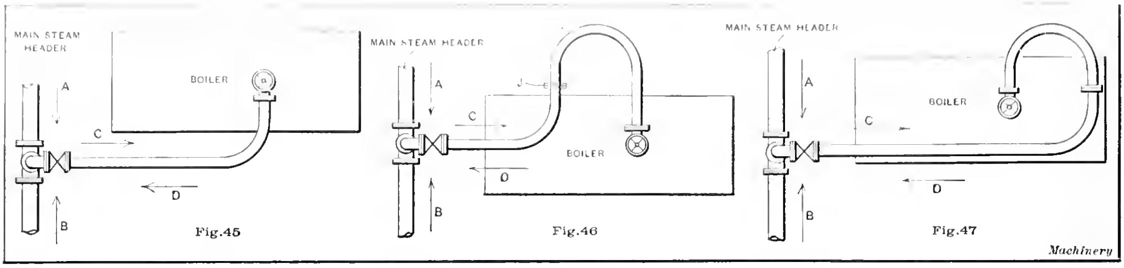


Fig. 44. An Expansion Bend formed of Three Pipes to secure Flexibility

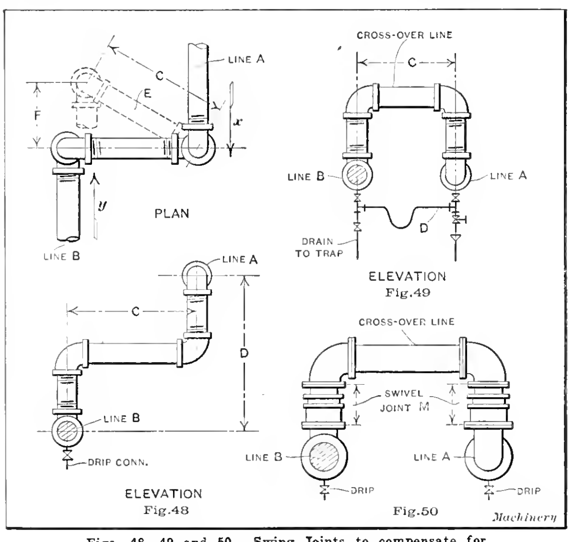
The old type of slip-expansion joints are seldom if ever used on high-pressure steam mains, as there is always more or less danger of the joint pulling apart from the pressure in the main. These joints, when used in the past, have proved a constant source of trouble and expense, requiring frequent repacking and adjustment, and almost invariably have been discarded for the more modern type of expansion bend, or balanced expansion joint now on the market. The balanced type of expansion joint is constructed so that the pressure is equalized in such a way as to prevent the joint from pulling apart. For high-pressure pipe work, expansion bends should always be given the preference over all types of expansion joints, provided there is sufficient space available to accommodate the bend. Expansion bends act as a spring, the deflection of the bend being distributed uniformly throughout the bend, thus serving to take up any movement of the pipe due to expansion or contraction.

Expansion bends made of large pipe are considerably stiffer and more rigid than bends of smaller pipe and do not deflect as readily unless bent to a very large radius. Where lack of space prohibits the use of an extremely large single-expansion bend, the expansion in a steam main of large diameter may be taken care of as shown in Fig. 44. In this case, the main header *A* is broken as shown, making connection with manifolds *B*, to which are connected U-bends *C*. The combined areas of bends *C* should be equivalent to, or greater than, the area of the main header *A*, in order that the flow of steam may not be retarded at this point. Of course, the use of a number of small bends *C* makes a more flexible connection than would a single bend of the same size as the main header, if bent to the same radius as the smaller bends. Referring to the elevation, shown in Fig. 44, we see that as the water of condensation tends to lodge in the manifolds *B* until it is picked up by the rapidly flowing steam and carried over at high velocity through bends *C*, it might cause a dangerous "water hammer" in the line. This should be guarded against by connecting a drain pipe *D* to the bottom of each manifold *B* as shown. Drain pipe *D* should be bent into the form of an expansion loop, in order to prevent expansion strains on the small valves and fittings in the drain line as the main header expands, as indicated by arrows *x-y*. Drain pipe *D* should be connected to a steam trap or other drip return system, through valve *G*. It is also advisable to provide an open bleeder, or emergency "test drain" connection, as shown at *H*, leading to an open funnel-shaped fitting, for testing or clearing the line of water when shutting down. Valves *E* are for emergency use only, being used in case it becomes necessary to disconnect or repair the drain pipe; they should always remain wide open during operation, so that if the trap or drip return system failed to operate, the water of condensation entering one manifold would flow down through drain pipe *D* into the bottom of the other manifold, where it would be carried on by the steam flow. In this manner, a dangerous water pocket could be avoided. (For further information regarding drip connections of this kind, see Fig. 28, page 705, MACHINERY, May, 1913.)



Figs. 45, 46 and 47. Different Methods of providing for Expansion and Contraction in Branch Pipes

Figs. 45, 46 and 47 show three different methods of providing for expansion and contraction in the branch pipes connecting the boilers with the main header. The connections take care of any movement of the pipes in either direction, as shown by the arrows *A*, *B*, *C* and *D*. The connection illustrated in Fig. 45 is not quite as flexible as that shown in Figs. 46 and 47. The connection, Fig. 47, requires more pipe than either of the other two. The connections, Figs. 46 and 47, are preferable where considerable movement has to be taken care of in the direction indicated by arrows *A* and *B*. The connection, Fig. 46, may be made up of two bends, if so desired, by using a flanged joint at *J*.



Figs. 48, 49 and 50. Swing Joints to compensate for Expansion and Contraction

Swing Joints

Figs. 48, 49 and 50 show different methods of taking care of expansion strains in steam piping by what are known as "swing joints." Figs. 48 and 49 show methods usually employed in making up swing joints on small and medium size pipe lines, where screwed fittings are used. In Fig. 48, pipe lines *A* and *B* are at different levels, as indicated at *D*, and are offset as at *C*. When the pipe expands in the direction of the arrows *x* and *y*, the pipe swings, or rotates on the threaded joints sufficiently to take up the expansion *F*, assuming the position shown by the dotted lines *E*. If, in this case, the steam flow were in the direction of arrow *x*, flowing from line *A* to line *B*, any water of condensation forming in the line, or carried over from the boilers with the steam, would be carried on by the steam flow without danger of water hammer at this point; but, if the steam flow were in the direction of arrow *y*, line *A* being at a higher elevation than line *B*, would form a water pocket in the riser. To prevent this, the line should be dripped at the low point as shown in the elevation.

Fig. 49 shows an arrangement of swing joints where pipe lines *A* and *B* are on the same level, but offset as at *C*. With this arrangement, the vertical legs of the cross-over connection will form a dangerous water pocket in the lines unless properly drained at the inlet side. In a case of this kind it might be advisable to connect a drain pipe to both vertical legs of the cross-over line and connect them as at *D*.

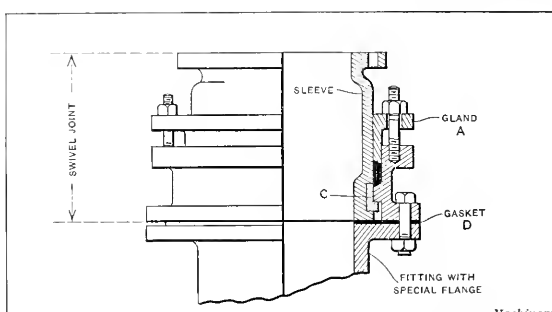


Fig. 51. Detail of Crane Co.'s Swivel Expansion Joint

Fig. 50 shows a method of connecting swing joints where either bolted flanged pipe and fittings are used or screwed pipe with screwed fittings. In this case, the swivel expansion joints *M* are connected to each vertical leg of the cross-over line, and rotate in a packed gland as the pipe expands.

Fig. 51 shows an enlarged detail and part section of one of these joints, as manufactured by the Crane Co. The upper half of these joints has flanges which match the fittings. The lower body flanges are of a special diameter and have special drilling; for this reason it is necessary to provide a special flange on the fittings to which the lower flanges connect. These swivel joints are constructed in such a manner that it is impossible for the sleeves to blow out or pull apart without shearing the circumferential bushing ring *C*. The joint, when made up, is packed steam-tight by screwing down the packing gland *A*. The upper sleeves of these joints will make a complete revolution while under pressure, with no danger of the joint blowing out or pulling apart.

Swivel expansion joints may be obtained with either screwed or flanged ends, as desired, for steam pressures as high as 250 pounds per square inch. For high pressures, however, it is advisable to use long radius steel pipe bends wherever possible in preference to expansion joints, or swing joints of any type. Pipe bends decrease the number of joints in the line, and if they are properly proportioned for the service will give far more satisfaction than the methods described in the foregoing. Swing joints are used mostly for low-pressure steam heating work, to take up the expansion in the different branches of the piping system, pipe risers, etc.

* * *

FORMULA FOR DETERMINING THE BALL CIRCLE DIAMETER FOR BALL BEARINGS*

BY WILBUR C. PRIOR†

The formula which is developed in this article is one which the writer has found very useful in solving ball-bearing problems, and it can also be used to advantage in other kinds of work. Its use will be illustrated at the end of this article. This is the only formula known to the writer for figuring the ball circle diameter where there is a space between consecutive balls. Smith and Marx, in their book on machine design, give the formula $R = \dfrac{r}{\sin \dfrac{180 \text{ deg.}}{n}}$ but this applies only to full type bearings and, even when it can be used, it is more cumbersome than the one given below:

In the diagram let:

D = ball circle diameter;

d = ball diameter;

S = space between balls;

n = number of balls.

It should be noticed that the distance S is measured on a straight line joining the centers of adjacent balls.

Construction

Draw the perpendicular bisector XZ of the chord WY. This line will pass through the center of the circle (A perpendicular bisector of a chord passes through the center of the circle).

Derivation of the Formula

In triangle XYZ:

$$\text{Side } XY = \frac{d+S}{2}$$

$$\text{Side } YZ = \frac{D}{2}$$

$$\text{Angle } XZY = \frac{180}{n}$$

$$\text{Cosecant } XZY = \frac{\dfrac{D}{2}}{\dfrac{d+S}{2}} = \frac{D}{2} \times \frac{2}{d+S} = \frac{D}{d+S}$$

Denoting cosecant XZY by C we have:

$$C = \frac{D}{d+S}$$

$$D = C\ (d+S) = \text{diameter of ball circle.}$$

* For further information on ball bearing design see MACHINERY'S Data Sheet No. 25, entitled "Formulas for Ball and Roller Bearings."
† Address: Forestville, Conn.

Example

The following example illustrates the use of the formula in connection with the values of C corresponding to different values of n in the table. Given the number and size of the balls, and the space required between consecutive balls; to find the ball circle diameter:

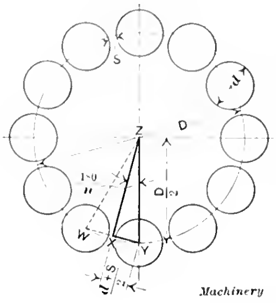
Let number of balls = 17;

diameter of balls = 5/16 inch;

space between balls = 1/8 inch.

Then looking in the table opposite 17 in the n column we find 5.4464 in the C column.

TABLE OF CONSTANTS FOR FINDING BALL CIRCLE DIAMETERS WITH SPACE BETWEEN BALLS



n	C	n	C	n	C
3	1.1547	13	4.1804	23	7.3496
4	1.4142	14	4.4964	24	7.6613
5	1.7013	15	4 8097	25	7.9787
6	2.0000	16	5.1258	26	8.3000
7	2.3051	17	5.4464	27	8.6138
8	2.6131	18	5.7588	28	8.9294
9	2.9238	19	6.0779	29	9.2445
10	3.2361	20	6.3924	30	9.5668
11	3.5502	21	6.7106	31	9.8785
12	3.8637	22	7.0282	32	10.2110

n	C	n	C
33	10.529	63	20.112
34	10.826	64	20.398
35	11.167	65	20.692
36	11.474	66	20.996
37	11.803	67	21.387
38	12.101	68	21.629
39	12 442	69	21.960
40	12.745	70	22.301
41	13.064	71	22.654
42	13.399	72	22.925
43	13.719	73	23.298
44	14.020	74	23.586
45	14.335	75	23.880
46	14.664	76	24.182
47	14.971	77	24.480
48	15.290	78	24.811
49	15.623	79	25.137
50	15.926	80	25.471
51	16.241	81	25.815
52	16.570	82	26.169
53	16.911	83	26.410
54	17.198	84	26.780
55	17.531	85	27.023
56	17.858	86	27.421
57	18.141	87	27.686
58	18.491	88	28.092
59	18.794	89	28.370
60	19.107	90	28.654
61	19.431	91	29.090
62	19.766	92	29.388

Machinery

Substituting known values in the formula $D = C\ (d + S)$ we obtain $D = 5.4464\ (5/16 + 1/8) = 2.382$ inches = diameter of ball circle.

* * *

PROJECTILE FOR DESTROYING AEROPLANES

The means for destroying aeroplanes and airships are keeping pace with the new inventions made in the aeronautical field. Thus, for example, tests have been made in Germany with a special projectile intended for the destruction of dirigible airships. The projectile is fired from a regular army rifle, and is provided with small wings or projections which open during the flight of the projectile under the influence of a spring, which latter is compressed while the projectile is still in the rifle barrel but expands as soon as it has passed from the muzzle. An ordinary bullet leaves such a small hole in the envelope of the dirigible that the gas escapes very slowly. The wings or projections of the present bullet will tear a hole of considerable size in the fabric and in addition will cause a device contained in the bullet to ignite the gas.

* * *

WAGES OF GERMAN LABORERS

Robert Grimshaw, of Dresden, Germany, writes that the wages of ordinary day laborers in twenty-three German cities of over two thousand inhabitants are officially reported as follows: Munchen (Munich), 3.70 marks (88 cents); Berlin, Charlottenburg and Rixdorf, 3.60 marks (85.7 cents); Leipzig, Dusseldorf and Stuttgart, 3.50 marks (83.3 cents); Hamburg, Frankfurt-on-Main, Nurnberg and Essen, 3.40 marks (80.9 cents); Dresden, Dortmund, Koln (Cologne) and Duisberg, 3.25 marks (77.4 cents); Bremen and Kiel, 3.20 marks (76.2 cents); Breslau, Hannover and Magdeburg, 3.00 marks (71.4 cents); Königsberg, 2.75 marks (65.5 cents); Chemnitz and Stettin, 2.50 marks (59.5 cents).

AUTOMOBILE REAR AXLE DESIGN

A DISCUSSION OF CHAIN AND GEAR TRANSMISSIONS

BY K. W. NAJDER*

There are two important methods of transmitting the torque of the motor to the driving wheels of a motor-driven vehicle—either by means of a chain or a shaft—and each of them possesses advantages and disadvantages.

Chain Drive

In almost every instance the chain is exposed to dust and dirt which causes it to wear out, and that means a considerable loss of power, or in other words, less efficiency. As the chain is placed between the frame and the wheel the distance between the wheel and the spring seat is greater, and in consequence the bending moment of the axle is much higher, as the bending moment varies directly with the distance of the spring seat from the wheel. Another great objection to the chain drive is the noise.

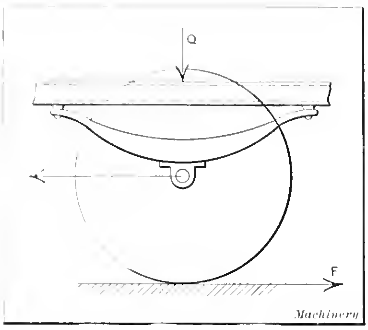


Fig. 1. Diagram illustrating Relation between Weight of Car and Retarding Force

On the other hand, when chain drive is applied, the rear axle is made from one piece, and is not parted in the center as is the case with a shaft driven axle. Further, in regard to the bending stresses, the axle can obtain the most favorable I-section. It does not carry any heavy parts, like differential gears and their housing, and being light and free from other weights, it can travel a rough road much more easily, is not subjected to very severe shocks, the bumps of the axle are reduced and in consequence the life of the tires and the rims is much longer. The shaft driven axles of heavy-duty trucks would have to carry the heavy weight of differential gears and their housings, and that is the main reason why the chain drive is applied to heavy commercial and racing cars.

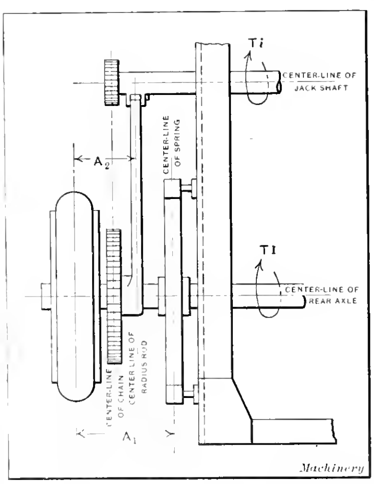


Fig. 2. Diagram showing Method of calculating Rear Axle Stresses with Chain Drive

Shaft Drive

The advantages and disadvantages of a shaft drive can be seen from what was said in regard to the chain drive. As long as the housings of shaft-driven axles were made of cast iron or steel, the shaft drive was not much in favor as the axles were heavy, the strains were great, the axles were subjected to severe shocks and bumps from the ruts of the road, and the life of the rims and tires could not be very long. With the introduction of pressed steel housings, however, the shaft drive began to receive preference over the chain drive.

An endeavor is being made to make all parts of the shaft driven axle out of pressed steel, and by that means the weight can be considerably reduced, but it will not lower the strains in the axle to any appreciable extent, as there will still be heavy parts which cannot be made lighter, such as bevel gears, ball bearings, and ball bearing housings. Generally the differential housings are supported from below by means of truss rods in order to reduce the bending moment due to the weight of the differential housings.

The rear axle pushes the car; consequently, means have to be provided to transmit this shoving force from the axle to the frame. The simplest way is to use the front end of the side springs for this purpose, and in such cases the front ends of the springs are fixed to the frame. The springs have to be strong enough to transmit this power and to withstand the skidding of the wheels; consequently they should also be figured for buckling. In heavy cars, radius rods are provided for this purpose. Another way to transmit this thrust is by means of a propeller shaft housing, the front end of which is fastened by means of a fork, or a globe joint to a cross member of the frame, or to the rear end of the transmission case. In order to make the construction sufficiently rigid, rods are run diagonally from the ends of the axle toward the front end of the propeller shaft housing.

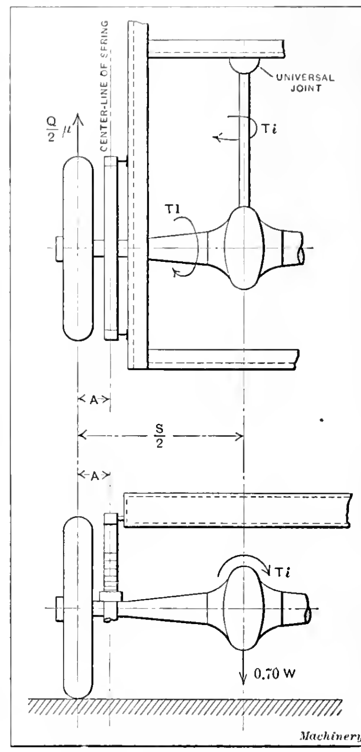


Fig. 3. Diagram for determining Rear Axle and Housing Stresses with Shaft Drive

Besides the shoving force, there is another force to be taken care of with the shaft drive construction. This is the torque exerted by the motor. On account of this torque, in starting the car forward the driving pinion tends to climb up on the gear and to carry the propeller shaft with it. The whole housing also tends to rotate in a direction opposite to that of the road wheels, and this must be prevented by proper means. The simplest way is to let the front end of the springs perform this duty. In this case the spring seats have to be fastened rigidly to the housing, and two universal joints between the axle and transmission have to be provided. In heavier cars, a special torque rod is attached near the center of the axle housing, the front end of which is pivoted, with coil springs interposed, to a cross member of the frame. In this case, two universal joints are usually provided also. If the propeller shaft housing is utilized to transmit the shoving force to the frame, as mentioned above, this same member can also be used for transmitting the torque. In this case, only one universal joint is required, but its fulcrum has to coincide with the center of the globe joint, or the fork on the front end of the construction. There should be sliding movements in the universal joints, and whenever the torque rod is applied the spring seats have to be arranged so that they can swivel around the axle housing.

The object of the shaft driven axle is to transmit power from the motor to the driving wheels. It is subjected to severe shocks and stresses due to the bumps and ruts of the road,

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and has to withstand all strains and stresses of stopping the car. In addition, it must carry more than half the weight of the car, and its load. The slightest deviation of a shaft from the correct line or the slightest inaccuracy in the meshing of the gears puts additional strains on the motor. To secure and maintain perfect meshing of the gears, good bearings are absolutely essential and they ought to be adjustable to take up inevitable wear. The weight of the car should be carried by the housing, and all shocks transmitted by it to the frame. The live axle should be absolutely free from all weights and shocks; it should transmit only the torque of the motor to the rear wheels, and should be subjected only to torsional stresses. In the chain construction, the jackshaft applies the power, and the dead rear axle only carries the load.

Adhesion

Let Q pounds indicate that portion of the weight of the car which is carried on the rear wheels. In Fig. 1, the weight Q is communicated to the ground through a wheel. No matter how much the friction between the wheel and the ground may be, the retarding force F cannot exceed the weight Q. If a greater force than this is applied to move the vehicle forward, the wheel will not only turn but it will also slip on the ground. Then, because the retarding force F cannot even be equal to Q, if the coefficient of friction of the wheel on the ground is μ, $F = \mu Q$ and that is the maximum condition. This factor μ is called the factor of adhesion. The coefficient of friction on an average road is 0.60. We see that we can make the calculations for the rear axle, starting with the torque of the motor, or we can start with the portion of the weight of the car which is carried on the rear wheels.

Rear Axle Calculations—Chain Drive

In Fig. 2, let

Q = Load on rear wheels;
r = Radius of the rear wheel;
i = Ratio of transmission;
I = Combined ratio of transmission and ratio of rear axle;
μ = Coefficient of friction = 0.6;
T = Torque of motor;

$$TI = Qr\mu \text{ and for one wheel } TI = \frac{Qr\mu}{2}$$

The radius rods have to withstand the skidding of the wheels and the tension of the driving chains. The maximum skidding of the wheels $= Q\mu$.

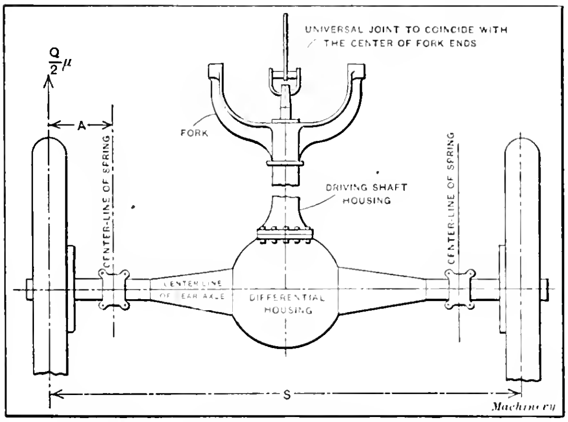

Fig. 4. Diagram for determining Stresses with Shaft Housing and Fork Construction

$$\text{Tension of driving chain} = \frac{\frac{1}{2}\,I\,T}{\text{Radius of large sprocket}} = \frac{\frac{1}{2}\,i\,T}{\text{Radius of small sprocket}}$$

The factor of safety for chains should be taken at from 8 to 10, the same as for radius rods. The rear axle should be made out of good nickel steel having a tensile strength of 90,000 pounds per square inch, elastic limit 57,000 pounds per square inch, elongation 19 per cent, reduction of area 53 per cent. The following gives the analysis of a suitable steel for axle construction:

Carbon	0.44
Manganese	0.36
Phosphorus	0.007
Silicon	0.03
Sulphur	0.019
Nickel	3.33

The rear axle is under the strain of bending on account of the load on the rear wheels and the strains of the radius rods. These factors are:

(1) Moment for one wheel $M_1 = \frac{Q}{2} A_1$

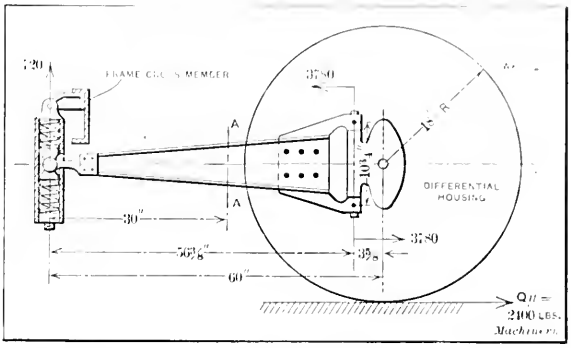

Fig. 5. Diagram illustrating Method of making Torque Rod Calculations

(2) Moment of the radius rod $M_2 = \frac{1}{2}$ ($Qr\mu$ + tension of the driving chain) A_2.

Resultant bending moment of the axle $M = \sqrt{M_1^2 + M_2^2}$.

Shaft Drive

The live axle is exposed only to a torsional strain TI, but as the axle is parted into halves, each half takes the torque $\frac{TI}{2}$. The factor of safety should be taken at from 7 to 8.

Rear Axle Housing

The housing is exposed to a strain of two bending moments between the two spring seats. These moments are as follows:

(1) Moment of the load of the car $M_1 = \frac{Q}{2} A$.

(2) Moment of skidding $M_2 = \frac{Q}{2} \mu A$.

Resultant bending moment $M = \sqrt{M_1^2 + M_2^2}$.

To be exact, there is also a third bending moment on account of the weight of the differential gears and housing. Let W be the weight of the whole rear axle and suppose that only 0.70 of this weight acts at the center of the axle. Then the bending moment on account of this weight is:

$$M_3 = 0.70\, W \frac{S}{4}$$

Resultant bending moment $M = \sqrt{(M_1 + M_3)^2 + M_2^2}$

We see that the most dangerous section of the axle housing is at the center of the axle. Very often an axle housing is of such construction that the strains of stopping the car when the brakes are applied are transmitted to the housing and from there to the torque rod. In this case, the housing should be strong enough to withstand the braking stresses, that is the torque $Qr\mu$ or TI. The factor of safety of rear axle housing should be from 10 to 12.

Rear Axle with Driving Shaft Housing and Fork

With the driving shaft housing and fork construction, the strains in the rear axle housing are somewhat greater. With this construction, one universal joint is sufficient. The driving shaft housing is utilized to transmit the shoving force of the axle to the frame and this same member is used for transmitting the torque. The fulcrum of the universal joint has to coincide with the center of the fork on the front end of the construction. The driving shaft housing is subjected to buckling and compression on account of the shoving force and is also subjected to bending on account of the torque of

the motor. There are the following stresses on the axle housing:

$$M_1 = \frac{Q}{2} A.$$

$$M_2 = 0.70\,W \frac{S}{4}$$

Besides these two moments, we have a third moment on account of the shoving force, that is the skidding of the wheels. As with this construction of the axle the springs do not take up the shoving force, this force is taken by the axle housing and we get:

$$M_3 = \frac{Q}{2} \mu \frac{S}{4}.$$

Resultant bending moment $M = \sqrt{(M_1 + M_2)^2 + M_3^2}$.

Torque Rod

The object of the torque rod is to transmit the torsional moment Tl from the rear axle housing to the frame. The torque rod is attached near the center of the axle housing, the front end of which is pivoted, with coil springs interposed, to a cross member of the frame. Two universal joints are usually provided with the torque rod construction.

Let the load on rear wheels = 4000 pounds.

Coefficient of friction $\mu = 0.6$.

The torque of the axle is $4000 \times 0.6 \times 18 = 43{,}200$ inch-pounds.

Torque of the ball is $\frac{43{,}200}{60} = 720$ pounds.

Torque of the housing pin is:

$$-10\tfrac{3}{4} \times F + 720 \times 56\tfrac{3}{8} = 0.$$

$$F = \frac{720 \times 56\tfrac{3}{8}}{10\tfrac{3}{4}} = 3780 \text{ pounds.}$$

where F = force acting on housing pin.

The bending moment of the rod can be easily obtained at any section, and so for instance, the bending moment at section A-A is $720 \times 30 = 21{,}600$ inch-pounds. The problem then consists in designing a coil spring which will not be overstrained when compressed under the load of 720 pounds.

Let P = Load acting upon the spring in pounds;
D = Diameter of spring wire in inches;
R = Mean radius of coil in inches;
K = Allowed stress = 70,000 pounds per square inch;
G = Torsional modulus 10,500,000;

$$P = \frac{\pi D^3}{16} \times \frac{K}{R} = 0.1963 \frac{D^3}{R} K;$$

$$D^3 = \frac{P R}{0.1963\,K};$$

$$D^3 = \frac{720 \times \tfrac{5}{8}}{0.1963 \times 70{,}000} = 0.032;$$

$D = \sqrt[3]{0.032} = 0.33$ inch = about 5/16 inch = thickness of wire.

$$\text{Deflection of one coil} = \frac{64\,R^3}{D^4} \times \frac{P}{G} = \frac{4\pi R^2}{D} \times \frac{K}{G}.$$

$$\text{Deflection of one coil} = \frac{4 \times 3.14 \times (\tfrac{5}{8})^2 \times 70{,}000}{0.33 \times 10{,}500{,}000} = 0.099$$

inch.

If there are, for example, ten coils, the deflection of the spring will be $0.104 \times 10 = 1.04$ inch.

The torsional forces become very great when a car is moving on a steep grade, but the maximum stresses occur when the wheels suddenly strike a large obstacle. The resistance to rotation of the wheels then increases rapidly, and the fly-wheel momentum, adding to the normal torque of the motor, produces a momentary driving effect greater than in regular running. The torque rod must be of proper dimensions to withstand such extraordinary stresses. In respect to the construction of torque rods, designers are of many different minds. Some favor a single tube, others favor two tubes arranged like a V, and still others prefer a tube around the propeller shaft with one universal joint. Many are coming to the use of stamped rods, and this is now considered very good practice.

ECONOMY IN TOOL DESIGN

BY E. H. PRATT*

The production of duplicate parts has developed many interesting features in regard to tool design. One feature which is of considerable importance is the study of tool economy. It is a well-known fact that jigs, tools and special machinery form the basis of all duplicate part systems and that the success of the system is judged largely from an economical standpoint. Many jigs and tools are so designed that even though they produce interchangeable parts accurately their use is prohibited on account of the excessive first cost; or, on the other hand, of the cost of operation. It is necessary,

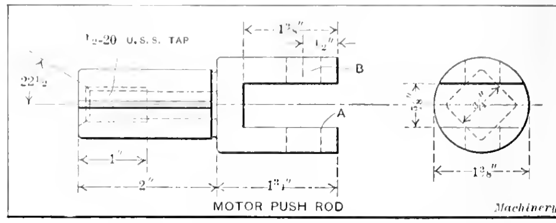

Fig. 1. Valve Push Rod for Automobile Motor

therefore, that the designer should study the problem in hand so that he will be able to design a tool as cheaply as possible which will at the same time be easily operated and produce accurate work. However, it is not always the cheapest tool that is the most economical in the long run, and it is the object of this article to show two extreme cases—one in which the cost was increased and the other decreased.

An Example of False Economy

Having many thousand automobile motor push rods of the type shown in Fig. 1 to machine, considerable time was taken

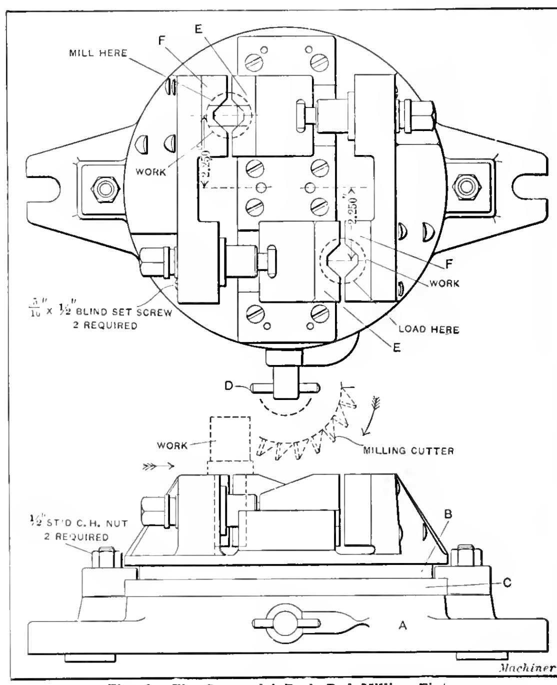

Fig. 2. The Successful Push Rod Milling Fixture

to design jigs and tools to perform the milling and drilling operations. The smallest diameter of these push rods was turned in an automatic screw machine and varied considerably in diameter, which made it necessary to hold them in an adjustable fixture. In turning these push rods in the automatic screw machine a very uneven surface was produced owing to the fact that considerable stock was removed.

The first fixture which was designed for milling the slot A in these push rods, which eventually proved unsuccessful,

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is shown in Fig. 3. This fixture was designed to hold twelve push rods at a time and was made on the indexing principle, so that while one row of push rods was being milled the operator was loading the opposite side. When the milling operation was completed the locking plunger *A* was withdrawn by means of handle *B* and the fixture indexed by hand. This milling fixture was rigidly constructed, and though considerable time was taken in making it accurate it was found mill the slot central with the large diameter, and therefore the fixture was a failure.

In endeavoring to locate the difficulty, it was found that by clamping more than one of the push rods in the jigs at a time the variation in the size of the V-blocks tended to throw the work in different directions. The variation in the size of the V-blocks was only about 0.002 inch—where the blocks fitted in the fixture—but when the lower end of

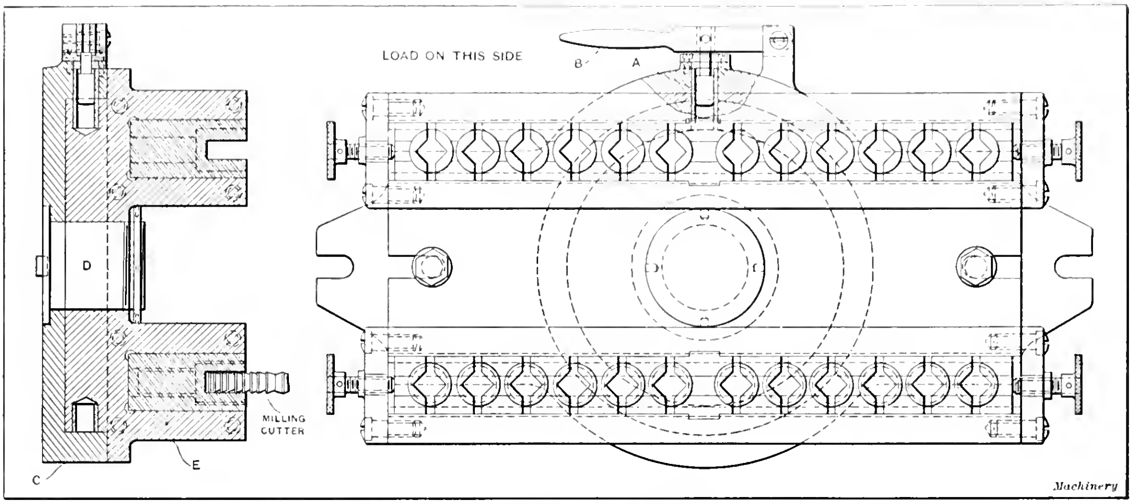

Fig. 3. Milling Fixture which proved Unsuccessful for milling the Slot in the Push Rod shown in Fig. 1

impossible to mill two sets of rods and have the slots central.

By referring to Fig. 1 it will be seen that the slot *A* is wide and deep, and the push rod could not be supported at the upper end to withstand the strain of the cut owing to the fact that the large diameter was not concentric with the small end. The construction of the milling fixture, as far as the base is the push rod was thrown out of line, the error was multiplied at the large end where the cutter was working. This not only caused the slot to be out of center, but prevented the succeeding push rods from being clamped tightly enough to hold them rigidly, therefore causing chatter. It was found, however, that by placing one push rod at a time in this fixture

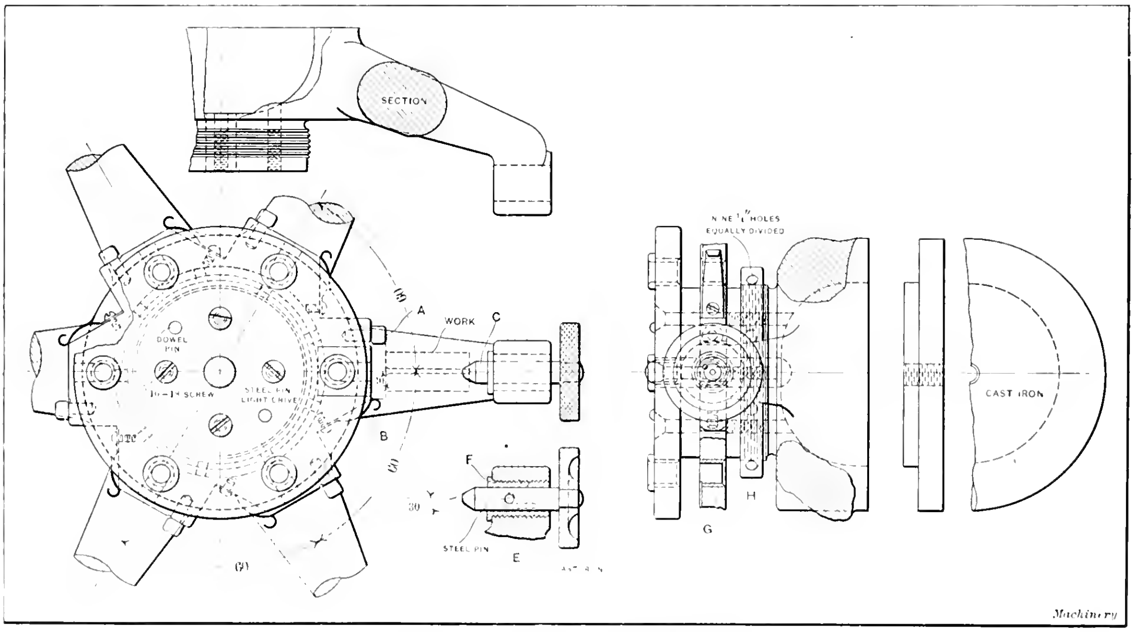

Fig. 4. The Drill Jig which proved a Failure

concerned, is of simple design and consists of a casting *C* provided with the usual pivot *D* and a top swinging member *E*. This top casting is formed to the shape shown and is provided with two channels for carrying the V-blocks in which the work is clamped. The milling operation is performed lengthwise of the jig. This fixture would be found suitable for many varieties of work, but for this push rod, which varies considerably in diameter, it was found impossible to the slot could be milled central. This furnished an idea that led to the design of the milling fixture shown in Fig. 2.

The Successful Milling Fixture

The fixture which proved successful for milling the slots in the push rods is shown in Fig. 2. This fixture consists of the usual base *A* to which is held the swiveling part of the fixture *B*, this being locked to an index plate *C* by the pin *D*. The index plate *C* is clamped to the base by two toe clamps as

illustrated. The principle on which this milling fixture was designed was to hold only two push rods at a time, so that while the cutter was operating on one the operator could be placing another piece in the opposite vise. The movable jaws *E* were operated independently of each other and were provided with adjustment for wear; and also made strong enough to insure long service. The jaws *E* and *F* were relieved in the center so that they only came in contact on the upper and lower portions of the smallest diameter of the work. This prevented the work from being thrown off center and also held it much more rigidly. The fixture was indexed one-half turn and was locked in position by pin *D* fitting in hardened and ground bushings. This fixture, although somewhat expensive to make, proved an accurate and rapid producer.

The Drilling Jig

By referring to the push rod shown in Fig. 1 it will be seen that a ½-inch hole *B* is drilled through the lugs. The first drilling jig made to handle this work is shown in Fig. 4 and was designed to hold six push rods at a time. This fixture was intended to be used on a multiple spindle drilling machine. The principle upon which this jig was designed was to hold the six push rods as indicated by the heavy dotted lines in Fig. 4. The push rod was held up against a hardened block *A* by a flat spring *B* and a cone-pointed plunger *C* fitting the hole produced in the push rod in a previous operation. This plunger was designed on the quick-acting principle, as shown in section at *E*. A pivot was driven into the rod *C* which worked in an elongated slot in the bushing *F*. The lower face of the slot on the push rod was held up tightly against the bushing plate *G* by a nut *H*. Although this drilling jig is apparently well designed, it was an absolute failure owing to the method of clamping. It also produced inaccurate work and was extremely expensive to make.

The Successful Drilling Jig

The drilling jig which was finally made for drilling these push rods is shown in Fig. 5. It was made from stock castings and consisted of a baseplate *A*, bushing block *B*, locating bar *C* and a hinge clamp *D*. Only three push rods were held in this jig at a time, but two jigs were made and used by the operator. One jig was filled while the other was under the drill press. Only three spindles of a six-spindle multiple

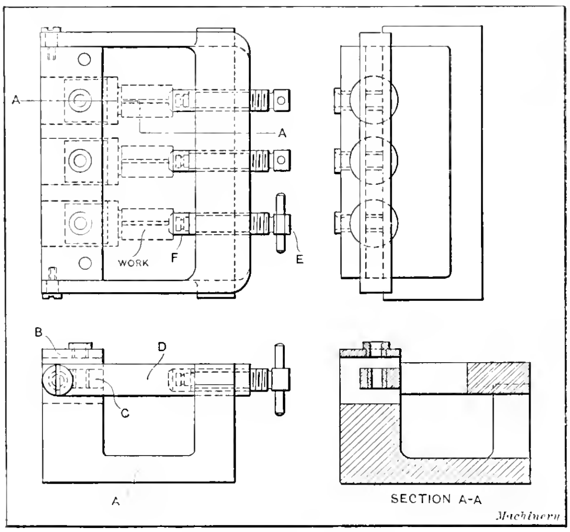

Fig. 5. The Successful Drilling Jig

spindle drilling machine were used for performing the operation, but this was handled so rapidly that there was no lost time between moves; hence the jig proved to be entirely satisfactory. In this case the largest body of the push rod fits in similarly shaped holes in the jig, being held in place by screws *E* which have compensating caps *F* fitted to them.

These examples of jig and tool design show what might be considered true and false economy. The expensive milling fixture and the inexpensive drilling jig for the push rods are tools that might be placed in the true economy class, as they are operated at a minimum of expense and produce accurate results. The first milling fixture that was thought to be technically designed and also the drill jig shown in Fig. 4 are tools that are not economical from a manufacturing standpoint. The conclusion can therefore be drawn that it is not always the simplest nor, on the other hand, is it the most expensive jig that is the most economical, but rather the one that is designed after a very careful study of shop conditions. Too much thought cannot be given to the manufacture of drilling jigs which are to be used by inexperienced workmen.

* * *

USING CURVED FILES ON AUTOMOBILE BODIES

An interesting development in filing has been made by the automobile makers in Detroit and vicinity, who have a great deal of filing to do on sheet metal automobile body sections. A large part of this work is the cleaning up of brazed joints, and for this purpose they find that files curved to a radius of approximately two feet give the best results in getting at the

Type of File used on Automobile Bodies

work and in clearing the chips. If an ordinary solid file is used it must be bent while hot, and only one side is available without rebending.

The Vixen File Co., of Philadelphia, Pa., has met the demand for curved files by furnishing a curved base upon which the ordinary straight "Vixen" file blade may be mounted. The steel used in "Vixen" files will stand this bending in a cold state, so that after one side has been worn out it is simply necessary to remove the blade and reverse the bend. The accompanying illustration shows a file and its application to the work. C. L. L.

* * *

The war in the Balkans, aside from attracting the attention of the world in general, has had a direct effect upon the machine trade in the curtailing of the emery supply. The best emery in the world comes from the island of Naxos, a Greek possession, and from this island and Asia Minor are mined the bulk of the world's emery. When the war broke out, the emery miners dropped their picks and shovels to take up their rifles and the emery supply was practically cut off. As a consequence, emery wheel manufacturers are devoting more attention to artificial abrasives, especially as a rise in the price of Greek emery is anticipated when the supply is resumed. The mining and exportation of the Naxos emery is under the direct control of the Greek government.

* * *

Some one has said that much valuable energy is wasted in preserving secrecy. Inefficiency and secrecy in a manufacturing plant are twins, and go hand-in-hand.

MAKING MOTOR POPPET VALVES

ELECTRIC WELDING, AUTOGENOUS WELDING AND MACHINING OPERATIONS

BY DOUGLAS T. HAMILTON*

The poppet type of valve generally used in gas engine construction is one of the parts which requires more attention and care in its manufacture than is usually recognized. It is absolutely necessary that the head or valve disk form a perfect bearing in the valve seat, not only to economize in fuel, but also to provide for a quiet and smooth running engine. The valve heads are necessarily subjected to the high temperatures of the burning gases and therefore should be made so that they will resist warping. They also should be made from a material which will resist the tendency to burn or oxidize, which results in a leaky valve. To overcome the rapid deterioration of engine poppet valves, many attempts have been made to secure a material that will give a long life. Among the materials which have been tried with more or

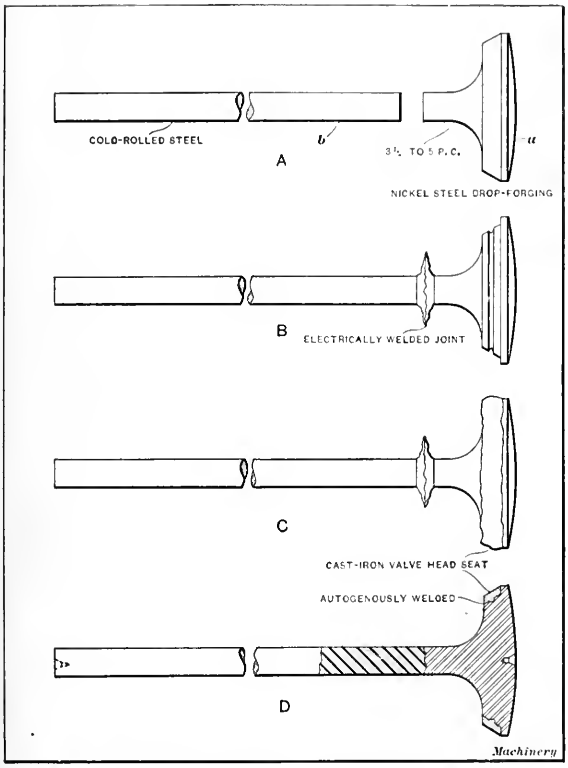

Fig. 1. Various Stages of Manufacture through which an Improved Poppet Valve passes

less satisfactory results are vanadium steel, nickel steel and cast iron. The disadvantage of making a valve head from cast iron is that it breaks off easily, and, although the bearing obtained is satisfactory, the life of the valve is short, owing to the corners breaking off. Several attempts have been made to secure a cast-iron head to the stem by riveting, but the results have not been entirely satisfactory. Another method which has been tried is to fasten a cast-iron ring to a nickel steel drop-forged head, but this has proved unsuccessful, owing to the ring's breaking, even though electrically welded. In the following article is described a method which consists in depositing a high silicon cast iron on the seat of the valve head by autogenous welding.

Preliminary Machining and Electric Welding Operations on Poppet Valves

As indicated in Fig. 1, a poppet valve consists of two parts, *viz.*, a head *a* and a stem *b*. As a rule, the head is made from a nickel steel drop-forging, containing from 3½ to 5 per cent nickel. The stem is made from a piece of cold-rolled steel, generally 25/64 inch in diameter, and long enough to meet the requirements of the engine in which it is to be used. After the drop-forging has been made and the cold-rolled stock has been cut off to the required length, these two members are welded together in an electric welder of the type shown in Fig. 2.

In operation, the head is clamped between copper jaws *A* and the stem held in a similar manner by the jaws *B*, the

Fig. 2. Electrically-welding Poppet Valve Heads to Stems in a Toledo Electric Welder

two ends of the work being butted together. The copper jaws are now brought down tightly on the work by means of a foot lever. The electric switch attached to the lever which the operator grips with his right hand, is then closed, turning on the current and immediately heating the ends of the work. When the proper temperature is reached—almost a white heat—the two pieces are brought together by means of the lever *C*, which the operator controls with his right hand, and as the metal is in a semi-fluid condition the pressure exerted on the lever joins the two ends, forming a homogeneous mass and a perfect weld. Forcing the work together in this manner when in a highly heated state, forms a flash at the joint, as indicated at *B* in Fig. 1, which is removed in a subsequent operation. For welding this particular valve stem, two legs of a three-phase 440-volt current are used,

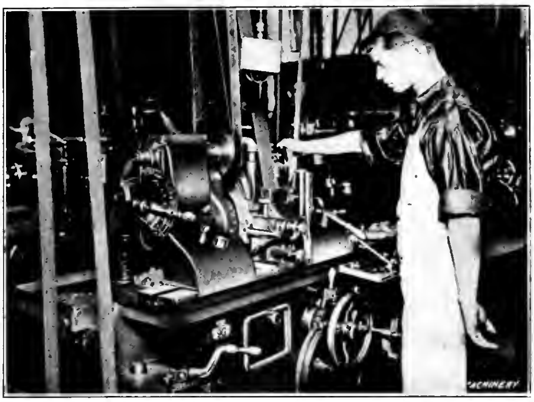

Fig. 3. Grinding Poppet Valve Stems in a Landis Plain Grinding Machine

which through a transformer in the machine is cut down to five volts. The welded stems are turned out at the rate of 2500 per day of nine hours.

After electric welding, the stem is cut off to the required length and both ends of the valve are centered; then the head is machined, a roughing and finishing cut being taken, and at the same time a small groove is cut in the seat, as indicated at *B* in Fig. 1. The next operation is to remove the burr or flash left by the welding operation in a hand screw machine.

* Associate Editor of MACHINERY.

Depositing Cast Iron on the Valve Seat by Autogenous Welding

What might really be considered the most interesting operation in the manufacture of this poppet valve is the building up of a seat on the head by means of what might properly be termed a "putting-on tool," the cast iron being deposited by means of an autogenous torch. To accomplish this operation, the valve is placed on the fixture *A*, Fig. 6, resting on its head.

Fig. 4. Group of Autogenous Welding Operators at Work on Motor Poppet Valves

This fixture is rotated by means of a foot treadle, thus enabling the operator to deposit the cast iron evenly around the surface of the seat of the valve head. The cast iron, before being deposited, is in the form of a rod ¼ inch in diameter, and is made from a grade of cast iron containing a high percentage of silicon—from 5 to 10 per cent. It has been found after many experiments that this grade of iron gives unusually satisfactory results for autogenous welding. The bar *B* is melted by the autogenous torch *C*, which develops a heat of about 6300 degrees F. It requires only a very short time for the operator to deposit the required amount of cast iron, when the valve is removed from the fixture and placed in the lime on the bench to cool, as indicated at *D* in Fig. 6.

Fig. 5. Poppet Valve before and after applying the Cast Iron by Autogenous Welding

Fig. 6. Close View of Welder at work applying Cast Iron to Poppet Valve Heads by Autogenous Welding

Fig. 4 shows a group of operators at work in the plant of the Metals Welding Co., Cleveland, where this information was obtained. The condition of the valve heads before and after depositing the cast iron is shown at *A* and *B* in Fig. 5, and also at *B* and *C* in Fig. 1. After the valve has cooled, it is taken to a hand screw machine and a light cut removed from that portion on which the cast iron was deposited. This operation is performed to determine whether or not there are any defects in the seat, due to the metal not running freely, and thus causing blowholes or cold shuts.

Final Machining Operations

The roughed valves are now taken to a hand screw machine and the cast-iron seat is machined. After machining, the valves are taken to the grinding machine shown in Fig. 3, where the valve seat is ground to the required angle and diameter, after which the stem is ground to ⅜ inch diameter, a limit of 0.0005 inch being allowed on a stem 7 inches in length. The lower end of the stem is casehardened and upon the completion of this operation the valve is ready for use.

It will be seen from the foregoing that although a poppet valve seems to be rather simple in construction, it requires the most painstaking care in its production, and its life depends largely on the proper execution of the various operations outlined. At *D* in Fig. 1 is shown a poppet valve completed and ready for use on a gas engine, with the exception of the cutting of the slot in the head which is used for driving the valve when grinding in the seat; this illustration also shows clearly the three materials used in its make-up.

* * *

The General Electric Co. has brought out a new incandescent lamp which is said to use only one-half as much current for the same candlepower as the present tungsten lamps. The new lamp contains a specially shaped tungsten filament surrounded by an inert gas like nitrogen at atmospheric pressure. The gain in efficiency of incandescent lighting thus made within the past six years, is about sixfold, the present tungsten lamps requiring only about one-third as much current as the common carbon filament lamp for the same lighting effect.

METHODS USED IN MANUFACTURING THE JONES SPEEDOMETER

MAKING THE PARTS, ASSEMBLING AND TESTING FINISHED INSTRUMENTS

BY EDWARD K. HAMMOND*

Few automobile accessories add more to the interest derived from driving an automobile than the speedometer, for this instrument affords a constant indication of the speed at which the machine is traveling, a record of the distance covered on each individual trip and the total number of miles traveled during the season. Various forms of mechanism have been employed for actuating the different types of speedometers on the market. In the Jones speedometer, with which this article is concerned, the mechanism is controlled by centrifugal force. When a body is rotating about a fixed center, a tendency is developed for the material to fly off at a tangent. The magnitude of centrifugal force is expressed by the following equation:

$$F = \frac{WV^2}{GR} = \frac{WRN^2}{2933.9},$$

where

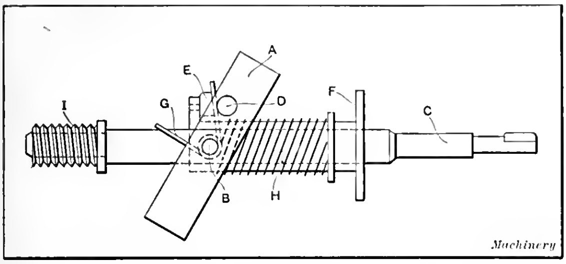

Fig. 1. Diagram illustrating Principle on which the Jones Speedometer operates

V = linear velocity of center of gravity of rotating body in feet per second $= \dfrac{2\pi RN}{60}$;

G = acceleration of gravity = 32.17;

N=R.P.M. of rotating body;

W = weight of rotating body in pounds;

R = radius in feet.

Fig. 1 shows the mechanism which actuates the Jones speedometer. A flexible shaft connects the instrument to a gear, secured to the inside of the hub of one of the front wheels. (One of these gears is shown in Fig. 2.) Hence, the speed at which the car is traveling controls the speed of rotation transmitted to the instrument. Referring to Fig. 1, A is the governor or rotating member, the centrifugal force of which actuates the speed indicator. This governor is pivoted at the point B. The spindle C is connected to the wheel of the car by means of the flexible shaft previously referred to. It will be evident that as the spindle C revolves, centrifugal force gives the governor A a tendency to rotate about the pivot B toward a position where its plane will be perpendicular to the spindle C. This tendency is resisted by the saddle spring G, which bears against the pin D in the governor. The tension of the saddle spring is so regulated that the position of the governor causes the needle of the speedometer to indicate the speed at which the car is traveling. The manner in which this result is obtained is as follows:

Fig. 2. Gear on Front Wheel of the Car, which drives the Speedometer

As the governor A moves toward the vertical position, the pin D, which engages with the finger E, draws the governor disk F forward. The governor disk is in contact with a small fiber roller at the end of a bell-crank. As the disk is drawn forward, the bell-crank revolves on its pivot and causes the indicating needle to move over the scale on the speedometer dial, thus showing the rate at which the car is traveling. The spiral spring H returns the disk toward the zero point when the speed of the car is retarded.

Making the Speedometer Parts

In the present article the purpose is to describe a number of interesting methods of instrument making employed in the factory of Jones Speedometer, New Rochelle, N. Y. Fig. 3 shows several of the parts, which will be referred to later in connection with the methods used in making or assembling them. The speedometer spindle is shown at C in Fig. 3. These spindles are roughed out from machine steel, the op-

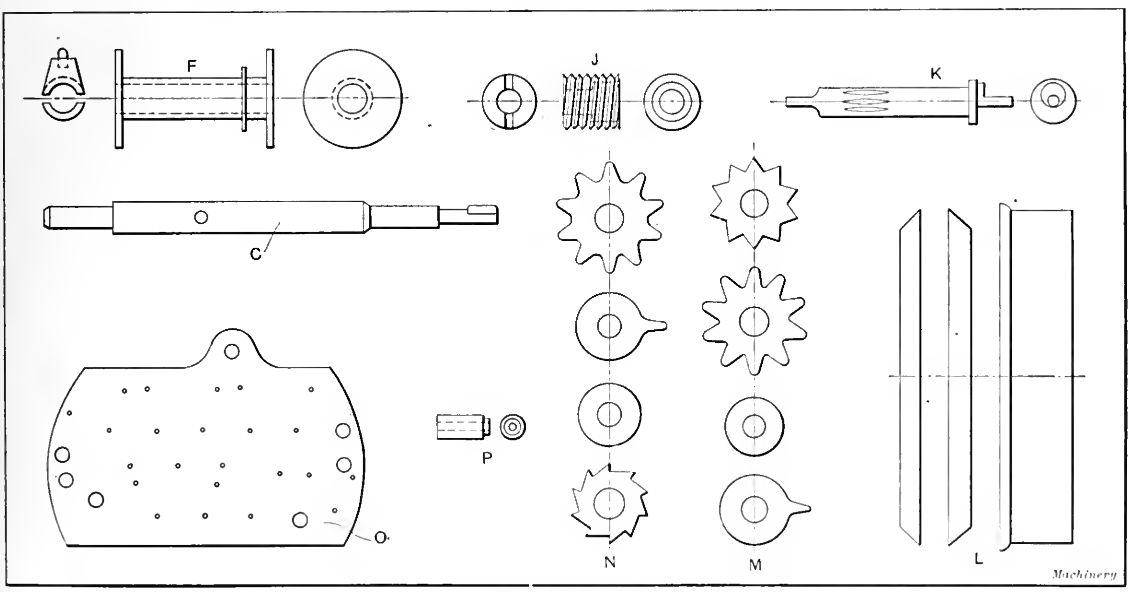

Fig. 3. Some Parts of the Jones Speedometer

*Associate Editor of MACHINERY.

eration being in accordance with standard practice. The next step is to form the key at the right-hand end of the spindle which engages with the coupling on the flexible shaft. This key is swaged on the shaft by the punch and die illustrated in Fig. 4. The end of the spindle which is to be swaged is inserted in the hole E in the die. When the press is tripped, the pins A are forced down by means of the hardened steel studs A_1, carried by the punch. The tapered ends of the pins A force the swaging punches B in against the work and form the key on the spindle. The top of the key is given the required shape by means of the pin C. This pin is forced down by means of the cam D, which is actuated by a hand lever. The position of the pin controls the height to which the metal can flow during the swaging operation. The punches B and pin C are returned by spiral springs when the ram of the press rises.

After the spindles have been roughed out and swaged, they are taken to the hardening department where they are hardened locally at the points where the cone bearings are to be ground in a subsequent operation. Upon the completion of the hardening process the hole is drilled in the spindle to receive the pivot B, upon which the governor is carried. The work is then taken to a Sloan & Chace bench lathe, equipped with a compound rest upon which the grinding attachment is mounted. The work is carried in an ordinary draw-in chuck and the bearing cones are ground at an angle of forty-five degrees. After this the work is taken to the Brown & Sharpe universal grinders where the body of the spindle is ground.

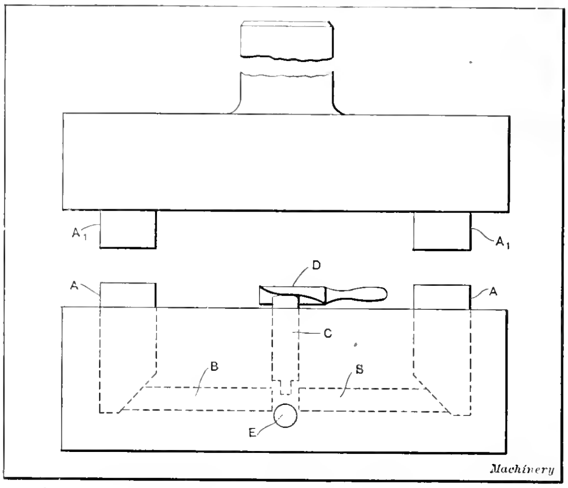

Fig. 4. Punch and Die used for swaging Key on End of Speedometer Spindle

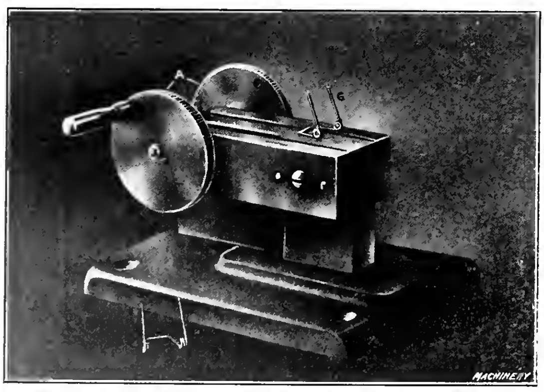

Fig. 5. Special Machine for winding Saddle Springs

The governor disk F is shown in detail in Fig. 3. These disks are made on Brown & Sharpe automatic screw machines, the only unusual point in this company's practice being the method of tooling the machines. It is necessary for these pieces to be finished to a high degree of accuracy, and experience has shown that better results are obtained by mounting the forming tool on the front slide and the cut-off tool on the rear slide, although this is at variance with the standard practice. The drill and reamer for machining the hole through the center of the governor disk are carried in the turret of the "automatic" in the usual way. After the governor disks have been cut off on the screw machine, they are taken to the punch press department where one end of the disk is finished in a die to the form shown in the end view to the left. The body of the spindle and the hole in the governor disk through which it slides have to be finished within a limit of 0.0001 inch, as the least shake between these two members would be detrimental to the operation of the instrument.

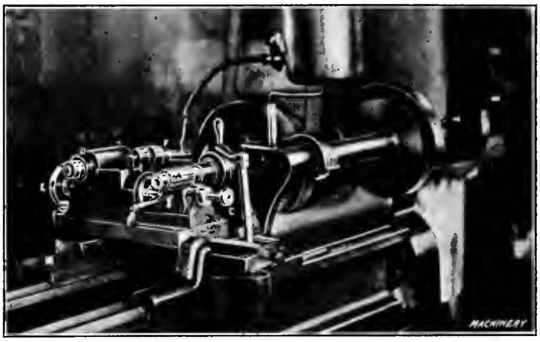

Fig. 6. Hobbing Attachment for Lathe, on which Eccentric Pinions are hobbed

Fig. 5 shows a special machine which was designed for producing the saddle springs shown at G in Fig. 1. These springs are made of piano wire, which is cut off to blanks of the required length and bent to form the U-shaped end of the saddle spring by means of a suitable punch and die. The work is then brought to the machine shown in Fig. 5. This machine grips the end of the saddle spring and two coils are wound around the mandrel by means of the handles on the index wheels. In operation, the two index wheels A are set at zero; the blank is then placed in the machine and both disks are turned through two revolutions, which brings them back to the index points. In this way the springs are turned out with the ends in exactly the same plane, the work being finished so perfectly that little if any adjustment is necessary before the springs are ready to be assembled in the instrument.

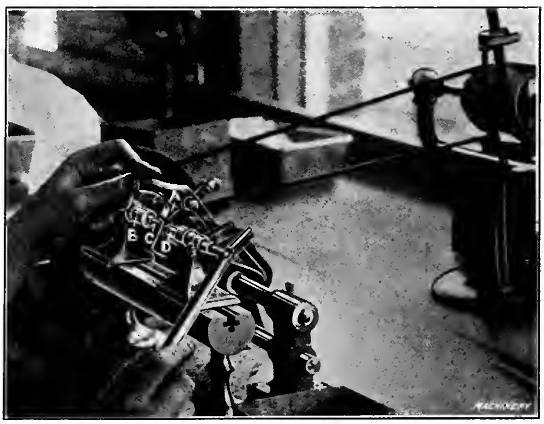

Fig. 7. Bench Lathe with Special Chasing Attachment for turning Bushings

The speedometer mechanism illustrated in Fig. 1 is carried in ball bearings of the cone and cup type. The bearing cups used for this purpose are illustrated in detail at J in Fig. 3. These cups are made on either Brown & Sharpe or Acme automatic screw machines. After being hardened, the bearing cups are ground on a Rivett grinder.

Making the Odometer Parts

It has already been mentioned that the Jones speedometer is equipped with an odometer which indicates both the dis-

tance traveled on individual trips and the total distance traveled by the car during an entire season. A number of different styles of instruments are made, some of which are arranged to indicate a season mileage of 100,000 miles, while others provide only for 10,000 miles. All types of instruments are arranged to indicate individual trips, up to 100 miles in length. A "reset" button is provided at the side of the instrument, and by pushing this button the dials which

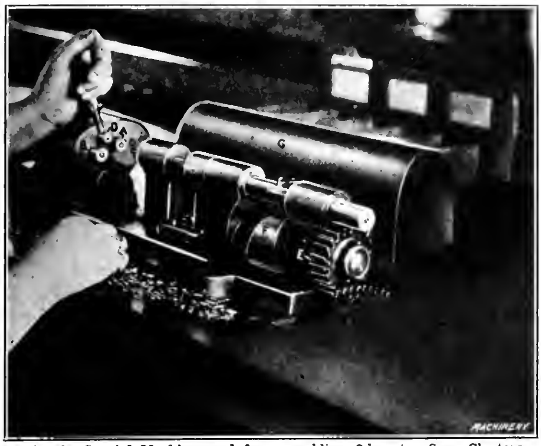

Fig. 8. Special Machine used for assembling Odometer Gear Clusters

indicate the distance traveled during individual trips are instantly returned to zero.

Motion is transmitted to the odometer by means of the worm I on the speedometer spindle, as shown in Fig. 1. This worm engages with teeth machined in a vertical "eccentric pinion," which is shown in detail at K in Fig. 3. As the speedometer spindle revolves the small eccentric at the end of the eccentric pinion operates a pawl which transmits motion to the trains of gears which turn the dials of the odometer.

The gears which actuate the odometer are arranged in clusters assembled on bushings P, Fig. 3. Each of the gears

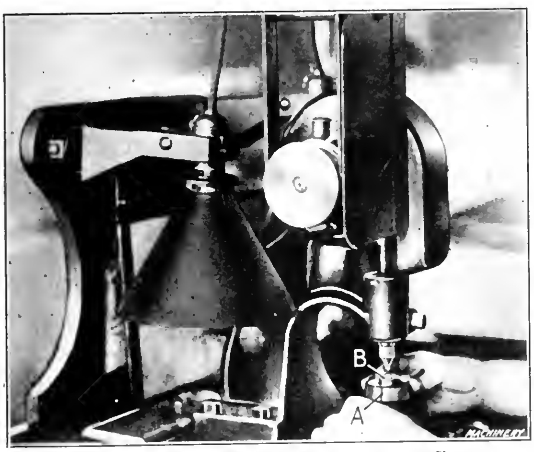

Fig. 9. Riveting the Odometer Dials onto the Gear Clusters

in these clusters has ten teeth and a dial graduated from zero to nine is mounted at the top of the cluster. The gearing is arranged in such a way that the dial at the right-hand end makes one complete revolution. At this point, a pawl of the type shown at the bottom of the series M in Fig. 3, engages with a gear of the next cluster to the left and moves it through one space, *i.e.*, one-tenth revolution. After this operation has been repeated ten times, a pawl on the second cluster of gears engages with a gear of the third cluster and moves it through one space. It will be obvious to the reader that the distances indicated by the successive dials to the left have ten times the value of the distance indicated by the dial to the right. Consequently the figures brought into view by the action of this train of gearing indicate the number of miles which the car has traveled.

The blanks from which the eccentric pinions K are made are formed in Brown & Sharpe automatic screw machines. After the forming operation has been completed, the work is transferred to a machine equipped with a magazine and feeding chute which delivers it to an eccentric chuck in which the work is held while the eccentric is turned. Fig. 6 shows a very simple form of hobbing attachment for an engine lathe, which is used to hob the teeth on the eccentric pinions. It will be seen that the hob A is carried on an arbor held in the lathe spindle. The work is held in the collet B and supported at its outer end by means of a tailstock C, in which the end of the eccentric pinion fits. The tailstock and collet are adjusted by means of the wheels D and E, respectively. The work is rotated by means of a universal-jointed rod F,

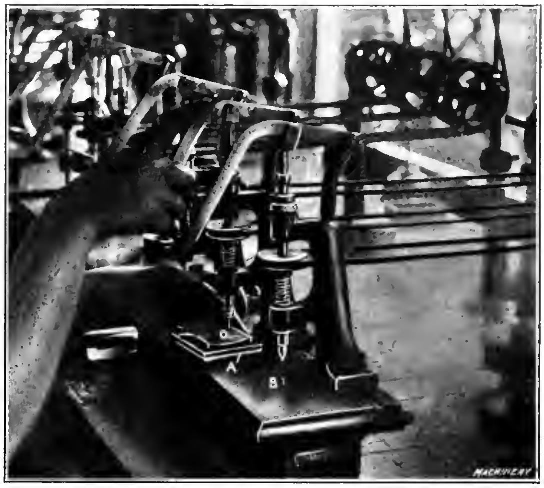

Fig. 10. Drilling the Odometer Plates with "Depthing" Gages

which is geared to the lathe and transmits motion to the collet through a worm and worm-wheel enclosed in the fixture.

The different forms of gears used to actuate the odometer are stamped out from brass ribbon stock. In order to have the work assembled properly, it is obviously necessary for the hole in each gear to be exactly at the center. Compound sub-press dies are used for this purpose, of the type generally used in watch, clock and instrument work. The small bushings on which the gear clusters are mounted are produced on an automatic screw machine. This work is fairly accurate, but there is always some doubt as to the parallelism of the hole with the outside of the bushing. In order to guard against errors from this source, the bushings made on the

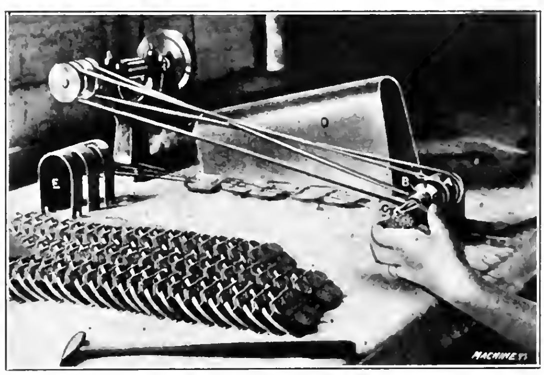

Fig. 11. Special Machine for winding Springs into the Odometer

automatic screw machine are transferred to the bench lathe shown in Fig. 7. This lathe has been equipped with a special chasing attachment. The bushings are carried on a small mandrel in the lathe spindle, which just fits the hole in the bushing, and the outside is turned by means of a tool carried in the chasing attachment. In this way, the hole is sure to

be parallel with the outside of the bushing. The design of the mechanism will be readily understood by referring to the illustration. A is the guide on the chasing attachment which fits over the guide bar B, carried in the lathe spindle. The parts A and B are hardened, ground and lapped, and any slight wear which may occur is compensated for automatically. The bushing to be turned is mounted on the small mandrel C, and the tail center D is pushed up against its outer end by means of the hand lever, thus providing the necessary drive. The mandrel on which the work is carried is ground after the fixture has been set up on the lathe, so that it is sure to be in proper alignment. At intervals, the operator measures the size of the pieces turned on this lathe with a micrometer, and three or four times a day she refers the work to the foreman of the department in order that he may have an opportunity of checking the accuracy of the parts.

Assembling the Gear Clusters

The finished bushings and gears are taken to the assembling department where the gear clusters are assembled on "nests" A, which are virtually small dies in which the teeth of the different gears in the cluster fit. In order to locate the dial in the proper relation to the gears in the cluster, a gage B is provided. This gage is merely a leaf hinged to the fixture and provided with three holes through which three numerals on the dial can be seen. After the cluster has been placed in the fixture, the dial is so set that the proper figures show through the holes in the gage. The riveting machine is then brought into action, riveting the end of the bushing down over the edge of the hole in the dial.

Drilling the Odometer Plates

The different parts of the odometer mechanism are assembled on a brass plate of the form shown at O in Fig. 3. It will be seen that there are thirty holes which have to be drilled in these plates. In order to do this work with the greatest possible dispatch, the method of drilling by means of a "depthing" plate has been adopted. This is another method which is in quite general use in instrument making and combines the benefits of rapid production with a high

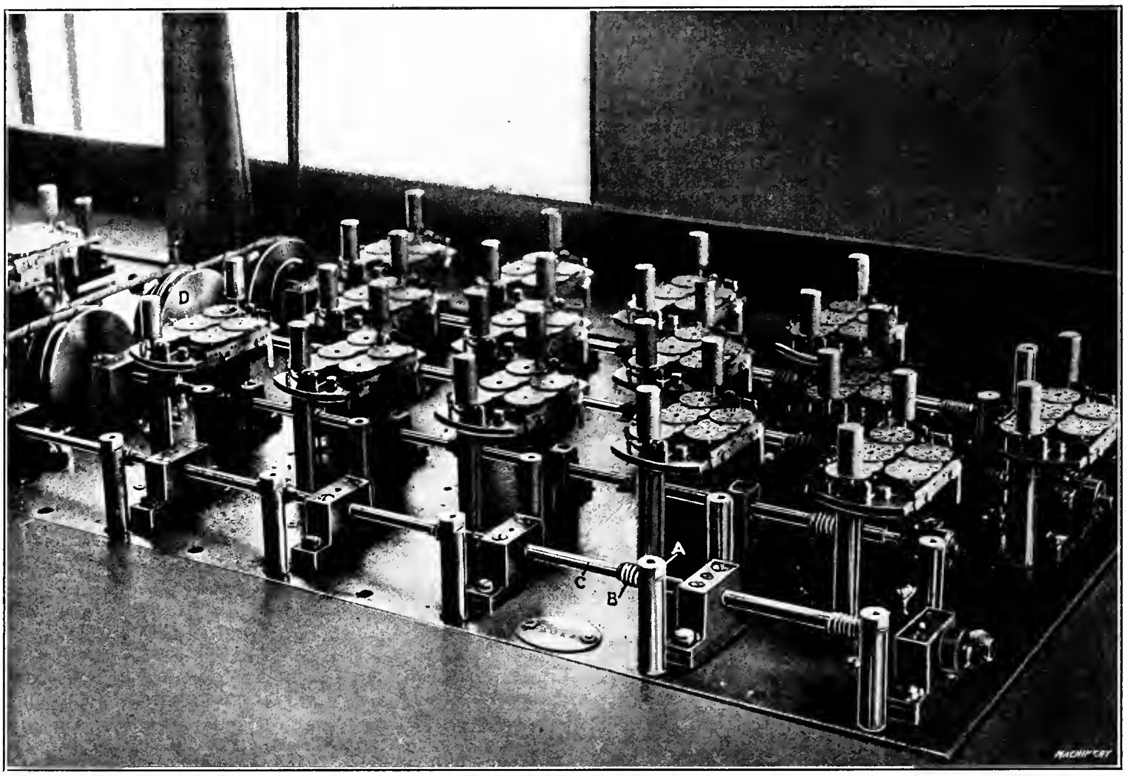

Fig. 12. Method used in testing the Accuracy of the Odometer

the special machine shown in Fig. 8. This machine consists of a horizontal press, equipped with dies to fit the different gears which constitute the cluster being assembled. Taking as an example the series shown at N in Fig. 3, the two upper gears are fitted in the dies A and B, and a bushing is then placed in the die at the end of the horizontal spindle C. The machine is operated by a foot-treadle which turns the cam F through the gears E. When the treadle is pushed forward, the spindle C moves over and forces the bushing into the hole in the gear carried in the die A. The index D is then set to bring the die B in alignment with the spindle, after which the foot-treadle is pressed a second time to push the bushing into the hole in the gear in die B. The relative positions of the dies are such that the different gears constituting the cluster are assembled in the proper position in relation to each other. The mechanism is enclosed by the guard G, which was removed to show the mechanism.

After the gear clusters have been assembled, they are transferred to an H. P. Townsend riveting machine, shown in Fig. 9, where the dials are riveted onto the top of the clusters. The riveting machines used for this purpose are fitted with degree of accuracy. The six large holes in the odometer plate have been drilled before the work comes to the battery of Stark bench drills, shown in Fig. 10, and two of these holes are utilized for locating the work on the depthing plate A. The pin B on the table of the bench drill is in exact alignment with the spindle. This pin fits into holes on the under side of the depthing plate and brings the work into the required position for drilling the different holes. The girls who operate these machines sit on stools which run on rails in front of the bench. After the holes have been spotted, the operator moves over to the next machine in which holes of one size are drilled; she then moves on as necessary, in order to get in position to drill and ream the different sizes of holes in the odometer plates.

It has already been mentioned that an instantaneous "reset" device is provided for use in connection with the part of the odometer which indicates the distance traveled on individual trips. This reset device is operated by pushing a small button on the side of the instrument. Each of the three dials in this part of the odometer works against the tension of springs, being held in the position to which they are moved

by means of suitable ratchets and pawls. When the reset button is pushed in, it releases the pawls and consequently allows the dials to be returned to the zero position. The springs which actuate the reset device are wound on the lower end of the bushings on which the gears and dials of the trip mileage odometer are assembled. There are three clusters of gears in the train and it will be evident that as two of these clusters rotate right-hand, the third (or intermediate) cluster rotates left-hand. Hence, it is necessary to wind two of the springs right-hand and the third spring left-hand. Fig. 11 shows a special machine which was developed for use in winding these springs. It consists of a spindle *C*, provided with a suitable clutch mechanism for engaging a small washer at the end of the sleeve on which the spring is to be wound. It will be noted that two belts run from the countershaft to the machine, one being open and the other crossed. There are two foot treadles under the bench, and by pushing one of these treadles the friction clutch *A* is engaged to drive the arbor through the crossed belt which winds the right-hand springs. By pushing the other treadle, the opposite side of the clutch is engaged with the cone *B* and the machine drives through the open belt, thus winding the left-hand springs. The belts and clutch are ordinarily enclosed by the guards *D* and *E*.

Fig. 13. Testing the Accuracy of the Speedometer

The springs consist of flat strips of bronze which are attached to the bushing at one end and are wound up by means of the frictional contact of the opposite end with the case in which the spring is contained. For a length of one inch at the free end, the spring is approximately double the thickness of the remaining section. These springs are rolled from bronze wire on a W. W. Oliver rolling mill equipped with a special form of rolls. These rolls are of such a size that a spring is produced at each revolution. The rolls are ground away slightly for a distance of one inch on their circumferences. This reduction leaves the necessary "thick spot" on the end of each spring. The wire from which the springs are rolled is fed into the mill from a reel, and the springs are rewound from the mill onto a second reel. They are then cut up, as required, for use in the assembling department.

The speedometer mechanism is enclosed in a brass case which consists of two parts. The lower part is a deep cup, while the upper part or cover is a sleeve in which a bevel glass is mounted. The method of setting the mechanism in the sleeve is quite interesting. It is obviously necessary for this joint to be both dust- and water-proof in order to protect the mechanism from injury. The method by which this is accomplished consists of first mounting the sleeve upon an expanding chuck. The nickel-plated "bezel" plate which goes under the glass is next placed in position, after which the plate of bevel glass is put in place and the brass cylinder is spun down over its edge. A very neat looking job is produced in this way, and the joint is tight enough to make it absolutely water-proof. The glass, bezel plate and sleeve are shown at *L* in Fig. 3.

Testing the Finished Instruments

The work produced in each department of the factory is subjected to strict inspection before being sent on to the assembling department. After the odometers have been completed, they are set up on testing stands of the type shown in Fig. 12. It will be seen that these stands consist of rows of vertical studs *A* on which the odometers are clamped by means of knurled-headed screws. The eccentric pinions which mesh with the worms on the speedometer spindle in the finished instrument engage with worms *B* on the horizontal shafts *C*. These shafts are driven by belts running over the pulleys *D*. The odometers are tested first at a speed of 125 miles an hour and then at a speed of 10 miles an hour. As the instruments are started from the zero point, their indications should all coincide at any period of the test. Any instrument which shows an error of as much as one-tenth mile an hour is sent back to the assembling department and adjusted until it will endure the test satisfactorily.

After the odometers have been tested as described, the entire instrument is assembled and then tested on machines of the type shown in Fig. 13. It will be seen that this machine consists of a fourteen-step cone *A*, and the speedometers to be tested are driven by means of a rubber pulley *B*, which is temporarily mounted on its spindle and engaged with the different steps on the cone. In this way, speeds of from 2 to 100 miles per hour are available. These tests are conducted for two purposes: First, to see that the instrument indicates accurately when running at the different speeds which are produced by successive steps on the testing cone; second, to make sure that the instrument runs steadily. When any error is discovered, it is usually due to imperfection in the saddle spring or else to improper adjustment of the ball bearings in which the spindle runs. The latter is the most frequent source of error, and the first step taken to remedy it is to adjust the bearings slightly. If this does not give the required result, the instrument is taken apart and the saddle spring adjusted or replaced as may seem advisable. It is the extreme care taken in producing each part of these instruments and testing them which has won a favorable reputation for the Jones speedometer in automobile circles.

* * *

ETCHING ON BRASS AND STEEL

BY WALTER H. STICKLER*

In the How and Why section of the August number of MACHINERY a request was made for information on the subject of etching. For etching on brass a satisfactory ground can be made from equal parts of beeswax, burgundy pitch and asphaltum. These constituents are melted together and thoroughly stirred in order to secure a uniform mixture. This ground is warmed before using and spread evenly over the surface that is to be etched. After the ground has had time to cool, it is removed from those sections of the metal that are to be etched, after which the etching fluid is applied. A satisfactory etching fluid consists of one part of nitric acid to four parts of water. After the "biting" has been completed, which takes only a few minutes, the work is dipped in hot water to wash off the acid. The surface of the work can then be cleaned by wiping it with a cloth dipped in benzine or gasoline.

For etching steel the ground is also made of equal parts of beeswax, burgundy pitch and asphaltum. This ground is applied to the work according to the instructions given for application on brass pieces. The etching solution used for steel consists of

Pyroligneous acid	4 ounces
Alcohol	1 ounce
Nitric acid	1 ounce

As soon as the biting operation is completed the work is dipped in hot water to wash off the biting solution, after which the work is cleaned with gasoline or benzine, as in the case of etching operations on brass. In order to obtain satisfactory results it is important to have the work perfectly clean before the ground is applied.

* * *

A man is not a genius simply because he does something that is odd but not particularly useful.

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THE ADVANTAGES OF CAST-IRON GEARS

BY EDGAR H TRICK*

There is more to be known about gears than most people think. All engineers and designers of machinery, and many users of gears know a lot about the theory of gears—systems of tooth development, involute and epicycloidal teeth, etc.; but, getting down to brass tacks, as the saying is, how many know just exactly wherein lies the superiority of one gear over another? The two principal sources from which this excellence may come are the material from which the gear is made and the process by which it is made.

General purpose gears are made from cast iron, cast or forged steel, or bronze. When made of the two latter materials some peculiar or extraordinary service is required of the gear—with the discussion of which we are not concerned. By far the greatest number of gears are made from cast iron and cast steel. Concerning the relative advantages of these two materials there is much difference of opinion. Of late years users of gears have quite run away with the idea that cast steel gears are best under any and all conditions. Nothing could be more erroneous; nothing more outrageously violates scientific knowledge. Under all ordinary conditions cast steel gears have but a single sharply defined superiority over cast-iron gears, *i. e.*, that of greater strength. Nor has this fact been clearly apprehended by designers, for no appreciable reduction has been made in the size of the hubs, arms or rims of gears out of consideration of the fact that they are made of steel—cast-iron sizes prevailing in all cases.

True economy is here altogether lost sight of; for, obviously, if cast steel is the stronger material, less of it should be used. How much less is the question. Designers may calculate and engineers may judge, but experience alone can demonstrate. The practical determination of this point must necessarily take years to effect, just as it did in the case of the cast-iron gears. Unfortunately the element of time cannot be eliminated. Until this important matter is satisfactorily settled all efforts for economy must be ignored in the matter of cast steel gears; a higher price must be paid per pound and an extravagant amount of material used.

On the other hand, cast iron has a number of distinct advantages over cast steel, both for the designer and the user. Cast iron is a much easier metal to work with than cast steel, having less shrinkage and less warpage than cast steel; nor will it so readily transmit vibration. This latter peculiarity can readily be demonstrated by striking with a hammer on a wheel of cast steel and on one of cast iron. The tone of the resulting noise is much higher in pitch in the case of the cast steel, due to the shorter and more rapid vibrations. The noise from the cast iron is lower in tone and of shorter duration, due to the opposite conditions. Thus cast-iron gears immediately take the preference from the standpoint of closest approach to silence in operation. It may here be said that it is a scientifically proven fact that workmen subjected to loud, raucous noises at their work become dull and sluggish in their mental processes, and their efficiency falls in exact proportion.

Only in exceptional cases is it necessary to use cast steel gears for their superior strength. In the vast majority of cases a good cast-iron gear is amply strong enough for the service required of it. There are three conventional methods of making gears. When the teeth are to be cut the rim of the pattern is made a solid blank. The resulting casting is bored, turned on its periphery and faced on both sides of the rim. The finished blank is then put on the gear-cutting machine and the teeth cut as desired. The two remaining methods relate to gears designed to have cast teeth. In the one case a full pattern is made; that is, all the teeth are cut on the pattern. This is the old fashioned, expensive way which entails a vast deal of labor both in the laying out and the formation of the teeth. Although tooth-forming machines have done much to relieve this situation in the jobbing shops, the spacing of the formed teeth on the periphery of the wheel is extremely difficult to do accurately—simple as it looks to those who have never had it to do. The other method referred to is that of machine-molding the gear. This is by far the best method, being the simplest, most accurate and the cheapest. All that is required in the way of a pattern is a sweep, a part of the hub, an arm, and a tooth block. The latter is fixed on the arm of the machine and two or three teeth, as may be desired, are rammed at a time, the spacing being done with absolute precision by the machine. The chances for inaccuracy are reduced to a minimum; the whole trick is up to the patternmaker and, since his efforts are confined to but two or three teeth on the block, he concentrates his whole ability there, with the result that a perfect gear is produced. The clearances in a well made machine-molded gear may be just as close as in a cut gear of the same pitch. The comparative ease with which machine-molded iron gears can be made makes them by far the most economical to use, and if this fact were better known to engineers and designers of machinery, cast-iron gears produced by this method would invariably be specified.

Everyone familiar with foundry practice knows that the outside skin of a casting is its hardest part. This single peculiarity lends to machine-molded cast-iron gears the soundest argument in their favor. It takes long service to wear through this hard shell on the faces of the teeth, whereas in the case of cut gears, all of this valuable wearing surface is entirely cut away before the wheels go into service. Cast steel gears do not have these advantages. The high temperature at which steel is poured necessitates the use of silica sand in the molds. This has to be rammed so hard that machines cannot conveniently be used, making a full pattern necessary. Moreover, steel castings are hard to make; it takes a "real molder" to make a good one. Since nearly all the labor in the steel foundries is done by unskilled foreigners, who do not appreciate the niceties of gear molding, it is extremely difficult to get a good cast steel gear, accurate to pitch, round, and true to theoretical tooth contour. The silica sand burns to the faces of the teeth, which "scabs" and "pits" them, so that almost invariably every tooth face has to be chipped to secure even an indifferent bearing: hence the noise and clatter that is so noticeable in cast steel gears with cast teeth. If the teeth do not bear across their entire face, the very object that the designer had in mind is altogether lost.

The matter of shrinkage in cast steel is difficult to control, so much so, in fact, that few manufacturers will guarantee large wheels to come near the pattern allowances. No two wheels will shrink just alike, so that the question of whether the wheels will preserve the circularity of the pattern is in grave doubt. Therefore, aside from exceptional cases where great strength is required, designers should be extremely chary of specifying cast steel gears unless the teeth are to be cut. There is but one principal object in cutting the teeth of gear wheels: there are a number of minor reasons. The first is to insure perfect tooth contact; the others are to lessen the noise of operation, to improve the appearance of the wheels, to discover flaws in the material, etc. Since perfect contact can be secured by machine-molding the teeth, why cut them? The expense of cutting is an appreciable consideration. If cast iron will do, why use cast steel? Cast iron is by far the cheapest. The argument is advanced that steel wears longest. The hard skin on the teeth of machine-molded gears of cast iron so lengthens their time of service that even that argument is in grave doubt. We are brought face to face with the fact that, after all, nothing can quite take the place of a well made machine-molded cast-iron gear. The matter of the gears is often the largest item of expense in certain classes of machinery, as in the case of bending and straightening machinery. If the greater part of the cost of the gear patterns can be saved by having them of cast iron and machine molded, why not do it? The specification of the cheapest as well as the best gears for the purpose in mind is the true indication of the designer's ability.

* * *

ATTACHING RUBBER TO METALS

Rubber may be attached to alloys containing one of the antimony group of metals by vulcanizing it while in contact with the alloy, and to other metals, by coating them, for instance, by electroplating, with an alloy containing antimony, and vulcanizing the rubber while in contact with this coating.

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AUTOMATIC TURRET MACHINE FOR MACHINING STEAM RADIATORS

BY CHESTER L. LUCAS*

While the automatic drilling and turning of small castings in a turret lathe is an everyday operation, it is somewhat out of the ordinary for similar automatic operations to be performed on castings weighing from fifty to seventy-five pounds.

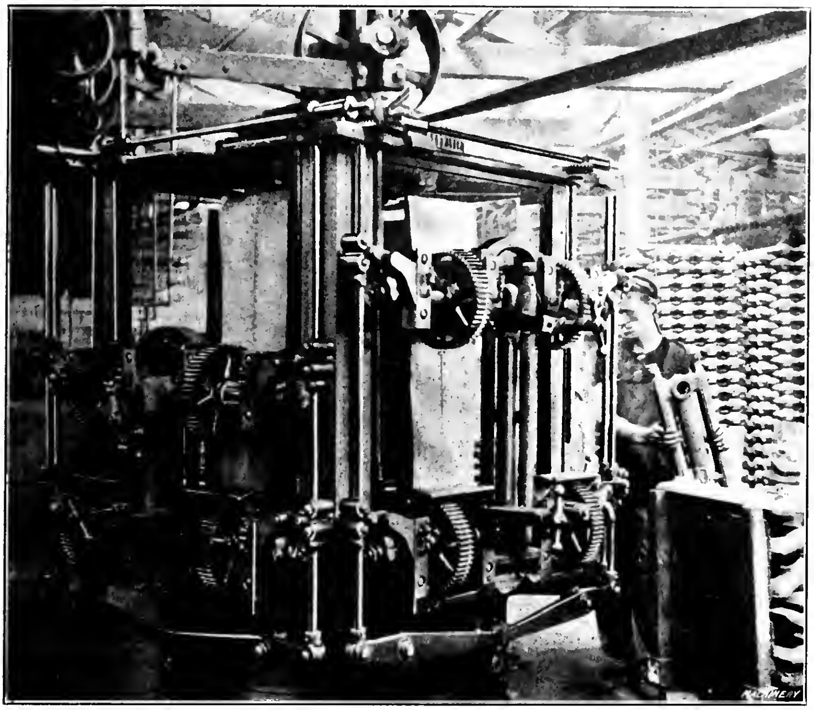

Fig. 1. A Turret Machine for Large Work

This is the class of work, however, that is being done on the automatic drilling and counterboring machine illustrated in Fig. 1. This machine was made by the O. Bryant Machine Co., Buffalo, N. Y., and is in successful operation at the radiator plant of the H. B. Smith Co., Westfield, Mass.

This machine has been nicknamed the "merry-go-round" by the operators, from the fact that the work and tool mechanism revolves continuously about a central supporting post, the entire mechanism of the machine being in the form of a square vertical turret. The turret has four working faces, each of which is provided with a separate set of tools and feeding mechanism, so that each face performs all the work on one casting complete. Referring to Fig. 1, the operator stands at the loading point and clamps a casting in place while the turret is passing. This being done, the feeding mechanism commences to advance the tools, drilling and counterboring at both ends of the casting on its way around the machine, and when the casting comes around again to the operator at the operating point, the work is finished and the casting ready to be taken out and replaced with another piece of work. The machine is continuous in its operation, there being no indexing mechanism of any kind. The main advantage of the turret construction is that the work is automatically returned to the loading point after being finished and the operator can do the removing and loading from one position. At the same time, by having four pieces of work under way at once, there is always one casting ready to be removed.

One of the radiator castings upon which the operations are performed may be seen near the bottom of Fig. 2. On each casting the work consists of drilling out a two-inch cored hole at each end of both sides, making four holes in all. There are four cutting tools working simultaneously on each casting, each of which combines a two-inch drill and a three-inch counterbore. Each of the holes is counterbored to prepare the radiator sections for assembling. These radiator castings come in various styles and lengths so that the machine must be, to a certain extent, adjustable for the various sizes. In order to accommodate the different lengths of castings the upper sets of working tools on each face of the turret may be raised or lowered to suit the particular piece which is being machined.

By referring again to Fig. 1 it will be seen that the cutters on the face of the turret, shown at the right, are working on long castings, while the mechanism on the left-hand face is operating on short castings. This means that the operator must have two piles of castings at the loading point so that when the "short face" comes around he can supply a short length casting, and when the "long face" of the turret appears he can put in a long casting.

A good idea of the feeding mechanism with which each of the turret faces is supplied, may be had by referring to Fig. 2. Here the casting is shown at *A*, being clamped in position by straps *B*, which are held in place by means of levers *C*. The cutting tools are shown at both sides of the top and bottom of the casting at *D*. These tools are operated from corresponding shafts *E*, which receive their motion through vertical shafts at the rear of each face, and these are, in turn,

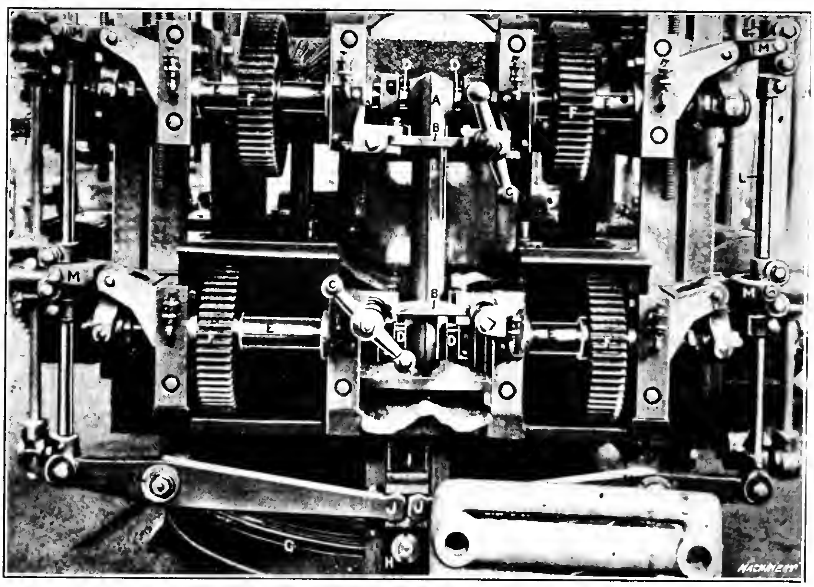

Fig. 2. One of the Turret Faces

*Associate Editor of MACHINERY.

operated by spur gearing from the central stud. The spur gears are at the top of the machine and may be seen in Fig. 1. Motion from the vertical shafts is transmitted to the tool spindles by means of bevel gearing. The tools on the opposite sides of the work revolve in opposite directions; therefore the cutting tools on one side of the work must be made left-handed. Upon auxiliary shafts, behind each face of the turret, are the broad faced driving gears which mesh with tool spindle gears *F*. These broad faced gears are wide enough so that the gears *F* which are fixed upon the tool spindles may have travel enough to allow for the machining of the work and still be properly in mesh.

The forward feeding of the tool spindles is accomplished in an interesting manner. There is a continuous circular cam track *G* around the base of the machine, and extending from each of the four faces of the turret is a cam roll mounted upon the opposite end of stud *H*, which continuously bears against this track. The cam track is straight at the loading point; that is, there is no rise, but as soon as the loading point is passed, there is a gradual ascent of the cam track, causing the cam roll to rise steadily and forcing slide *I* up with it. Pivoted in this slide are the ends of the two toggles *J*, which are fulcrumed upon studs *K* on the turret face. Therefore, as the inner ends of the toggles are raised, the outer ends are depressed, and carry downward with them vertical shafts *L*. Upon these shafts *L* are mounted bellcranks *M*, which, through connections at their lower ends with tool spindles *E*, tend to force these spindles inward when shafts *L* are lowered. Thus as long as the ascent in the cam track is maintained, the tool spindles feed in, causing the drilling and counterboring tools to act on the work from both sides of the casting. The cam track is made perfectly straight for the last one-eighth revolution, so that the counterboring tools simply revolve against the work and smooth the surfaces. This is just previous to the ejecting and loading point, at which time there is an abrupt drop in the cam track, allowing the spindles to retreat, and permitting the operator to unclamp the work and set in a new piece before the commencement of the cam ascent is reached again by the turret.

* * *

HIGH-SPEED SHAFTING

BY J. E. LINABURY*

One of the most significant steps in the advancement of machine shop economics, since the introduction of high-speed steel, has been the advent of high-speed lineshafting and small high-speed belts, made possible by the use of ball bearing shaft hangers. The increased friction from high rotative speed, and the low melting point of babbitt bearings have, after many years, established an average lineshaft speed of from 150 to 200 R. P. M. Occasionally, by extremely careful attention to lubrication and alignment, 300 R. P. M. has been reached, but rarely any more. This low rotative speed has made comparatively large size shafting necessary, thus adding to the weight and cost. If a motor is used for power, its speed is usually from 900 to 1200 R. P. M. It is generally conceded that a belt will give the most efficient service at a velocity of from 4000 to 4800 feet per minute. To get this the motor pulley should be 15 to 18 inches in diameter. If the main shaft turns at 200 R. P. M., its driving pulley would then be from 5 to 7 feet in diameter, with an alternative of a heavier and more expensive belt with greater tension, or a smaller pulley—usually the latter. This holds true with regard to all the pulleys on the main shaft; either the pulleys are excessively large and heavy, or the belts are not working to their best efficiency. When a 2-inch belt, costing 20 cents per foot, might be used, a 4-inch belt, costing 40 cents per foot, is required.

The ball bearing hanger, however, has changed much of this. Now many progressive engineers, looking everywhere to save installation and manufacturing charges, lay out their main and countershafting to run in ball bearings at 400 to 600 R. P. M., using light narrow pulleys and narrow belts, thus saving materially in total first cost, and from 50 to 75 per cent of the power consumed in the shafting, which in the majority of cases is not less than 40 per cent of the total power used. They also save in maintenance, for where the old type of hanger required lubrication every day, the ball bearings do not require attention oftener than once in four months.

Let us make a cost comparison of two lines of shafting, 100 feet in length, say, transmitting the same horsepower. Let the first be 2 7/16 inches in diameter, and turning on babbitt bearings at 200 R. P. M., with hangers every eight feet. Between hangers consider two 30-inch pulleys, with 4-inch belts, each 25 feet long. Each foot of this shaft weighs 15.87 pounds, or 1587 pounds in all, costing 2¼ cents per pound, or about $35.60. To transmit the same amount of power with ball bearing hangers at 600 R. P. M. will require a shaft only 1 11/16 inch in diameter, weighing 7.6 pounds per foot, or 760 pounds in all, and costing but $17.10. This means a saving of 827 pounds in weight, and $18.50 in cost. Where two 30-inch pulleys with 4-inch face were used in each bay in the first case, with the high-speed shaft, 20-inch pulleys with a 2-inch face will do the work. This saving in pulleys is about 50 per cent in their weight, and $3 a piece in their cost, or $72 in the total pulley cost of 24 pulleys. With the slow shaft, using 25 feet per pulley, 600 feet of 4-inch belt, costing about $240, would be required; while with the high-speed shaft, 2-inch belt, costing $120 would handle the same work. From this it is apparent that by the use of the ball bearing hangers, the saving in the initial cost of shafting, pulleys and belting is $210.50 in one 100 feet. While the ball bearing hangers cost more than the plain ones, the difference will not be as much as their saving in first cost. Add to this the longer life of the hanger, the freedom from dripping grease, the brighter, neater appearance overhead, the low maintenance charge, with a probable saving of 20 to 30 per cent in total power used, and one realizes the reason for ball bearing hangers becoming so generally popular. The use of high-speed shafting has not been confined to manufacturers using specialized machines, but to practically all classes of work. General machine departments, grinders, automatic machines, and the rigid and varied requirements of a toolroom, all find the application most practical, and reap the benefit of a lighter, brighter and quieter overhead construction, coupled with economy in installation, maintenance and power.

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* * *

WHERE IS THE FALLACY?

The "proof" below indicates that any two unequal numbers may algebraically be shown to be equal.

Let a and b be the two unequal numbers. Let c be their arithmetical mean; that is, $(a + b) \div 2 = c$, or $a + b = 2c$.

Then:

$$(a + b)(a - b) = 2c(a - b)$$
$$a^2 - b^2 = 2ac - 2bc$$
$$a^2 - 2ac = b^2 - 2bc$$
$$a^2 - 2ac + c^2 = b^2 - 2bc + c^2$$
$$(a - c)^2 = (b - c)^2$$
$$a - c = b - c$$

Hence $a = b$

But a and b were assumed to be unequal.

* * *

A fleet of large self-propelled barges, fifteen in number, to ply between New Orleans and the coal fields of northern Alabama, is of interest in that they are the first craft of their kind in America to be propelled by producer gas engines. The barges are of steel construction, and are similar in design to those in use on the canals of Holland. Their measurements are as follows: Length, 240 feet; width on deck, 32 feet; width at bottom, 28 feet; depth, sides, 8 feet; depth, center, 8½ feet. Their capacity is 1000 tons, and the draft when fully loaded is 7 feet. They are propelled by twin screws driven by twin engines and have a speed of approximately seven miles an hour when fully loaded. The weight of each barge and equipment is close to 240 tons. The screws are driven at 300 R. P. M. by two 75 H. P. Fairbanks, Morse & Co. vertical producer gas engines. Gas for the engine is furnished by a 150 H. P. producer, made by the same company. The fuel used for the producer is what has heretofore been a waste coke from the ovens of the Birmingham district, and which consequently is secured at a low price.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

CONCERNING AN OFFSET DRILL HEAD

Fig. 1 shows the sub-base of a machine which was to be built in large quantities. Its size and weight made it very desirable to do all of the drilling on a radial drill. The holes *A* were easy enough to drill, but holes *B*, being at right angles with the others and parallel with the drill press platen, gave considerable trouble, and much time was lost by using

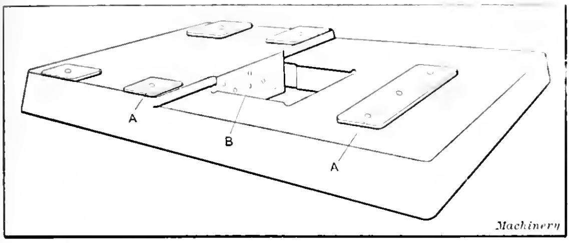


Fig. 1. Sub-base of Machine which required Special Fixture for drilling Holes B

a small ratchet drill. The saving that would be effected by drilling these holes with a power-driven drill head warranted designing and making the special tool shown in Fig. 2, which cost but $26 to make and has proved entirely satisfactory.

The yoke *D* is securely clamped to the radial drill spindle. The yoke extension *E* is hung to the yoke *D*, with a screwed-on plate *F*, so constructed that the yoke extension can be turned to any angle in relation to the radial drill arm and set by means of the lever *G* and its brass plug *H*. At *J* is shown a short drill with a taper shank which enters the collet *K*. This collet *K* is keyed to a miter gear *M*, which, in turn, is driven by gear *O*, the hub of gear *M* being freely mounted in bushing *N*. The gear *O* is fastened to the spindle

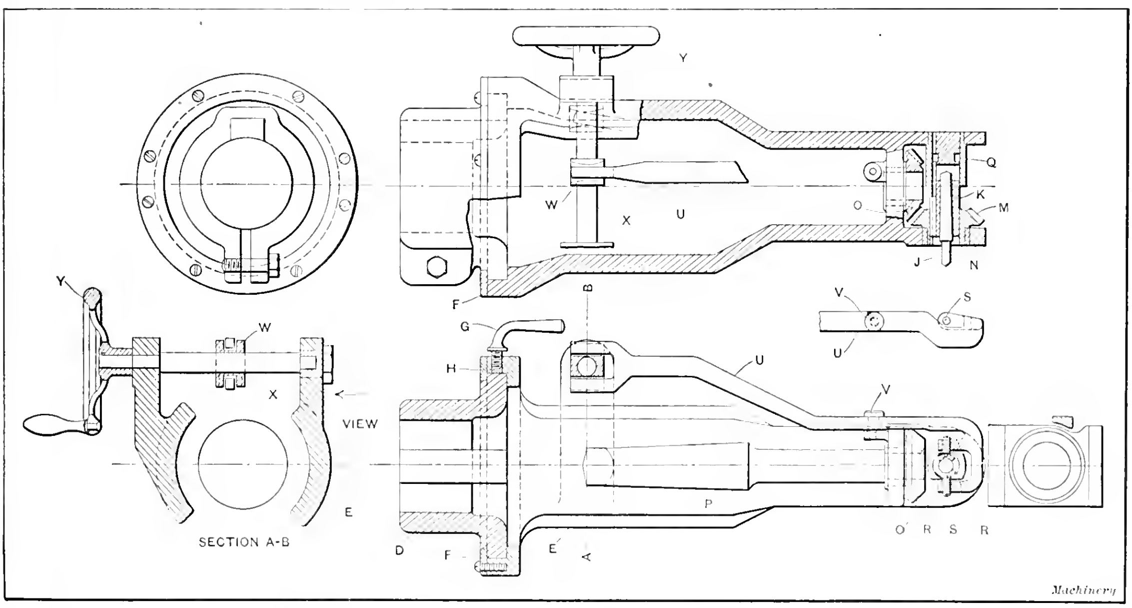


Fig. 2. Offset Drill Head designed for drilling Horizontal Holes on Radial Drill

P, which enters the taper collet in the radial drill spindle. The drill-holding collet *K* is supported by a bushing *Q*, which is slabbed off and slotted as shown in the illustration. Two small crescent-shaped pieces *R* are fitted into collet *K*, and two screw pins *S* inserted through slots in the bushing *Q*. These screws are set in the lever *U*, which is fulcrumed at *V* and propelled as shown by means of the block *W*. The screw *X* and handwheel *Y* allow the operator to feed the drill with ease.

Although at the first glance the construction of the smaller working parts of this drill head may appear frail, it must not be forgotten that it will enter an opening that is but 5 by 3½ inches in size and drill a ½-inch hole 1¼ inch from the side of the opening quite as rapidly as under ordinary conditions. This special head has paid for itself many times in the saving which it has effected in drilling the horizontal holes in the sub-bases.

RICHARD RUSSELL

TURRET LATHE SET-UP FOR A SMALL SCREW

"To cut costs, cut the cutting time and cut the time between cuts" is a slogan which has been popularized by the Bullard Machine Tool Co. This advice applies to all classes of machining operations, and scientific management is merely a "classical" title for this simple formula for cutting costs. It will be readily understood that in certain operations it is more important to make a reduction in the cutting time, while in other cases the time between cuts is more easily reduced. Of course, if both the cutting time and the time between cuts can be reduced a still greater saving will be effected.

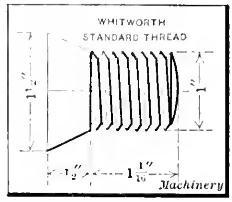
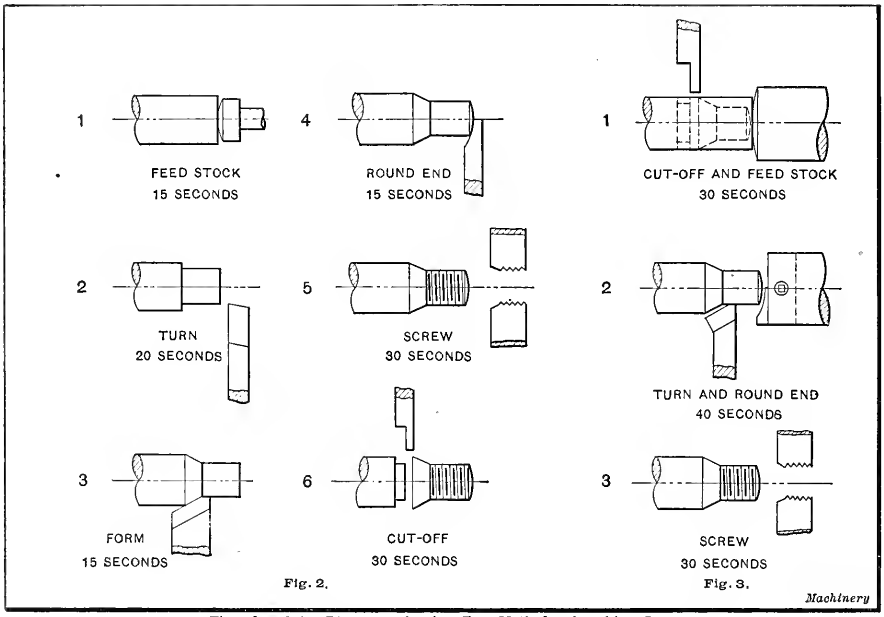


Fig. 1. Screw to be made

It is the purpose of this article to describe the method by which both the cutting time and time between cuts were reduced in making the countersunk head screw shown in Fig. 1. It will be evident that if a sufficient number of these screws had been required it would have been quite a simple job for the "automatic." It happened, however, that the quantity required was not large, and a more serious objection lay in the fact that the equipment of our shop did not include an automatic screw machine. Consequently the only alternative was to do the work on the most suitable hand-operated machine which was a Herbert No. 2 turret lathe, taking bars up to 2¼ inches in diameter. Fig. 2 shows what would ordinarily be the sequence of operations from feeding the stock in the first operation to cutting off the finished screw in the sixth, the time for each being given. It must be understood that each of these operations required a separate face of the turret so that it was necessary to advance and withdraw the turret

six times to complete a single screw. With a heavy turret and carriage, such as the one used on the Herbert No. 2 machine, these hand movements became decidedly monotonous and fatiguing when the machine was being operated on such short cuts.

To reduce the number of idle movements to a minimum, the tool set-up shown in Fig. 3 was adopted. By combining certain cuts this arrangement did away with three operations, so that instead of advancing and withdrawing the turret six times for each complete screw, only three movements of the turret were necessary. The operation of feeding the stock is accomplished without having to move the turret from the cut-off position, a piece of cold-drawn bar being clamped in the turret hole to act as a stop. The second operation of the new system combines the second, third and fourth operations of the original method. Referring to the illustration it will be seen that the turning tool is shaped to form the head of the screw as well as to turn the body, and a second cutter carried by a bar clamped in the turret hole forms the end of the screw. In operating the machine according to the second method the feed is tripped just before the tool which forms the end of the screw starts to cut, so that the actual ending and forming of the head is done by hand. The third operation consists of threading the screw, after which the piece is cut off and the bar fed up to the stop ready for the next sequence of operations.



Figs. 2 and 3. Diagrams showing Two Methods of making Screws

Referring to the notation showing the time of each operation according to the two methods, it will be seen that it required only 100 seconds to complete a screw when the second method of tooling was used, while 125 seconds was required by the original method. This saving may not appear very substantial, but it is certainly worth while, and it is also possible that a much greater saving could be effected on a long run because the operator would not be fatigued so soon. The only outlay involved in changing over to this new method of tooling was for the forming tool used for the second operation; the stop and the ending tool were also of special design, but as they could be used to advantage on many other classes of work they were not charged to this particular job.

ALBION

SOME EVERYDAY SHOP PROBLEMS

As it has come to my notice that some of the common operations performed in machine shops every day present apparently insurmountable difficulties to apprentices and to some so-called "journeymen," I will describe briefly my methods of doing certain work in the hope that they will be of help and benefit to some who have had troubles.

I have particularly noticed the difficulties that some machinists have in squaring up a piece in a shaper vise. I have seen machinists who had the reputation of being a little better than the average, spend a great deal of time and energy taking many cuts over a block jig which had to be planed on all six sides. Work of this kind can be done quickly and accurately if the procedure is right. My method is to plane one side with a roughing tool and then place that side against the back jaw of the vise with a round piece of stock between the opposite side and the vise jaw in order to hold it securely against the back jaw. A rough cut is taken off the side then presented to the tool. In this way, I proceed until the block is planed on four sides. Then the block is tested with a square to find two sides that are square. These are marked with chalk.

A piece of scrap cast iron about the size of the jig is then placed in the vise, pinched with the jaws, and a cut is taken from it. The jig to be finished is then placed on this false bottom using pinch parallels to hold it with the square or chalked side down. A finishing cut is taken over the block, continuing around until finished all over.

I do not pretend to say that this is the best method of doing work of this kind, but I have met success with this method of procedure and having seen so many failures when men have tried to do it other ways, believe that the reader will find my way produces satisfactory work with a minimum of labor and trouble.

Another difficult job for many mechanics is planing a pair of V-blocks so that the vees come exactly central in the blocks. I have seen many mechanics who did not seem to be able to do this simple job without spending a great deal of time at it. The way I plane V-blocks is to rough out the vees first and then finish them, placing one at a time on the false bottom of the vise. The planer head is set at an angle of 45 degrees and a cut taken down the side of the vee, being sure that the block is held down firmly on the bottom and against the back jaw of the vise. Now without moving the table run the head up for another cut and reverse the block. Take the finishing cut down the other side of the vee and finish the other block in the same way. This procedure will produce the V-blocks with the vees as nearly central as it is possible to get them.

Another kink that is sometimes found useful in turning quick tapers on a lathe is using the taper attachment in combination with the tailstock set-over. When the required taper is greater than can be obtained with the taper attachment, swing the attachment as far as it will go and then set the tailstock over sufficiently to make up the required taper.

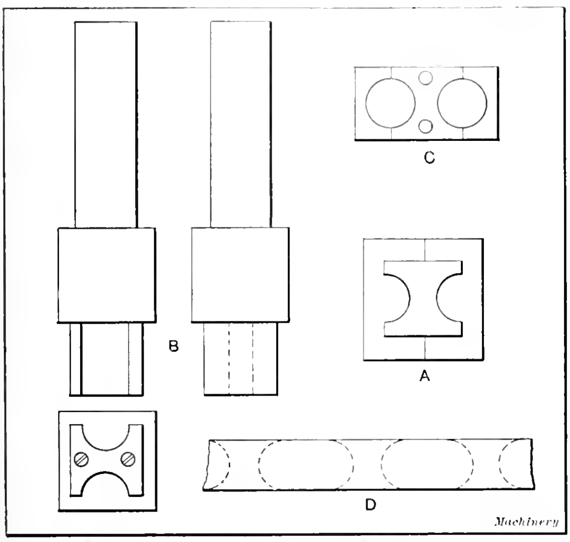
Some men seem to think that figures were invented for office use only. If they see a machinist working with a pencil and note book, they are likely to turn up their noses and say, "We don't take any stock in book learning. Experience is the best thing." Did you ever notice that "what such men lack in the head, they usually make up in the heel"? In other words, they have to do a great deal of walking and trying and cutting and fitting to accomplish what a short calculation will often do. For example, we had some square pieces that were required to be screwed in place and to stand at a certain angle when screwed in tight. The pieces were threaded eight threads per inch. Hence one complete turn would advance the piece 0.125 inch; that is, 360 degrees angular movement

would advance the piece 0.125 inch. Now, dividing 0.125 by 360 gives 0.000347 or 0.00035 inch, which is close enough for any common practice, as the advance for 1 degree. Now for the application of the figures: First, try the piece in the hole and set the bevel protractor on it, and ascertain the number of degrees it has to travel to stand at the required angle. Say, for example, it has to be turned 15 degrees. Now multiplying 0.00035 by 15 gives 0.00525 or practically 0.005 inch as the amount to be faced off in order to have the parts stand at the required angle.

Sharon, Pa. ROY B. PLATT

A LABOR-SAVING SHEAR

In an establishment where the writer was recently employed, long strips of iron, both flat and bevel-edged, were cut into shorter lengths for use on various "ironing" operations on vehicles. In order to give the ends of the pieces a more finished appearance, they were (after being cut off on an ordinary shear) rounded with a suitable die. This, of course, necessitated a second handling. Later, both the cutting and rounding were completed at one operation by the use of the special shear (or, properly speaking, punch and die) illustrated herewith. This device is adapted to cutting off a variety of widths and thicknesses, and has the additional advantage of being made entirely on a lathe and shaper, which will recommend it to many shops where the tool equipment is limited.



Punch and Die used for Combined Shearing and Trimming Operation

The die block *A* is made in two parts, doweled together. This enables the die to be cut out in the shaper, one-half at a time, and also makes it possible to readily vary the clearance between the punch and die. It can be made of almost any desired size, to suit the stock used. The one mentioned cuts the ends of the pieces with a radius of 5/8 inen, while the stock used varies in width from 3/4 inch to 1 1/4 inch, and in thickness from 3/16 to 3/8 inch.

The punch *B*, which at first glance looks like a difficult shape to produce, is easily completed by using a piece of steel considerably longer than the finished punch, and boring two holes of equal size clear through the block. Afterward, the two ends of the piece are cut off, as shown at *C*. The waste of steel made necessary by this method is more than made up by the saving in time that is effected. The punch is afterward fitted to a holder suitable for the press used.

The strips of iron are fed against stops set for the length required, and the portions of the strips *D* between the dotted semicircles are completely punched out of the strip, thus both cutting off and rounding the ends of the pieces at one handling.

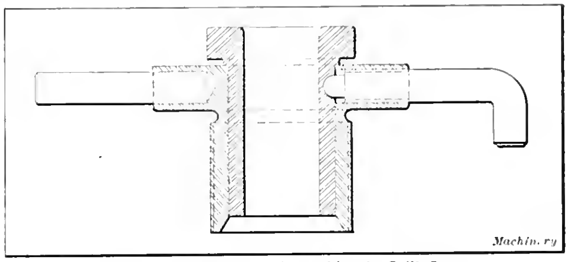
The punch may be made quite narrow in the middle and thus the amount of stock lost in cutting will be very small. Many small pieces used in "ironing" wagons, auto bodies, and on many other manufactured articles can be greatly improved in appearance by cutting off the stock in this manner, and the cost of so doing is no greater than the usual method of employing a common shear for this purpose.

Troy, Ohio. HENRY J. BECK

METHOD OF FASTENING SLIP BUSHINGS

The April and June numbers of MACHINERY contained articles and drawings of different methods of fastening slip bushings in drill jigs to prevent them from crawling up on the drills. I would like to add the accompanying example and explanation to those already given.

As slip bushings are used to a greater extent in screw bell bushings than in other styles, and as it is always necessary



Method of fastening Slip Bushing in Drill Jigs

to provide some means for screwing down the bell bushings, four pieces of drill rod inserted in the bell bushing as shown, and at right angles to each other, seem to constitute the most satisfactory way of doing this. As shown in the illustration, in place of one of the pieces of drill rod, a hole is tapped out and a form of set-screw is used with the end turned to some convenient radius, as 1/8 inch. Then the slip bushing is drilled at one point so that as the screw is turned in, it engages in the hole provided in the bushing and locks it firmly in place, thus answering the double purpose of a lock for the bushing and a prong to simplify the screwing in and out of the bell bushing.

Lima, Ohio. R. E. DODGE

THREAD CUTTING TOOLS

The process of thread cutting has been widely discussed from both practical and theoretical standpoints. The various thread forms have been described and established, but very little definite information on cutting threads has been made public, and accurate thread cutting still remains a problem for the individual to solve.

A number of threading tools are on the market which answer the purpose of screw cutting fairly well, but screw

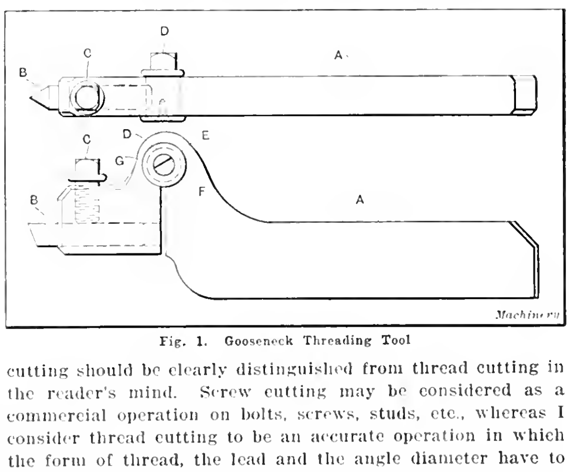


Fig. 1. Gooseneck Threading Tool

cutting should be clearly distinguished from thread cutting in the reader's mind. Screw cutting may be considered as a commercial operation on bolts, screws, studs, etc., whereas I consider thread cutting to be an accurate operation in which the form of thread, the lead and the angle diameter have to be rigidly adhered to. In the last few years the writer has been employed on accurate thread cutting and in the follow-

ing he will endeavor to describe some of the tools that have been successfully used and which may be useful to others:

Fig. 1 shows an outside threading tool of the gooseneck form. The holder *A* is forged from ½ by 1 inch tool steel stock. *B* is an inserted tool made from round stock, preferably turned down from a larger size, high quality steel rod to about $\frac{5}{16}$-inch diameter. It is held in position by the set-screw *C*. As the tool body is round, it can be set for any lead to cut the required angle. This is one of the principal requirements of an accurate thread cutting tool. *D* is a plug by which the desired amount of spring in the gooseneck is regulated. The hole in which the plug is fitted is drilled to the desired size, ½ inch being the diameter of the hole in the tool shown, and the bottom part is filed slightly, so as to produce an elongated or oval hole. The plug *D* is also made slightly oval and is fitted loosely in the hole, being held in place by a flat-head screw and washer, *F* and *E*. The hole in the stock may be countersunk, if preferred, and the wedge bolt *D* riveted over to hold it in place.

In laying out the holder, care should be taken that the hole is so placed that the weakest part of the gooseneck is at a point *G*, about midway between the horizontal and vertical, next to the tool. The thickness should gradually increase toward the back of the stock. This shape of holder causes the tool to spring away from the cut when the pressure becomes heavy and does away with all tendency to dig in. In roughing, the wedge bolt *D* is twisted, preferably so as to bring the high point to the front beneath *G*. This makes the tool quite rigid but still leaves a slight amount of spring available. When the finishing cut is taken, the wedge bolt is loosened so that the full spring of the gooseneck is available.

An objection may be offered to the design of the tool because it is not offset as ordinary gooseneck tools often are, and for that reason threading cannot be done close to a shoulder. The objection to offsetting is that it causes a sideways deflection of the tool, often resulting in roughing or tearing the thread. These tendencies are much reduced when the tool is set at right angles to the work where it gets the stiffest possible support. As to the objection that a shoulder cannot be worked to closely, the class of work on which accurate threading is required, in most cases, has either a shank or an arbor extending beyond the thread, thus giving ample space for the tool-post and tool when set in the right-angle position. Examples are taps, gages, various forms of hobs, etc.

Fig. 2 shows an inserted-cutter inside threading tool and holder. The tool-holder *A* is made of a ½-inch piece of drill rod with a $\frac{5}{32}$-inch hole drilled through the end at an angle of 30 degrees. The hole is drilled and tapped at right angles for a ⅜-inch hollow set-screw and acts as a clamp-screw. The set-

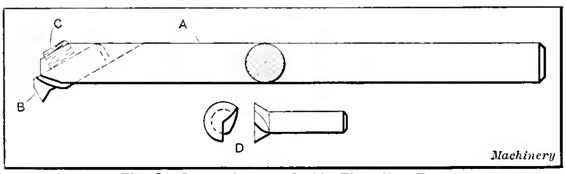


Fig. 2. Inserted-cutter Inside Threading Tool

screw must be short if limited in height to the over-all dimension of the holder, but the writer has proved out this type of holder under hard test and has found the short screw amply strong to hold the tool firmly in position. He has used a ⅜-inch standard hollow set-screw of only three or four threads length, but if desired, users can make special set-screws with finer and more threads.

The tool *B* is a round piece of tool steel ground to the shape shown in the illustration. This tool also possesses the important feature of lead angle adjustment as mentioned in connection with the description of the gooseneck holder, Fig. 1. It has another equally important feature, which is that it extends beyond the holder so as to make it convenient to reach to the bottom of a hole or to a shoulder, as is often necessary in inside threading work. *D* shows another form of cutter adapted to this holder which possesses the feature of lead angle adjustment and in addition, being circular in form, may be ground many times, the form remaining unchanged. It is at a disadvantage, however, in small openings or when working close to the bottom of a hole or shoulder, because the opposite part of the cutter projects beyond the cutting edge and thus prevents the cutting edge working as close to a shoulder as the form shown in Fig. 2.

Fig. 3 shows a center gage which the writer has found to be superior to the ordinary flat type. Its design resulted from necessity, illustrating again the fact that necessity is the mother of invention. The writer had to cut a hob having a 90-degree thread and knew of no reliable way of setting the tool correctly, until the idea of this tool was conceived. The scrap box furnished the stock which was accurately centered. The 90-degree angle groove was cut by using a compound rest. This gage is placed between the lathe centers and the tool set in the groove. The 90-degree angle groove was found to work so satisfactorily that a 60-degree angle groove, a 55-degree angle groove and a square groove were also cut. Both ends were

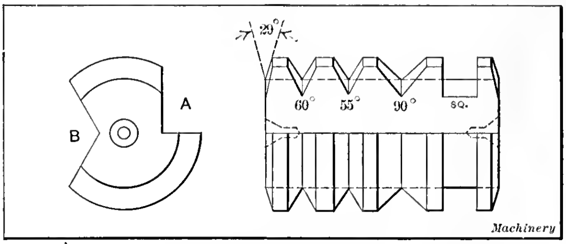


Fig. 3. Center Gage for 29, 55, 60 and 90-degree Threads and Square Threads

faced to an angle of 14½ degrees from the vertical, thus making it available for setting 29-degree angle "Acme" thread tools. The right-angle groove *A* permits the tool to be set flush with the gage and thus favors very accurate adjustment. The tool as first designed did not have the groove *B*, but the need for it was felt when a heavy piece of work between the centers would have required removal had not the gage been adapted to use *against* the work by cutting the groove *B*. The groove *B* permits the gage to be laid against a cylindrical piece of work held between the centers, and used in the same manner as when held between the centers. To set an inside threading tool, the gage is placed with one end against any surface at right angles to the line of center, such as the faceplate, chuck jaws, etc., and with groove *A* facing the threading tool.

After making the gage, the writer found a similar tool in MACHINERY's Reference Book No. 31, but inasmuch as this was original with him and has a strikingly different feature, it probably will be of interest and novelty to many readers.

Waterbury, Conn. JOSEPH WALDMAN

SETTING DIAMONDS

Referring to the article on setting diamonds in the July number, I wish to state that the diamond setting proposition was a troublesome one where I was formerly employed as foreman. The diamonds were held in the holder by a cap screwed onto a piece of ⅜-inch soft steel rod. We were always in trouble with this arrangement because of the cap loosening and the diamonds getting lost. We finally abandoned the use of the screwed cap holders and resorted to solid settings.

The method employed was to drill a hole in the end of a ⅜-inch soft steel rod just large enough to admit the diamond. The diamond was placed in the hole with the largest end at the bottom of the hole, and the end of the rod was peened around the diamond sufficiently to prevent it from falling out. The holder with the diamond in place was then given to the blacksmith who heated it to a white welding heat and with light blows, using a small hand hammer, closed the metal in over the diamond. The holder was then taken to the emery wheel and ground on the end until the diamond touched the wheel.

We found this was a very good method and used it afterwards with satisfaction. The welding heat did not appear to affect the diamond and the light blows having closed the metal around the diamond it was held very tightly when cold. With this setting, emery wheels could be trued many times before having to reset the diamond.

Montreal, Quebec, Canada. MICHAEL MCGIVERN

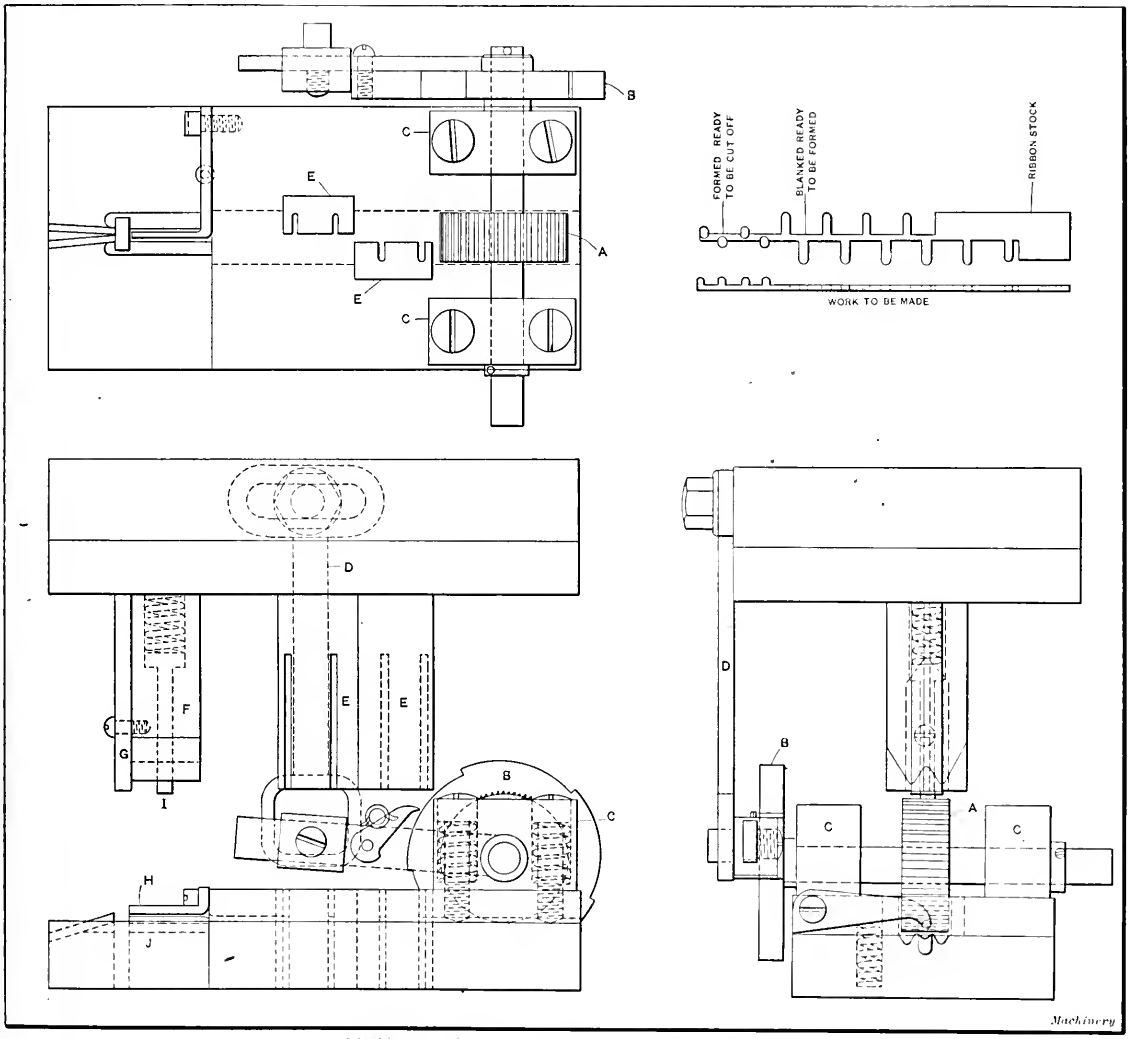
BLANKING, FORMING AND CUTTING DIE

The punch and die shown was designed for producing the piece illustrated in the detail view. This piece is produced from ribbon brass 0.012 inch in thickness, and at each stroke of the press one piece is blanked, another formed and a third cut off, from which it will be evident that one piece is completed for each stroke of the press. In an average working day this punch and die has a capacity for 60,000 pieces.

Referring to the illustration, the operation of the punch and die may be outlined as follows: The ribbon stock is fed into the die by means of the corrugated roll *A* which is given the required pressure by means of springs under the bolt heads in the pillow blocks *C*. The five-tooth ratchet wheel *B* is mounted on the end of the shaft which carries the feed-roll *A*; this ratchet wheel is operated by the arm *D* which is connected with the punch-holder. At each stroke of the press, the ratchet wheel *B* is rotated one tooth space, and this rotation is transmitted to the feed-roll *A*, thus advancing the stock through a distance of 5/8 inch.

The work is blanked by the punches *E*, formed by the parts *F*, *H*, *I* and *J* which constitute the forming punch and die, and cut off by the blade *G*. The blanking punches are quite simple and any mechanic will understand their operation from the illustration. The forming punch and die is interesting. Referring to the illustration, *H* is a pin about which the prongs which were produced in the blanking operation are curled. As the punch-holder descends, the punch *I* bends the ends of the prongs down around the forming pin *H*. After performing this function the punch *I* rises into the holder against the tension of a spring, and allows the forming punch *F* to come into action. This punch forces the pin *H* down into the forming die *J* and finishes curling the prongs on the work around the forming pin. When the punch-holder rises, the pin *H* is returned to its normal position by the action of a spring. During the upward stroke, the ratchet wheel *B* feeds the stock into position for the next operation, and by so doing the work is pushed off the forming pin. The shear blade *G* then comes into action and cuts off the finished piece against the edge of the forming die *J*.

Ambridge, Pa. AUGUST J. LEJEUNE



Blanking, Forming and Cutting Die and Work produced in it

DETERMINING CHORDAL THICKNESS OF SPIRAL GEAR TEETH

The method of finding the dimensions of spiral gear teeth described by Arthur C. Maxfield seems needlessly complex. A simpler method is submitted in the following:

First find the normal diametral pitch. In the majority of cases this is known, inasmuch as the angles and diameters have been fixed to correspond with regular diametral pitch cutters. Then find by the usual formula, the same as that used for finding the cutter number, the number of teeth in the equivalent spur gear. Take the value given in a table of chordal thicknesses for the new number of teeth and divide by the normal diametral pitch found. The formula for determining the cutter number is:

$$\text{Cutter number} = \frac{\text{number of teeth}}{\cos^3 \text{(spiral angle)}}$$

In the case selected by Mr. Maxfield, *viz.*, 8 teeth, spiral angle 48 degrees, the number of teeth in the equivalent spur gear is found by dividing 8 by $\cos^3$ 48 degrees, which gives us 27.

Manchester, England. FRANCIS W. SHAW

ANALYZING STRENGTH OF CYLINDER HEAD BOLTS

In the July issue of MACHINERY appeared an article entitled "Analyzing Strength of Cylinder Head Bolts." With all due respect to the author, I would like to submit my view of this problem. Mr. Farnsworth, like many others, contends that the internal steam pressure must exceed the total pressure holding the cylinder head on, before any extra tension is exerted upon the cylinder-head bolts. This may be true, but at present I am not convinced.

Fig. 1 shows a sketch similar to that shown in the July number. With a tension of 10 pounds registered on each of the side scales, it is obvious that there must be a compression in the piece EF equal to 20 pounds. Now it may appear that the spring-balance at G must register 20 pounds before any perceptible difference is noticed on the side scales, but what has become of the compression on the piece EF? With no tension on the scale at G it would be difficult to remove the piece EF, but with the scale at G showing a tension of 20 pounds, the piece could be removed without altering the reading on any of the three scales.

Fig. 2 is similar to Fig. 1, with the exception that weights are used instead of the spring-balance. To illustrate more clearly, in Fig. 3 a rubber gasket I (exaggerated to illustrate more clearly) is placed between the cover and the cylinder flange. Assuming the cover to have no weight, and the gasket, in a free state, to be 3/8 inch thick, then weights W suspended from each of the six bolts, exert a pressure of 60 pounds on the gasket I and compress it to a thickness of 1/4 inch. There is a tension of 10 pounds in each of the six bolts, due to the weight on them. Now, if a spring-balance is placed at G

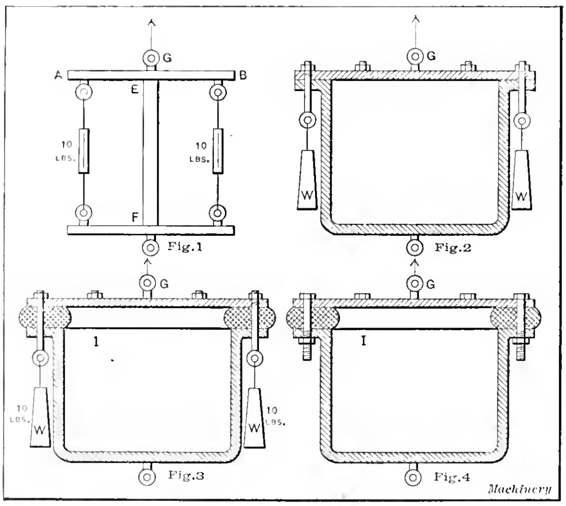
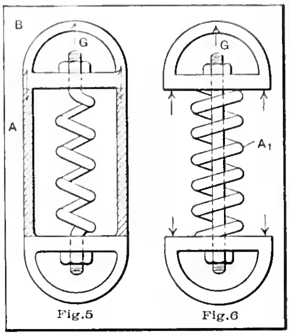


Fig. 1 to 4. Diagrams illustrating Principles relating to Stresses in Bolts

(the base being firmly secured) and a pull exerted, any tension registered on the scale must have an inverse effect on the gasket I. As the tension on G increases, the compression on the gasket decreases until the scale at G registers 60 pounds, when the gasket has regained its original thickness of 3/8 inch.

In this case, the resistance has only been transmitted from the gasket I to the spring-balance at G, which is in accordance with Newton's third law of motion: "To every action there is always an equal and contrary reaction." It will be clearly seen that there still remains a tension of 10 pounds in each stud, due to the weight W, but the cover has risen 1/8 inch due to the pull at G. Now in place of a weight being used to give a tension of 10 pounds in each stud, suppose bolts and nuts are used to compress the same gasket from 3/8 inch to 1/4 inch (as shown in Fig. 4.) Then the vital question is: If a pull is exerted at G, or an internal pressure of steam or air, or a force of any kind, acts to remove the cover, what is the result? It seems quite evident that a pull of 60 pounds at G must double the tension in the bolts, as the gasket (which is compressed to 1/4 inch) is already exerting a force of 60 pounds.

To acquire a certain tension in a stud or bolt, a similar resistance is absolutely necessary, and, if in the case in hand, the resistance of the initial tension of the bolts is taken by the flanges and gaskets, what resists any added pressure? As the compression of the flanges and gaskets is already exerting a force tending to separate the cover from the cylinder, any additional force, be it ever so small, must be added to it.



As the foregoing is only the version of a young mechanic (and perhaps a mistaken one), any light on this apparently debatable subject would be highly appreciated by mechanics in general.

Hamilton, Ont., Canada. JAMES H. RODGERS

[Whether the initial tension on a tightened bolt holding a part subjected to pressure is increased by that pressure before the initial tension is exceeded, depends upon the following conditions: When a bolt is more elastic than the material compressed, the stress in it equals either the initial stress (due to tightening the nut) or the force applied, depending upon which is greater. If the material compressed is more elastic than the bolt, the stress in the bolt equals the initial stress plus the force applied. The principles involved are illustrated by the diagrams, Figs. 5 and 6. The bolt in Fig 5 is in the form of a spring and part A is under compression. Now, while an upward pull at G would reduce the pressure between parts A and B, the tension on the bolt would remain constant until pull G exceeded the initial tension. In Fig. 6, the bolt is straight and spring A_1 is under compression. In this case, the tension on the bolt equals pull G plus the upward thrust of the compressed spring. When flanges are held together in direct contact, they are much more unyielding than bolts, and the condition illustrated by Fig. 5 exists. If they were separated by a gasket more flexible than the bolts, the total stress (as in Fig. 6) would equal the sum of the initial tension and the force applied.

Referring to Fig. 1, obviously the compression on EF will diminish as the upward pull G is increased, as our correspondent states, but the tension on the side scales (representing the bolts) remains constant until pull G, in this case, exceeds 20 pounds. The load is gradually transferred from EF to G, but without affecting the tension of the side scales, until the pressure on EF is reduced to 0; then, any additional upward pull will increase the tension on the side scales. The principle is also illustrated in Fig. 2. If the weights W weigh 10 pounds each, it is apparent that the tension of 10 pounds on each bolt will not be increased by an upward pull at G. If this same tension had been obtained by tightening the bolts with nuts, it would also remain constant until pull G exceeded the total initial tension, unless a flexible gasket were used in the joint. Any upward pull at G, however, would reduce the pressure between the flanges. If a thick flexible gasket were used, as shown in Fig. 4, the total stress would equal that due to compressing the gasket plus the pull G, because, in this case, the material compressed is more elastic than the bolts. A more complete explanation of the principles involved will be found in MACHINERY's Reference Book No. 22, "Calculation of Elements of Machine Design."—EDITOR.]

EPICYCLIC TRAINS

An epicyclic train is one in which all or some of the gears or wheels have a motion consisting of a revolution about an axis and a revolution or movement of the axis itself.

In Fig. 1, *A* is called the link or arm of the train. Rotation when right-handed will be considered as positive (+) and when left-handed as negative (−). Gear *B* has 60 teeth; *C*, 20 teeth, and *D*, 30 teeth. Gear *B* will not rotate. The problem is to find the number of revolutions made by gear *D* if the arm *A* makes + 5 turns.

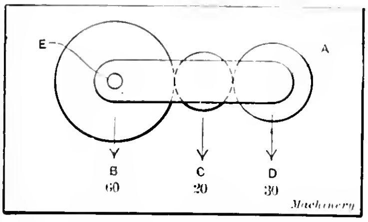


Fig. 1. Diagram illustrating Principle of Epicyclic Trains

There are several methods that can be used in solving, but I believe the following to be the most comprehensive:

	B	*D*	*A*
1. Train locked	+ 5	+ 5	+ 5
2. Train unlocked (arm fixed)	− 5	$-5 \times \frac{60}{30}$	0
3. Resulting motions (algebraic sum)	0	− 5	+ 5

First consider the train locked and turn the arm + 5 times about point *E* as an axis. This results in the gears and arm being turned + 5 times, as shown in line 1 above. The train is then unlocked and the arm assumed to be fixed. It will be necessary to turn gear *B* − 5 times in order to make its resultant movement zero, which the problem states is true. The wheel *D* would then turn $-5 \times \frac{60}{30}$ times, $\frac{60}{30}$ being the ratio of the gears. The resulting motion of each gear and the arm is shown above and is the algebraic sum.

An excellent use to which this principle may be put is shown in the example of the boring bar when used on a lathe or other machine, as illustrated in Fig. 2. Suppose the right-hand screw *A* has eight threads per inch. It is desired to find the distance the cutter bar *B* will travel for one positive (+) turn of *C*, which is the bar placed between centers. We will call the motion of *C* positive (+) when rotating in the direction of the arrow.

	H	*E*	*C*
1. Train locked	+ 1	+ 1	+ 1
2. Train unlocked (arm fixed)	− 1	$-\frac{3}{13}$	0
3. Resulting motion	0	$+\frac{10}{13}$	+ 1

With the train locked we assume *C* (arm) to be turned + 1 revolution, with the result that all the gears would be turned + 1 revolution. With the train unlocked and *C* stationary, we find it necessary to turn gear *H* minus one turn in order to have its resultant movement zero, which would be true, as gear *H* is fixed to the lathe tailstock and cannot rotate. We find that gear *E* has turned − 3/13 revolution. Adding, we find the resultant motion of *E* to be + 10/13 revolution. But this is relative to gear *H*, which is stationary and cannot move. It is necessary to find the turns of gear *E* relative to *C*, which is not stationary, but turning about the same axis as *E*, or + 10/13 − 1 = − 3/13. If the lead-screw *A* has eight threads per inch (right-handed) the cutter bar *B* will move 3/13 × 1/8 = 0.028 inch to the right for one turn of *C*.

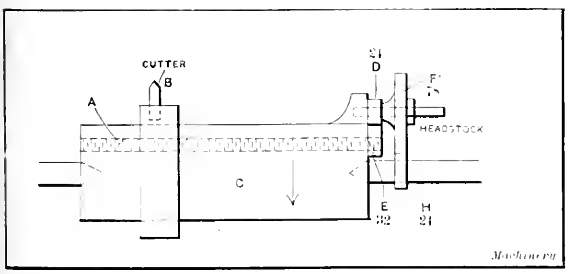


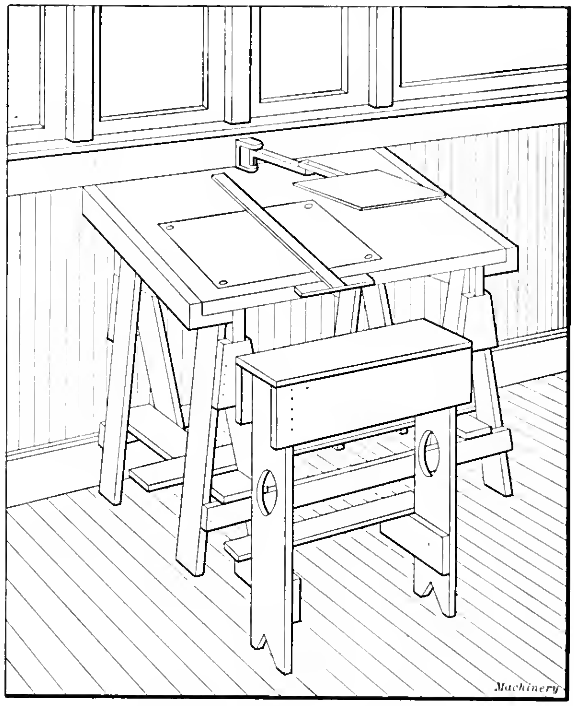
Fig. 2. An Application of the Epicyclic Gear Train

Cliftondale, Mass. I. E. Miller

DRAFTSMAN'S SEAT AND INSTRUMENT HOLDER

The illustration represents my idea of a well arranged drawing board, seat and instrument holder. I have been using this arrangement for several years and find it satisfactory. A bench seat which will accommodate two persons is convenient when the superintendent or head draftsman wishes to sit down on the seat with the draftsman for a while to inspect a drawing or to talk over matters of detail. The bench is useful also when making large drawings as one can slide along so as to keep his work in front of him. With the draftsman's stool commonly used, it is necessary to stand in order to do very large drawings, as one cannot sit on a stool and reach far.

The seat I use is 11 by 36 inches on top and 25½ inches high. The foot-rest is 8 inches from the floor. The height of the bench is right for that of the drawing board, which is



Draftsman's Seat and Instrument Holder

arranged for use either as a stand-up board or when sitting on the seat. The height of the front edge of the drawing board is 33 inches from the floor and this is very nearly right for the average man whose height is about five feet ten inches. The height is right for doing work where the draftsman has to lean over and against the board; it puts the pressure against his body where it will do him the least harm. This is an important consideration when making many large drawings.

The homemade instrument holder over the board is useful for keeping the instruments, scales, squares, etc., out of the way of the T-square, especially when it is necessary to use the T-square to draw in vertical lines. The folding arm of the instrument holder is an old square folding gas fixture. The tray is made of galvanized iron, the edges being folded over so that no square edges are exposed.

Chattanooga, Tenn. R. W. J. Stewart

* * *

A small business of some importance in New York City is the collection of steel filings from machine shops for use in fireworks. The price paid for clean filings in New York City is about twelve cents a pound.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LANDIS ROLL GRINDING MACHINE

The Landis Tool Co., Waynesboro, Pa., has recently added to its line the roll grinding machine illustrated in Figs. 1 to 4. This machine includes a number of important features in its design and embodies the method of traversing the grinding wheel carriage, which is a distinctive feature of Landis grinders. Uniform and positive lubrication of the ways is provided and a rigid foundation for the work, no matter what its length or weight may be. There is no overhang of the work-table, as it is supported for its entire length by the column of the machine to which it is firmly clamped, thus avoiding vibration; this is a feature which is essential to rapid and accurate grinding. This machine is built in seven sizes. The smallest size is a 16 by 72 inch machine weighing 15,000 pounds, while the largest swings 52 inches, takes 20 feet between centers, and weighs 90,000 pounds.

The machine has been designed for manufacturing purposes and while it is primarily intended for grinding hardened steel and chilled rolls, it is also well suited for finishing a variety of cylindrical work such as large shafts, pistons, Corliss valves, torpedo tubes and similar pieces. The design has been worked out to make the machine entirely self-contained and no overhead works are required except when it is desired to drive the grinder from a lineshaft; in such a case an auxiliary shaft with tight and loose pulleys and a cone pulley over which the belt runs to the machine is required. Owing to the fact that the machine can be operated without any overhead works, it is convenient to place the grinder under a crane for lifting the work into place and removing it.

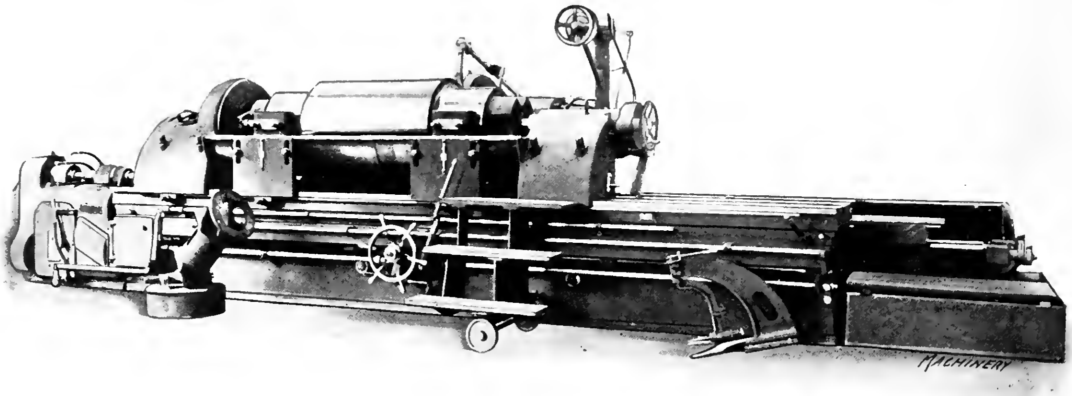


Fig. 1. Front View of Landis Roll Grinding Machine

Where electric motor drive is employed, the motor is mounted on an extension of the base and can either be connected directly to the driving shaft or power can be transmitted by a belt, as desired. The machine can also be driven by a motor placed on the ceiling or wall, in which case the extension on the base of the machine is not required. The main drive is located at the rear of the machine and consists of a shaft extending the full length of the bed. The different mechanisms are driven from this shaft independently by means of belts. The driving shaft is thoroughly protected for its entire length by means of a sheet metal guard.

The grinding wheel driving pulley traverses with the wheel carriage and is trunnioned in an independent carriage which travels on a track provided for the purpose. The pulley is driven by rolls in its hub engaging with step grooves in the main driving shaft. In traveling, this arrangement makes a practically frictionless driving connection. The grinding wheel belt passes over idler pulleys which are so arranged that its length does not change as the wheel head is moved on the cross-slide. One of the idler pulleys automatically adjusts itself for any change in the length of the belt due to stretching and at the same time keeps it under a uniform tension. The work and traverse speeds are varied independently of each other. This is an important factor in commercial grinding, as it affords the necessary traverse feed for any work speed. For grinding tapers, the table swivels and is provided with two scales which are graduated in degrees and inches per foot, respectively.

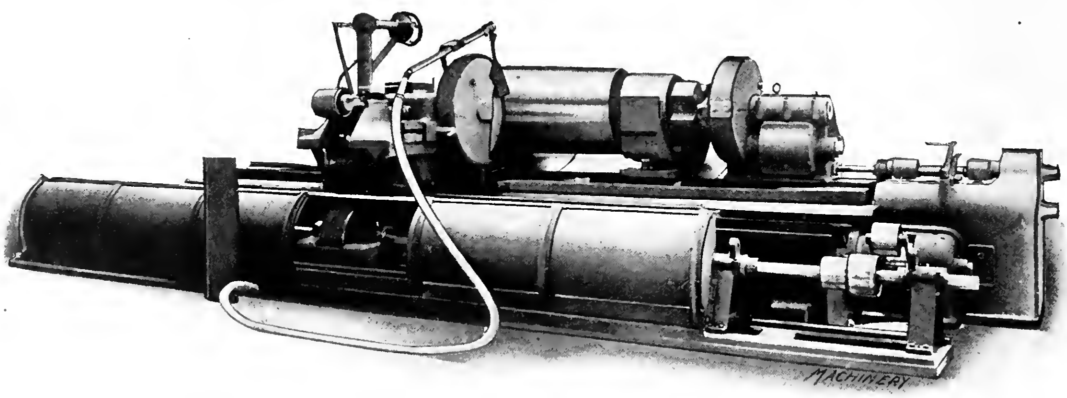


Fig. 2. Rear View of Roll Grinding Machine

The headstock is of heavy construction and powerful gearing is provided for driving the work. The speed changes are made

by an arrangement of levers at the front of the machine. The footstock is operated by a handwheel which is geared to the screw so that the center can easily be run into the heaviest piece of work that the machine will carry. The grinding wheel head is mounted on a vee and flat guide of ample proportions to provide a smooth and positive action when feeding for the lightest cut on the work. The spindle is made of steel and runs in phosphor-bronze bearings which are made with tapers to provide for taking up wear. The bearings have a ball and

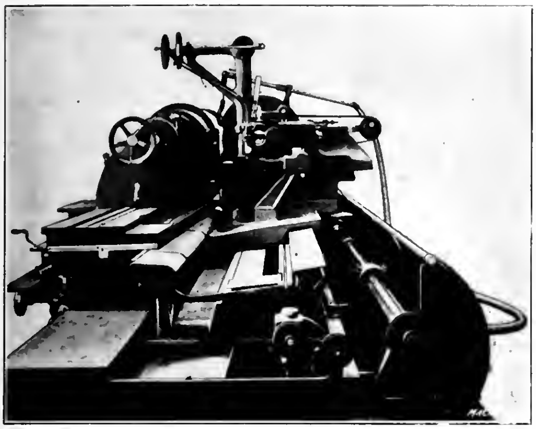


Fig. 3. Right-hand End of Roll Grinding Machine showing Driving Shaft

socket connection with the base, which makes them easy to keep in alignment with the spindle. The grinding wheel is fed to the work either automatically or by hand, and there is also a rapid power feed for moving the wheel back out of the way when changing the work and also for bringing it forward to the grinding position when the machine is ready to be placed in operation. This is an important feature as it saves a considerable amount of time as well as making the operation of the grinding machine simple and convenient. The rapid power feed is independent of the hand and automatic feed, being operated by a lever and simple arrangement of clutches. The automatic cross feed for the grinding wheel operates at each reversal of the wheel carriage and can be set to reduce the work diameter from 0.00025 to 0.012 inch at each traverse.

The grinding wheel is provided with three truing fixtures.

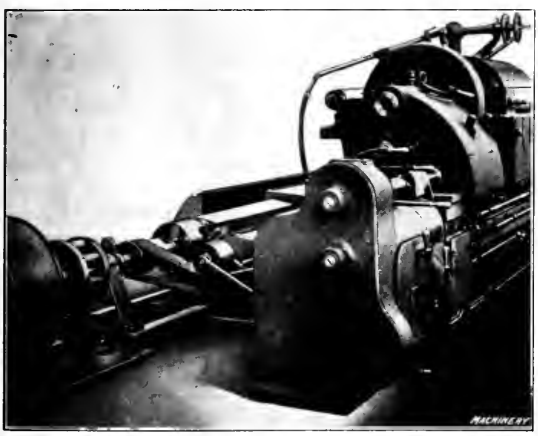


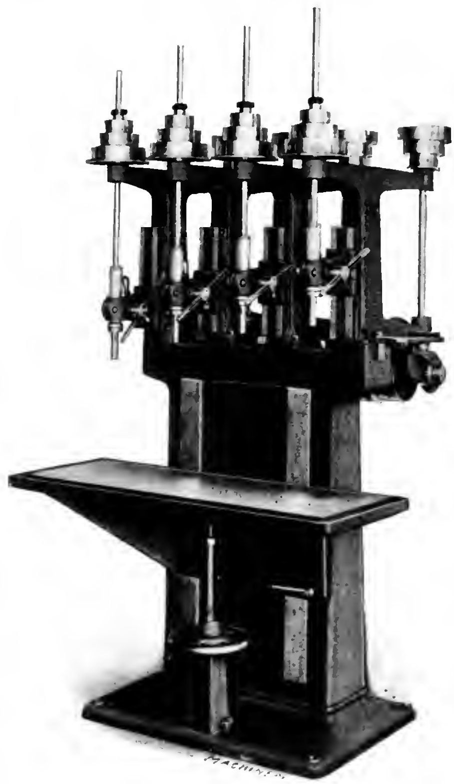
Fig. 4. Left-hand End of Roll Grinding Machine showing Arrangement of Motor Drive

One of these fixtures is permanently mounted on the footstock, where it is in a convenient position for dressing the wheel when it is engaged in grinding necks on the rolls. Another truing fixture is located on one of the bearings which carries the roll by its neck and is used when grinding the face of the roll. The third fixture is used for forming or rounding the corners of the wheel for grinding the fillets of the necks. This truing fixture is attached to the table of the machine.

It has already been mentioned that the rolls are supported by their necks in bearings while the body of the roll is being ground. These bearings have three points of contact which are adjustable for the variation which exists in the size of the necks due to wear and regrinding. They can be quickly removed and replaced by other bearings to accommodate a different size of roll. For grinding concave work, special bearings are required. These are provided with vertical adjustment for tipping the roll to an angular position with one end above and the other below the horizontal center line of the wheel. This results in a concave form being ground. The vertical adjustments of the ends of the work are controlled by screws, the amount of adjustment secured at either end being indicated by graduated scales. These bearings can also be used for grinding straight rolls and the arrangement of the pads is the same as described in the foregoing. The concaving outfit includes a universal driver for the work.

REED MULTIPLE SPINDLE DRILL

In the March, 1913, number of MACHINERY, the improvements made by the Francis G. Reed Co., 43 Hammond St., Worcester, Mass., in its line of bench drills, were illustrated and described. Since the completion of this work, the same attention has been given to the line of multiple spindle drills manufactured by this company, a four-spindle drill of the



Improved Design of Reed Multiple Spindle Drill

improved type being illustrated herewith. The general design of the machine has been retained, but various improvements have been made to adapt these machines for the most severe classes of modern manufacturing.

Among the changes which have been made, the following may be mentioned. All of the bearings have been lengthened and the length of the belts has also been increased to add to their driving power. The top cones have been brought down nearer to the frame of the machine to reduce the strain on the bearings, which are oiled through the top of the shafts. The swing has been increased to 14 inches, while the capacity remains the same; *i. e.*, up to ½ inch drills. Gear guards have been added which practically enclose all of the gears. A new material has been adopted for the bevel gears which is very tough and possesses excellent wearing qualities combined with the ability to give a practically

noiseless transmission. The drive is so arranged that there is only one belt for each spindle, this being a straight open belt.

It will be seen from the illustration that the column of the machine has been changed to the rectangular pattern, as in the case of the improved bench drills. The table bearings are made of ample length and the table is provided with a deep oil channel extending all the way around it. The table is supported and raised or lowered by means of a telescoping screw, a binder handle being provided to lock it to the column in any desired position. This improved type of machine is known as the Reed No. 300 multiple spindle drill.

HESS EDGE PROTECTORS

In lifting heavy, finished castings the edges are frequently damaged by the chain slings, this damage being due to both the indentations produced and to the result of the chain slipping on the casting. Where rope slings are used in place of chains, the damage to the castings is avoided, but at the expense of the ropes, which are soon worn out. Both of these difficulties are avoided by the edge protectors, illustrated herewith, which are a product of the Hess Steel Castings Co., Bridgeton, N. J. It will be seen that these protectors consist of a casting having two plate members at right angles to each other and a pair of stiffening ribs to

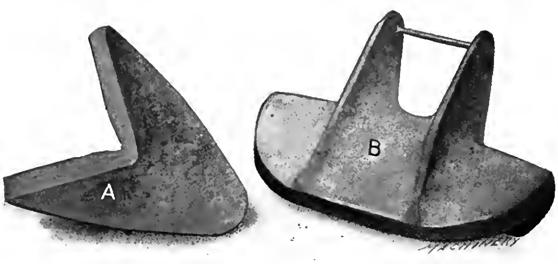


Fig. 1. End and Side Views of Hess Edge Protector

provide the necessary strength. The chain or rope rests between these ribs, the protector being thickened and rounded at this point to form a seat which will prevent the sling being damaged. The ribs are carried far enough back to receive a cotter pin which holds the protectors in place on the sling when they are not in use.

Provision is made against the slightest damage being done to castings with sharp finished edges by running a groove along the protector at the point where the two plate members join. This groove will be readily seen in the end view of one of the protectors, which is illustrated at *A* in Fig. 1, a side view being shown at *B*. The protectors are made of a very low carbon alloy, which is of essentially the same composition as pure wrought iron. This material is so ductile that there is no danger of the protectors being broken, even when they are subjected to the roughest handling. Where great care in handling is required, protectors are made with a babbitt or lead lining. This lining may be renewed as it becomes worn or charged with chips, suitable pouring dies

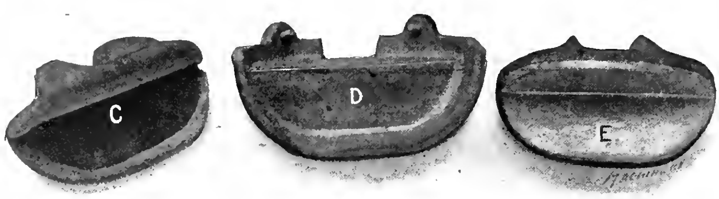
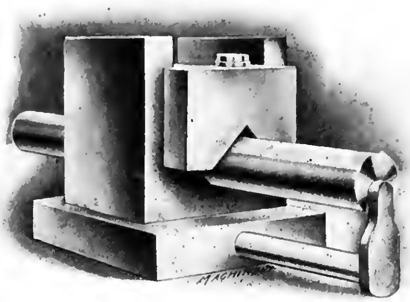


Fig. 2. Recessed Casting for Babbitt Lined Protector, Pouring Die and Finished Protector

being provided for the purpose. A recessed casting for one of these protectors is shown at *C* in Fig. 2; the pouring die is illustrated at *D* and the protector with the babbitt lining is shown at *E*. With guards of this nature, finished pieces of work can be handled without any danger of marring them.

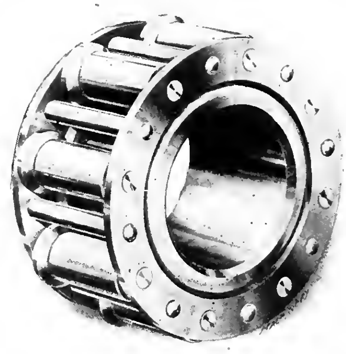
HOLTON V-BLOCK

The double V-block illustrated herewith is a product of the Holton Co., Jackson, Mich. This is a particularly useful drill press tool, and with it holes can be drilled perfectly straight through a bar, no special skill being required for the operation. The block is made of cast iron, accurately milled by means of special milling cutters designed for the purpose. The master bushing is made of steel and fitted into the upper V-block. This bushing is hardened and ground to



Holton V-block for holding Work to be drilled

¾ inch inside diameter and pressed into place. Interchangeable bushings are provided which fit into this master bushing and adapt the V-block for the use of different sizes of drills. The interchangeable bushings are also made of steel, hardened and ground in the customary manner. A set of ten interchangeable bushings forms a part of the regular equipment of these V-blocks. Referring to the illustration it will be seen that the V-block is equipped with an adjustable gage



Bower Roller Bearing for Combined Radial and Thrust Loads

which makes it a simple matter to produce duplicate pieces. The capacity of the V-block is for pieces ranging from ¼ inch to 2 inches in diameter.

BOWER ROLLER BEARING

The Bower roller bearing illustrated herewith is adapted for carrying combined radial and thrust loads, but the two components of the load are carried by individual bearing members. In this particular, the design of the Bower roller bearing differs from most forms of roller bearings designed for such service. The rollers used in this bearing consist of a long cylindrical portion upon which the radial load is supported. At one end of the cylindrical portion of each roller there is a flanged head; this head fits into corresponding grooves in the races of the bearing and the thrust load is supported upon the inclined faces shown at the left in the halftone. The heads which receive the thrust load do not come into contact with the radial raceway and therefore do not support any portion of the radial load. As the radial and thrust supporting members of the bearing are independent of each other, an increase of either radial

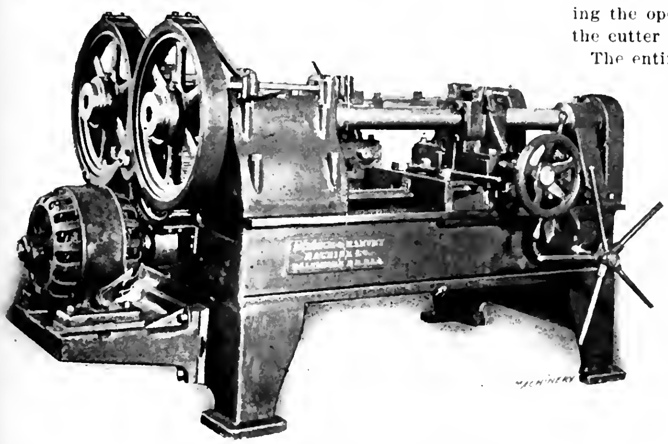
or thrust load does not affect the efficiency of the bearing for carrying the other kind of load for which it is designed.

This bearing is absolutely non-adjustable as regards radial alignment, but the end play in the bearing may be increased or diminished to suit individual requirements without in any way affecting the alignment of the shaft or spindle. Owing to the self-aligning principle which is employed, the rollers always run in a parallel path without any wedging action, and it is stated that, when correctly mounted and of the proper size, the bearing will run for years without appreciable wear. The rollers are freely mounted at one end and held at the other end by means of the heads which carry the thrust load. This bearing is manufactured by the Bower Roller Bearing Co., Detroit, Mich.

DETRICK & HARVEY BORING MACHINE

The duplex boring machine illustrated herewith is a recent production of the Detrick & Harvey Machine Co., Baltimore, Md. This machine was designed for machining car boxes, and the bed is of sufficient length to enable boxes 6 inches in diameter by 12 inches in length to be bored and faced.

The spindles of this machine are made of cast iron; they are $4\frac{1}{4}$ inches in diameter and run in bearings 17 inches in length. The spindle bearings are capped. Sliding tooth clutches keyed to the spindle and actuated by an eccentric lever engage or disengage toothed sleeves which revolve loosely on the spindles. The driving gears are made of cast iron and the pinions of either bronze or steel. The boring bars are secured to sockets in the ends of spindles and are supported at their outer ends by bearings; the two spindles can be operated simultaneously or independently as desired. The bars have no movement longitudinally.



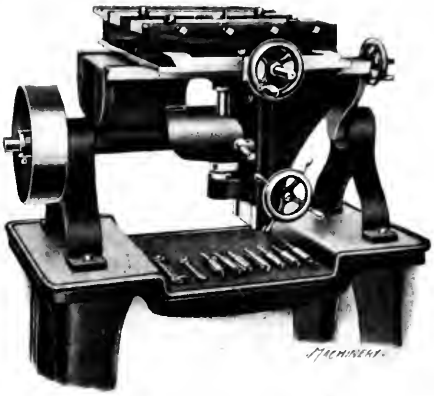
Detrick & Harvey Duplex Car Box Boring Machine

The carriages are fitted to the inner locks of the shears and are moved longitudinally by hand or power. A quick hand movement operated by the spider shown in the illustration is provided by means of the rack and pinion, while a slow hand movement is provided by means of the handwheel. Power feeds are provided by spur gearing at the end of the bed farthest from the headstock. Each carriage contains a square locked cross-slide upon which two slides are fitted, the slides being adjusted to and from the center line of the spindle by a screw, as shown in the illustration.

The change gears are located at the end of the machine farthest from the headstock. Motion is transmitted to the feed mechanisms from their respective spindles so that the feed is only in action while the spindles are revolving. Each spindle is provided with independent feed changes. The feeds to the carriage cover a range of from 1/16 to 3/16 inch per revolution of the spindle. The spindles are driven by a $12\frac{1}{2}$ H. P. motor which has a speed variation of 1 to 2 and gives spindle speeds from 25 to 50 revolutions per minute. It will be seen that the motor is mounted on a bracket at the head end of the machine so that the unit is entirely self-contained.

THURSTON DIE MILLING MACHINE

The Thurston Mfg. Co., Providence, R. I., has recently redesigned its die milling machine, a number of improvements having been incorporated in its construction which add materially to the efficiency of the machine. The illustration shows the redesigned machine, and, as in the preceding type, the die to be milled is held on a table which is carried by cross



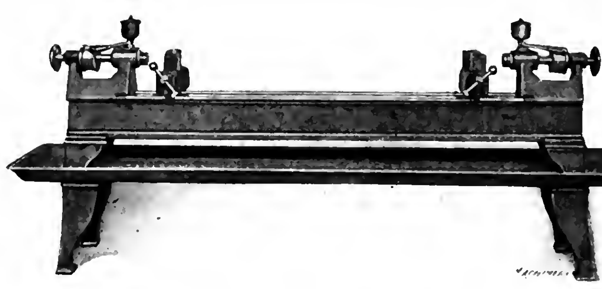
Improved Design of Thurston Die Milling Machine

and longitudinal slides. The cutter spindle projects upward through the die opening, and by manipulating the handles which operate the two slides the work is fed against the milling cutter until it has been recessed to the desired shape. Taper cutters are used, a suitable taper being employed to provide the clearance that is required for the die. In starting the operation, a hole is drilled in the die-block in which the cutter starts to operate.

The entire frame is mounted on trunnions so that the work may be inclined to the position which is most suitable for the operator. In the original machine, the cutter spindle was simply mounted in small brackets, but in the redesigned machine the cutter spindle is supported by a slide having broad bearing surfaces so that it is rigidly held; this slide also facilitates the adjustment of the position of the cutter. The raising and lowering of the cutter-slide is accomplished by means of a handwheel. The handwheels which control the cross and longitudinal movements of the work-table, are fitted with adjustable collars which provide for compensating for wear, so that backlash may be entirely eliminated. The spindle has been made much heavier than in the preceding type of machine and runs in taper bronze bushings which are carefully protected from chips and dirt. The construction of the machine has been made heavier throughout, so that it is better adapted for the heavier classes of work for which it is used.

HENDEY CENTERING MACHINE

For some time past, the Hendey Machine Co., Torrington, Conn., has been manufacturing single-spindle centering ma-



Hendey Double-spindle Centering Machine

chines. In order to enable a shaft to be centered at both ends by a single operation, this company has developed the

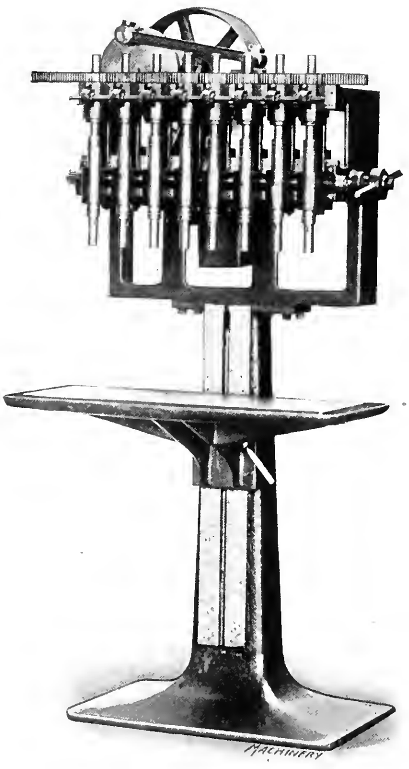
double-spindle machine illustrated herewith. The design has been worked out along the same general lines followed in the construction of the single-spindle machines, but several noteworthy improvements have been made.

The heads are rigidly clamped to the bed, thus affording permanent alignment for the spindles. The spindles run in ample bearings which are equipped with felt oilers; the front journals are made taper and have ball thrust bearings for carrying the end load. The spindles carry draw-in attachments with watch tool chucks for accurately holding combination center drills and reamers. Back locking pins working in the flanges of the pulleys are provided for use when it is necessary to remove or replace the center drills. The vise jaws are made of hardened and ground steel. The alignment of the spindles and jaws is obtained by means of a proof bar carried in the spindles. This care in providing for the alignment of the work is necessary in order to enable the machine to center stock accurately for finishing operations after it comes from the turret lathe or screw machine. No matter what the diameter of the bar may be within the limits of the machine, it will always be supported in a horizontal position.

The incline surface on the bed, sloping away from the operator, tends to direct the chips into the pan rather than have them accumulated around the heads and necessitate a frequent cleaning before being able to shift the vise carriages. Heavy parallel bars running the length of the machine serve as a rack for holding stock which is to be centered. The capacity of the machine is from 5/16 inch to 4 inches inclusive.

FOOTE-BURT MULTIPLE SPINDLE VALVE GRINDER

The adjustable multiple spindle oscillating valve grinder which is illustrated herewith is a product of the Foote-Burt Co., Cleveland, Ohio. This machine was designed for use in



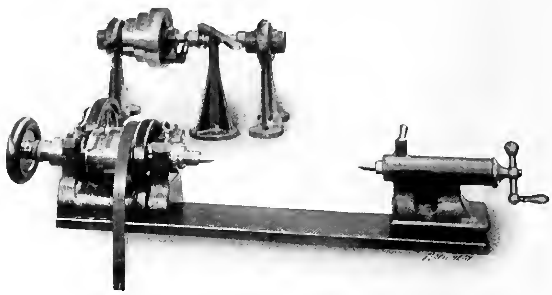
Foote-Burt Multiple Spindle Oscillating Valve Grinder

the manufacture of automobile engines and enables a complete set of valves to be seated in less time than is ordinarily required to seat one valve by hand. The spindles reverse at every one and one-quarter revolution and a cam is provided on the machine which raises and lowers the spindles at intervals of twenty revolutions to allow the grinding compound to enter the valve seat.

Machines of this type are built with from two to twelve spindles, depending upon the type of cylinder, and the spindles are made adjustable, the minimum center distance being two inches. The spindles are arranged with a ball thrust bearing on each end of the bearing and have a travel of $2\frac{1}{4}$ inches. The spindle noses are No. 1 Morse taper. The table may be adjusted up and down to enable the machine to handle different sizes of cylinders, making it sufficiently flexible to handle any type of cylinder, the valves of which might suitably be seated on this machine.

DAVIS MAGNET WINDING MACHINE

The W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y., has recently added to its line the machine shown in the accompanying illustration which is used for winding



Davis Machine for winding Electromagnets for Automobile Self-starters

electromagnets for automobile self-starters. It will be seen from the illustration that this machine is equipped with a back-geared head and that the nose of the spindle is threaded left-hand; also that the rear end of the spindle is provided with a handwheel which is used by the operator for starting work and for making corrections.

The spindle is driven by a countershaft placed on the bench at the rear of the machine. This countershaft has a friction clutch in the cone which is so adjusted that it will slip when the brake is applied. The brake consists of a strap, shown in the illustration, which runs over the large step of the cone pulley and is actuated by means of a foot treadle. Machines of this type are built in four sizes, an 11-inch, a 14-inch, a 16-inch and an 18-inch size. The illustration shows the 11-inch machine.

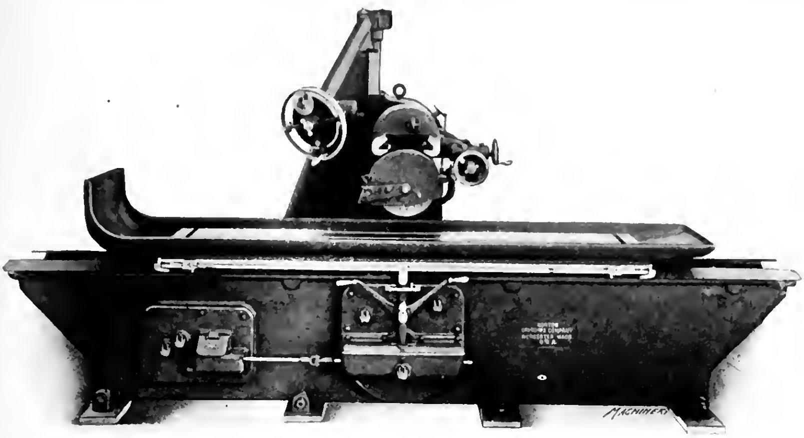
NORTON OPEN-SIDE GRINDING MACHINE

Experience has shown that in the operation of grinding wheels, the smaller the arc which is in contact with the work, the more efficient the operation of the wheel becomes, and as a result it is advisable to use wheels of small diameter. This is especially necessary when grinding plane surfaces, as the arc of contact in such cases is much greater than when round work is being ground. With a large arc of contact, the opportunity for the chips to escape is reduced. This results in heating, undue power consumption, and general inefficiency. When, for any reason, the chips cannot escape freely, a satisfactorily finished surface cannot be produced.

The open-side grinding machine illustrated herewith is a recent product of the Norton Grinding Co., Worcester, Mass. This machine is designed for grinding plane surfaces, and in order to attain the most satisfactory results, the periphery of the smallest wheel that is practical for the work in hand is used. The machine is designed to carry wheels 14 inches in diameter and for the usual class of work handled the wheel should have a 6-inch face. For special work, wheels of different widths can be used. The working surface of the table is 15 inches wide and is made in lengths of 6, 8, 10, 12 and 14 feet. The wheel head can be raised so that the distance between the surface of the table and a 14-inch wheel is 17 inches; this provides for the use of a magnetic chuck

or supplementary table when necessary. The countershaft is located in the machine base, so that the machine is self-contained. Power is transmitted to this countershaft by a belt running from the motor which is placed at the side of the machine. It will be evident from this description that all overhead works are eliminated. A 15 horsepower motor provides ample power for the requirements of ordinary work.

The grinding wheel is carried on a cross-slide operating at right angles to the travel of the table, and in order to secure the high rate of production that is made possible by the wide wheels used on this machine, no automatic feed of the wheel has been provided. A hand traverse has been designed for locating the grinding wheel in order to utilize the full width of the wheel face. Provision is also made for a slower traverse of the wheel when truing its face, this traverse being obtained through worm-gearing. The cross-slide is carried on a vertical slide, which is raised and lowered on the column by means of a ½ horsepower motor. For small distances, the vertical traverse is obtained by means of a handwheel on a shaft geared to the vertical traverse screw, and a micrometer index, which reads in quarter-thousandths, provides for making delicate adjustments.



Norton Open-side Grinding Machine for Plane Surfaces

The table is provided with T-slots of standard dimensions, which facilitate strapping work to the table or the application of a supplementary table, special fixtures or a magnetic chuck. The table traverse is obtained by means of worm-gearing which affords a perfectly uniform motion that is essential for the production of smooth, accurate work. The reversal of the table is pneumatically cushioned at the ends of the stroke. All kinds of plane surfaces which are within the capacity of the machine can be quickly and accurately ground. The machine can also be used for grinding surfaces of a variety of shapes, and for this class of work a special forming attachment is used to form the wheel to produce the shape required.

Ball bearings are employed on all shafts operated by handwheels and the worm and worm shafts are provided with ball thrust bearings. All of the worm-gearing runs in oil. The worms and wheel spindle are made of chrome-nickel-vanadium steel and all shaft bearings are ground to run in self-oiling boxes. Special equipment is used in scraping the ways in the base, which results in such accuracy of alignment that when the table has been ground in place, it presents a neat and uniform surface free from chatter marks. The inspection to which the machine is subjected requires a B. & S. straightedge the length of the finished table surface to hold pieces of tissue paper two inches apart throughout its length, with the straightedge laid at any angle on the table. The machine is supported on adjusting wedges mounted on iron plates which are imbedded in a concrete foundation; this makes it possible to realign the machine easily should such a procedure become necessary. A large tank is provided with a pump which will deliver thirty gallons of lubricant per minute to the wheel and work.

PRATT & WHITNEY 22-INCH VERTICAL SURFACE GRINDER

For several years the Pratt & Whitney Co., Hartford, Conn., has been manufacturing a small size of vertical surface grinder. The results obtained with this machine were so satisfactory that it was decided to build a larger machine along similar lines which would be suitable for heavier classes of work. The result of this undertaking is shown in Figs. 1 and 2 which illustrate front and rear views of the 22-inch vertical surface grinder which has recently been placed on the market by this company. While the design adheres to the general lines of the smaller size, the machine has been improved in many respects in order to adapt it for the severe service which is required of a grinder engaged on modern manufacturing work. Every refinement which experience has demonstrated to be essential for a machine of this type has been incorporated in the design, and although of unusual dimensions, the machine is a precision tool in every particular. It is very sensitive and easy to operate, all of the operating mechanism being contained in a single unit which is conveniently situated for the operator.

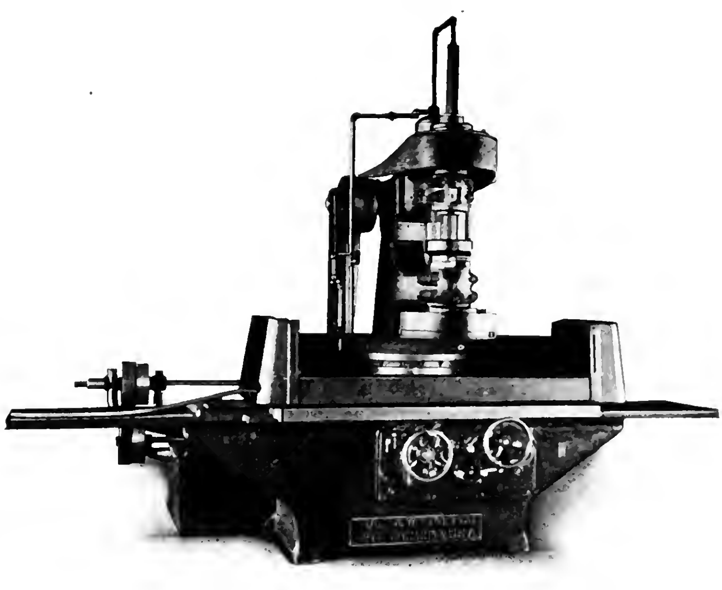


Fig. 1. Front View of Pratt & Whitney 22-inch Vertical Surface Grinder

The bed is provided with wide bearing surfaces of the vee and flat type, oil reservoirs being located in the bed for oiling the ways by means of rolls. The pan which surrounds the rear of the bed for collecting the water and receiving the chips is of liberal proportions and easily accessible for cleaning. The machine may be regularly furnished with either 4- or 7-foot tables, the bed being made in two lengths to accommodate these sizes; both the bed and table are finished perfectly true by means of masters. The table is provided

with guards which protect the bearing surfaces at all times from injury. A spacious pan is cast integral with the table for controlling the water and chips. The upright is bolted solidly to the bed, wide bearing surfaces being provided for the accommodation of the head. A taper gib forms part of the construction which makes it easy to maintain the proper relation between the head and the upright bearings. The bearing surfaces are also protected by means of very efficient wipers and guards.

The spindle is made of special steel, proportioned to resist the peculiar strains to which it is subjected. Attention is directed to the fact that the spindle is of ball bearing construction throughout. This also applies to the driving pulley which is mounted on ball bearings that are independent of the spindle. Thus the pull of the belt is absorbed by this independent bearing and is not transmitted to the spindle. This is a most important feature, without which it is practically impossible to design a head that will operate sensitively or retain its accuracy for any length of time. Furthermore, this construction places the driving belt in a protected position away from the water spray, so that it does not lose its efficiency by becoming moist. The ball bearing construction has been subjected to exhaustive tests and has proven efficient in every particular. With its use the loss through friction is reduced to a minimum and practically the entire power is utilized for driving the wheel.

The table is provided with an automatic reciprocating motion, any desired length of stroke being readily obtainable by means of adjustable table dogs. The feed mechanism is of a most efficient and substantial construction which is contained in one compact unit. The table is driven through a rack and pinion, the construction eliminating the possibility of vibrations (commonly called tooth marks) showing in the work. Two table feeds are provided, both of which may be instantly controlled through the lever *A* shown in Fig. 3. When adjusted to the right-hand station, the slow feed is engaged; and the left-hand station engages the fast feed in a similar manner. This lever, when adjusted to the central station, also serves as a means for stopping the table. The table, in addition to the two feeds mentioned, is also provided with power quick return for use in connection with rotary chucks. The power quick return becomes operative and the regular feed inoperative by moving lever *B* to the lower station. It will be noted, however, that the lever *B* is locked by means of a lock-bolt *C* and cannot be operated while the regular feed is engaged. In order to unlock lever *B*, it is necessary for the regular feed lever *A* to be in the neutral position, after which the lock-bolt *C* may be adjusted to its outward position, which has the effect of releasing lever *B* and locking lever *A*. Thus it is impossible to engage both the regular and quick return feeds at the same time. After the quick return mechanism has become operative it is controlled through lever *D*.

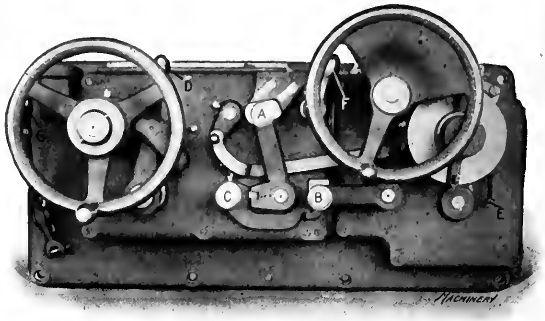


Fig. 3. Control Mechanism of Table Feed on Pratt & Whitney Surface Grinder

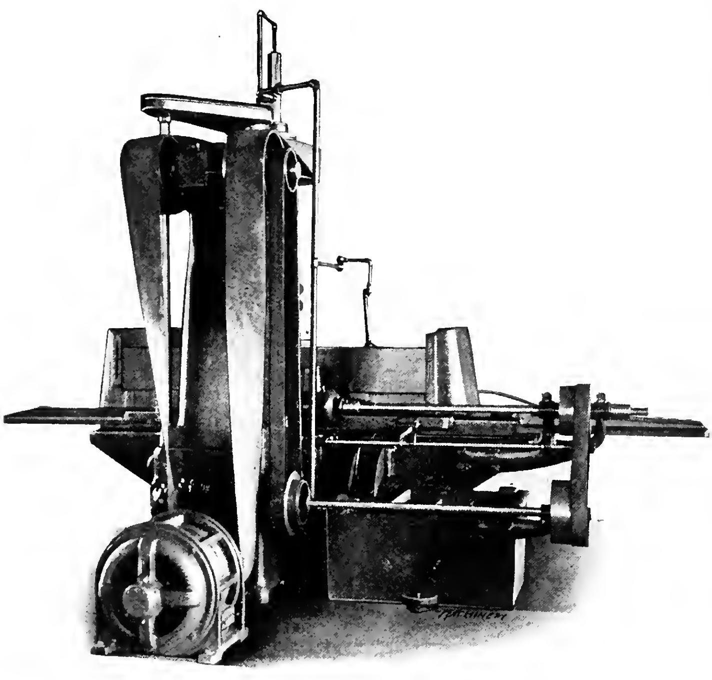


Fig. 2. Rear View of Pratt & Whitney 22-inch Vertical Surface Grinder

The wheel is provided with both hand and power feeds in addition to the rapid hand feed. The vertical adjustment is very sensitive, the head being perfectly counterbalanced and very accurately controlled through the feed mechanism. The power feed is operated through a ratchet wheel and pawl, the rate of feed being controlled by means of the adjusting screw *E*. A large micrometer dial for gaging purposes and also an automatic power feed knock-off forms part of the construction. Both the regular and rapid hand feeds are controlled through the lever *F*. This lever is operated in and out; when adjusted to its inner station, the regular hand feed is engaged, the outer station engaging the rapid hand feed. The design is such that when the rapid feed is engaged the power feed is automatically disengaged and cannot be used. The reason for this precaution is that the rapid feed is altogether too fast to be used when the machine is in operation, and if the power feed should become engaged through error the wheel would be broken. The machine is designed for motor drive only, the method of mounting the motor directly on the floor being clearly shown in Fig. 2. Provision has also been made whereby the correct belt angle from the idler to the motor pulley may be always maintained, irrespective of the diameter of the motor pulley. This is accomplished by means of the left-hand idler pulley which is so mounted that it may be swiveled to the correct angle, after which it is permanently doweled in place. The size of the motor varies from approximately 20 to 35 horsepower, according to the nature of the work for which the machine is to be used. A constant-speed motor is used, running at approximately 1200 revolutions per minute.

The machine is provided with a pump of new design which is capable of supplying an abundance of water. One stream of water is carried through the spindle, the centrifugal force of the spindle driving the water between the wheel and the work, and thus keeping both cool and free from dust. The inside stream of water is controlled through the lever *G* which is conveniently located on the front of the gear-box unit. An outside stream is also provided for conveying water to the outside of the wheel and for cleansing purposes. The wheel guard also assists in controlling the water. An exceptionally large tank is located on the back of the machine in an accessible position where it may be readily cleaned. The water is returned to the tank without being carried through pipes; in fact, the design is of such a nature that the collection of dirt or grit in inaccessible places is impossible.

Special attention has been given to the lubricating problems involved and large self-feeding oil reservoirs are provided which insure an ample supply of oil at all times. All bearings are absolutely dust- and water-proof.

A most important factor in the productive capacity of this type of machine is the cup-shaped wheel which covers the full width of the work, insuring perfect flatness, together with the greatest possible production. The wheel is protected by means of a guard, the guard being so mounted that it may be conveniently adjusted for height as the wheel wears. A wheel band is also furnished which should at all times be used upon the wheel.

The rectangular magnetic chuck affords a convenient appliance for holding a large variety of work; it may be readily applied to the table and is of water-proof construction throughout, so that water may be freely used without any danger of short-circuiting. The rotary chucks have been designed with a view of attaining the maximum efficiency as regards durability, accuracy and power consumption. They are absolutely dust- and water-proof, the drive units being located outside of the water guard, making it impossible for water to get into the chucks. The driving mechanism is so designed that it engages automatically when the chuck is brought in under the wheel and disengages when it is removed to be reloaded. The chucks are lubricated throughout by means of two large self-feeding oil reservoirs. The single rotary chuck is made either plain or magnetic. It is designed so that it may be tilted, permitting the grinding of either concave or convex surfaces. This is a desirable feature on a large variety of work, such as circular saws, cutters, and similar parts.

Special attention is directed to the duplex and quadruplex chucks which have recently been developed for use in connection with the Pratt & Whitney vertical surface grinders. Their value can readily be appreciated, as it is obvious that on work within their range the productive capacity of the machine has been practically doubled and quadrupled. A double chuck possesses all the features of the single chuck, in that it can be tilted to permit grinding concave and convex surfaces, or it may be adjusted to grind perfectly flat. The adjustment for each of the chucks is independent and when necessary they may be adjusted horizontally and reground to absolute accuracy. This chuck has proved very efficient in grinding saws and cutters with concave surfaces and is equally well suited for convex or flat surfaces. The quadruplex chuck is always horizontal and non-adjustable; thus it is only suitable for grinding flat work and will not handle concave or convex surfaces. The quadruplex chuck is by far the fastest on work such as gear blanks, washers, disks, etc.

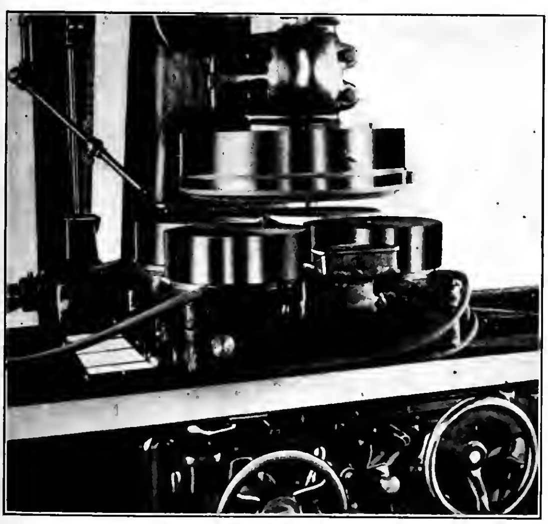


Fig. 4. Arrangement of Multiple Chucks on Pratt & Whitney Vertical Surface Grinder

LANGELIER DRILL FOR ROLLER BEARING CAGES

A special design of multiple spindle drilling head, which is illustrated in Figs. 1, 2 and 3, has been developed by the Langelier Mfg. Co., Providence, R. I., for use in drilling roller bearing cages for motorcycles. These cages, one of which is shown in Fig. 4, have eleven roller seats 0.255 inch in diameter, which are spaced equidistant from each other around a pitch circle 1 1/8 inch in diameter. The comparatively large size of the roller seats that had to be drilled on this small circle made the spacing of adjacent holes so close that it was impracticable to drill the eleven holes at one operation and at the same time retain a sufficiently strong spindle construction to enable the head to operate satisfactorily. As the layout contained eleven holes, the drilling could not be done in two operations with an ordinary multiple spindle drilling head. The head was, therefore, designed for drilling the eleven holes in three operations and to work simultaneously on three roller cages.

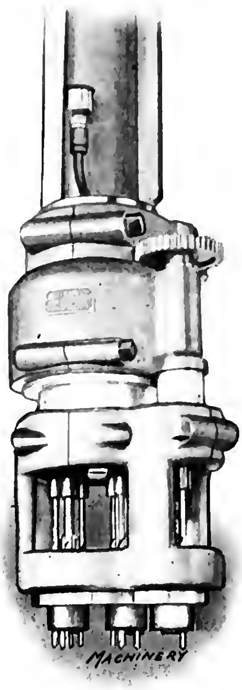


Fig. 1. Side View of Langelier Drill Head

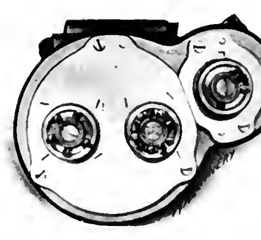


Fig. 2. End View of Drill Head showing Arrangement of Spindles

The head used for this purpose is attached to and driven by an automatic dial feed drill press having power feed and quick return to the head. The machine has a turret indexing table containing twelve chucking stations evenly spaced around a circle 9.658 inches in diameter, in which the cages to be drilled are placed by the operator. The two groups of five multiple spindles and the auxiliary spindle for drilling the eleventh hole are located in the head on an arc of a circle corresponding to the circle on which the chucking stations of the indexing turret are located. As the work in the turret indexes clockwise 1/12 of a revolution after being operated upon by the first drill head, it comes under the second head, which drills five more holes; it is then indexed a second time, bringing the work under the auxiliary spindle, which drills the eleventh hole in the cage. The eleven holes are thus drilled in three operations, which are carried on successively until one cage has been completely drilled. While these operations are going on the operator has ample time to take out the cages and put in fresh blanks.

The chucking stations in the dial feed table hold the cages freely and allow a pilot to enter the bore of the cages ahead of each set of spindles, thus bringing the work into the desired alignment. The pilots for the second group of spindles, and for the auxiliary spindle, have a number of steel locating pins which project from the drill bushings and enter the holes drilled by the first operation before the second and

third operations take place. In this way, the holes drilled in the second and third operations are properly located in relation to the holes already drilled in the cages. In Fig. 1 the drills are shown projecting from the pilot simply to show where they pass through, but while clear of the work the drills are beyond the base of the pilot, as shown in the sectional view of the drill head which is presented in Fig. 3. The multiple head consists essentially of a substantial cast-iron housing which is made to clamp around a special form of saddle on the automatic drilling machine and designed to clamp tightly over a phosphor-bronze spindle head. The spindles are located on fixed centers; they are machined from solid alloy tool steel and provided at their lower ends with chucks especially designed for receiving straight shank tanged drills. Bronze and steel washers for receiving the upward thrust are used to eliminate sliding friction as much as possible. The balance head is forged integral with the main spindle of the automatic drilling machine. The auxiliary spindle at the right is driven from a cut steel gear mounted on the main spindle of the machine through an intermediate fiber gear. The drill steadyrest with hardened and ground steel guide bushings is clamped to the lower end of the drill head and supports the drills close to their cutting end to insure having them start accurately. The drills project from the guide bushings just enough to penetrate the cage to be drilled. In order to compensate for the shortening of the drills due to grinding, the drill steadyrest may be adjusted up or down over the spindle boring head.

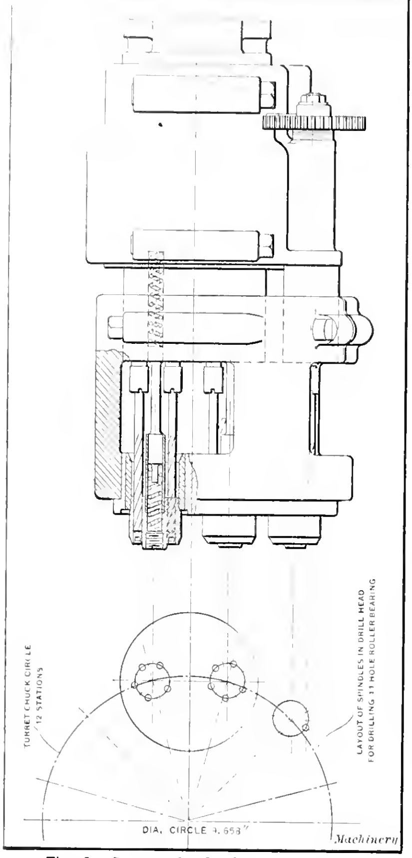


Fig. 3. Cross-sectional View of Drill Head

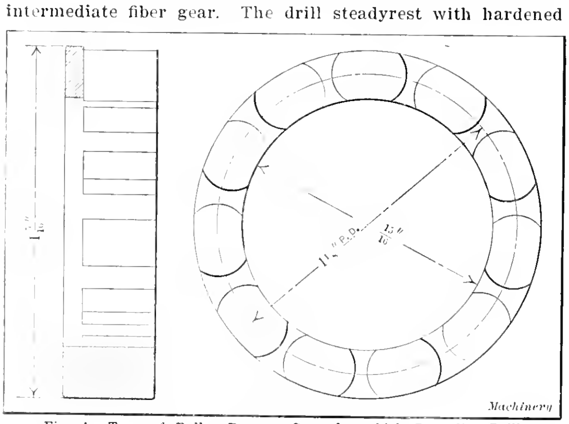
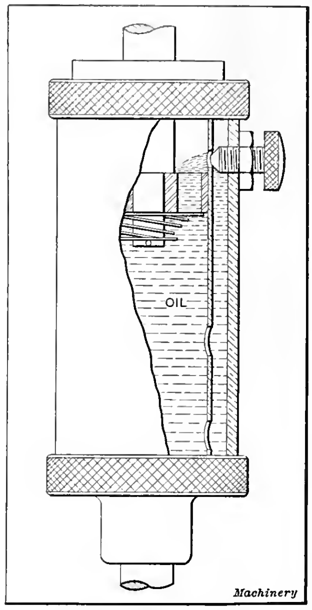


Fig. 4. Type of Roller Bearing Cage for which Langelier Drill Head was designed

BOWDLE PUNCH PRESS SAFETY DEVICE

Power presses are generally recognized as one of the most dangerous forms of equipment used in industrial plants, and various forms of safety devices have been developed for the protection of operators of this class of machinery. The accompanying illustration shows a punch press safeguard which has recently been placed on the market by Bowdle & Co., 507 Jackson Blvd., Chicago, Ill., and it is claimed that this device will positively prevent the accidental tripping of a press. The device is connected to the rod which joins the treadle with the latch pin, a section of the rod being cut away at the point where the safeguard is attached. The illustration shows the interior construction of the device, with the different parts in position ready for operation.

The action of the safeguard may be briefly outlined as follows: A quick and decisive stroke of the treadle forces the cylinder upward, and this motion is transmitted through the oil to the piston, which, in turn, is forced up sufficiently to release the latch and allow the press to rotate. At the beginning of the pressure on the treadle, the oil starts to flow through the lower ports of the inner shell and then up through the by-pass, back into the cylinder on top of the piston. This releases the pressure below the piston, and by timing the flow of the oil by means of a cone valve in the by-pass, the piston and latch pin will resume their normal positions in time to disengage the clutch. This action is entirely independent of the action of the treadle, which may remain down. When the treadle is released, the cylinder drops back to the normal position and the oil passes down through the disk valve in the piston. In case the treadle should be pushed down in any ordinary way, instead of using a quick, decisive stroke, the oil will flow through the by-pass without imparting any motion to the piston. It is thus evident that the press can only be tripped by the deliberate act of the operator.



Bowdle Safety Device for Punch Presses

WHITCOMB-BLAISDELL TAPER TURNING LATHE

The illustrations show a lathe which has been designed by the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., with the idea of developing a machine for taper turning operations that is capable of producing work on a manufacturing basis. The design of the machine is simple. Referring to the illustrations, it will be seen that the carriage and tool-rest are carried on the outside bed, while the inside bed carries the headstock and tailstock of the machine. The inside bed swivels on a stud at the head end of the machine and is carefully fitted to the outside bed, being supported by a broad bearing at both the head and tail end and on a cross-tie member at the center of the machine.

This lathe swings 14 inches and is built with either 5-foot or 6-foot bed, the 5-foot bed taking 2 feet between centers. Particular pains have been taken to make this a rigid and durable tool adapted for manufacturing purposes. With this idea in mind, the outside bed has been made of the dimensions used for the regular 16-inch lathes of this company's manufacture, which have exceptionally large bearings. The inside or swivel bed is of corresponding proportions, so that ample rigidity is secured. Provision is made for adjust-

ment of the swivel bed through the adjusting screws shown at the tail end of the bed in Fig. 3. On a machine with a 5-foot bed the maximum taper that can be turned is 1.6 inch to the foot.

By locating the point about which the inside bed swivels

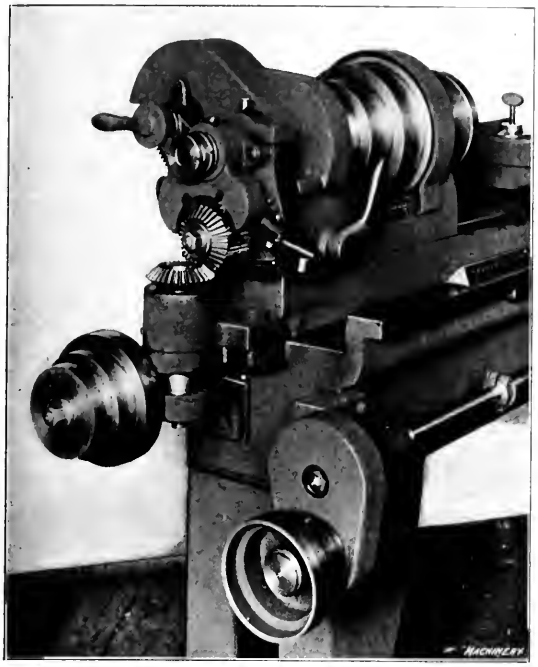


Fig. 1. Head End View of Taper Turning Lathe

at the head end of the machine, it is not necessary to change the length of the feed belt when changes are made in the feed. The feed mechanism is very simple, the feed being obtained through bevel gears and feed cones, the upper cone being driven by two spiral gears. Provision is made for adjusting the lower cone to allow for taking up the feed belt. When desired, the machine can be equipped with geared feed,

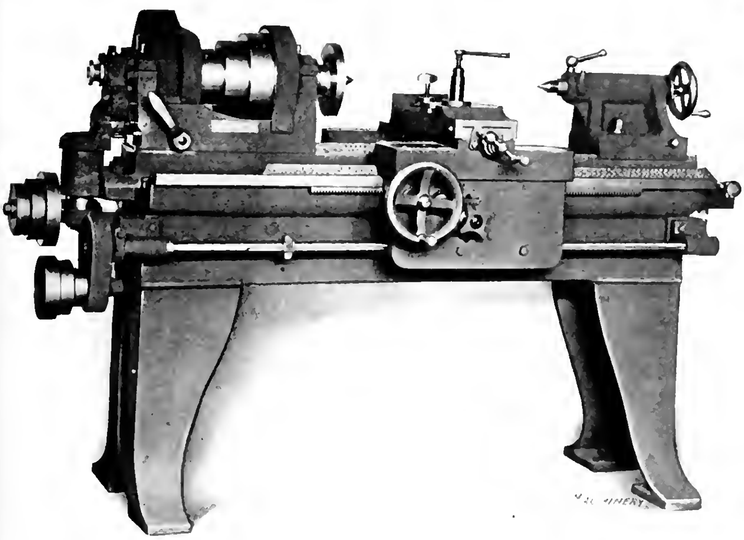


Fig. 2. Front View of Whitcomb-Blaisdell Taper Turning Lathe

providing three changes without substituting fresh gears.

The headstock on the lathe shown in the illustrations is of the three-step cone double back-geared type, giving nine spindle speeds in geometric progression. The back gears are locked in and may be shifted from the front of the machine. They are cut with a special involute cutter which gives a sharp pointed tooth, enabling them to be thrown in instantly. If desired, the machine could be furnished with a single pulley drive giving three changes through gears, the driving pulley being controlled by a powerful expanding ring friction. The tool-rest on the machine is of the elevating type which is the style regularly provided, although a plain gibbed block can be furnished if preferred. The rest is equipped with a screw gage for setting the tool, and the cross-feed is graduated to thousandths. The regular equipment

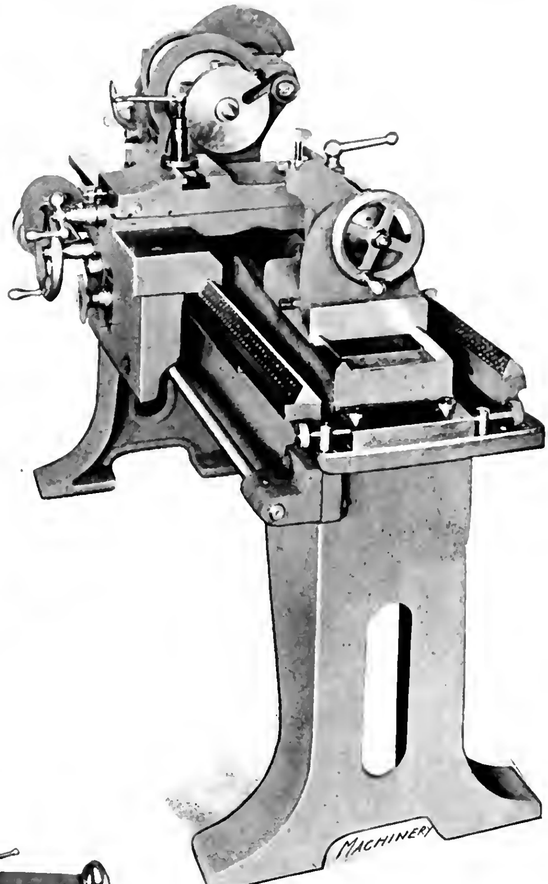


Fig. 3. Tail End of Lathe showing Bolts for clamping Inside Bed

includes an automatic stop for the longitudinal feed, a double friction countershaft and the necessary faceplates, wrenches, etc.

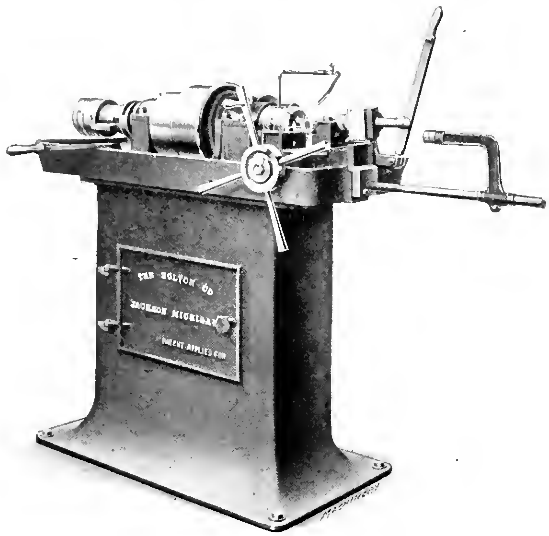
HOLTON CUTTING-OFF AND CENTERING MACHINE

The Holton Co., Jackson, Mich., has recently redesigned its cutting-off and centering machine, the improved design being shown in the accompanying illustration. The more important changes which have been made in this machine may be briefly outlined as follows: The column has been changed to the pedestal type which is more substantial and enables a tank for lubricating fluid to be contained inside the base of the machine. The improved machine has a single spindle which does away with all back gearing and a pilot wheel is provided in place of the handwheel formerly used, which enables the machine to be operated more rapidly.

This machine is designed for cutting off gas pipe, tubing and small bar stock and leaves the ends square and true. In cutting off tubing, the hole is left full size and without any burrs or other obstruction on the inside; consequently

it is unnecessary to perform a reaming operation after the stock has been cut off. Pipe or tubing can be cut to any length and as rapidly as if a rotary cutter were used. The spindle bushings are amply proportioned to insure rigidity and to withstand the most severe service to which a machine of this type should be subjected. The collets which hold the work are hardened and ground and are controlled by a lever which may be operated while the machine is working.

A new type of centering device is fitted to this cutting-off machine which makes it possible to handle centering operations most efficiently. The centering device can be attached or detached in about five minutes and if desired it may be left on the machine without interfering with cutting-off operations. The shaft to be centered revolves and the center drill and countersink are forced against it by a lever movement and then quickly withdrawn. By means of the same



Improved Type of Holton Cutting-off and Centering Machine

lever, the centering device may be drawn back on a hinged joint, leaving the front of the collet unobstructed. A long bar may be placed in the machine and pieces of any desired length may then be centered on one end and cut off. After the bar has been completely cut up, the pieces may be replaced in the collet and centered on the other end.

The oil reservoir is located directly beneath the table and can be easily cleaned by removing a plug from the bottom. The rotary pump which supplies oil or cutting compound to the tool is direct-connected to the shaft of the machine. The floor space occupied by the machine is 25 by 38 inches; the machine has a capacity for handling pipe ranging from 1/8 inch to $1\frac{1}{2}$ inch or for any size of stock up to 2 inches outside diameter. The net weight of the machine is about 950 pounds.

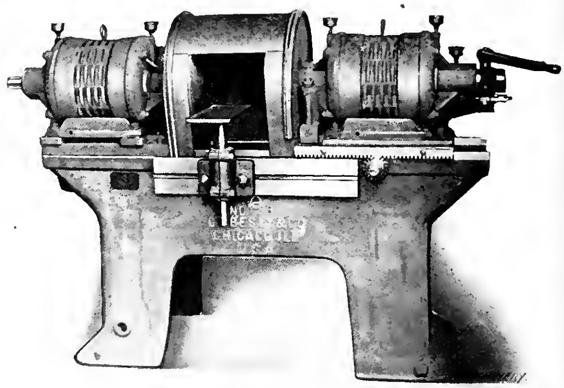
BESLY DOUBLE-SPINDLE DISK GRINDER

The illustration shows a motor-driven, double-spindle disk grinder which is a product of Charles H. Besly & Co., Chicago, Ill. This is a No. 6 machine and is equipped with 18-inch disk wheels. The double-spindle feature of this machine enables two grinding disks to be brought into contact with the work simultaneously, thus increasing the capacity and providing for grinding two surfaces of a piece exactly parallel. This type of grinder is largely used in the manufacture of wrenches, brass nuts, and for similar purposes.

The motors with which the machine is equipped are of the new pressed-steel type, which has recently been brought out by the Westinghouse Electric & Mfg. Co. These motors were described in the August issue of MACHINERY. The motors are bolted onto sub-plates, being clamped in position in a similar way to that used in securing the headstock and tailstock of a lathe. The motors develop 5 horsepower and are designed to operate at 1400 revolutions per minute on a 25-cycle, alternating-current circuit. Motors of this type can also be furnished to operate on a 60-cycle circuit. Machines equipped with these motors have disk wheels 20 inches in diameter and run at 1200 revolutions per minute, in order to give the proper abrasive speed. These disk grinders are not built with motors adapted for operation on direct-current circuits.

The left-hand head of the disk grinder is stationary, while the right-hand head can be moved along the bed by means of a gear and rack. After the head has been adjusted to the required position, it is clamped in place ready for the grinding operation. To bring the disks into contact with the work, the spindle of the right-hand head is provided with a longitudinal movement of one inch. This movement is obtained by means of a lever which actuates a rack and pinion. The rotor of the motor is displaced one-half inch from magnetic balance while grinding, but careful tests show that this displacement reduces the efficiency not more than 2 per cent, while the maximum output of the machine remains the same as when running in magnetic balance. The longitudinal movement of the sliding spindle is limited at the inner extremity of its travel by means of an adjustable micrometer stop graduated to 0.001 inch, so that the duplication of work which must be accurately ground is made possible. The work-rest is provided with vertical adjustment and is supported from a slotted pad on the front of the bed casting. The regular equipment of the machine includes ten work-rests in widths varying from 1/4 to 5 15/16 inches.

The grinder is equipped with an automatically telescoping dust hood, which is hinged at the back in order to give free access for changing the disks, and an air-tight connection in provided at the back of the machine for exhausting the grindings. The design has been worked out in such a way that a third wheel and rocker shaft may be attached to the left-hand end of the machine. A suitable work-table may be mounted on the shaft to serve the third grinding disk. The spindles are made of crucible steel and run in inserted bearing bushings of phosphor-bronze. The end thrust of the spindles is taken on hardened and ground steel collars, and the end play of the spindle is controlled by an adjustable keyed collar which is held in place by a lock-nut at the



Besly No. 6 Motor-driven Double-spindle Disk Grinder

end of the spindle. In the right-hand motor, both of the bearing bushings slide with the spindle and completely surround it; this construction reinforces the spindle when under load and protects it from emery dust. The spindle and thrust bearings are lubricated by grease from compression oil cups. The oil grooves are so placed that the oil is forced to the points where it is needed by positive feed. The movement of the grease is always outward, thus preventing grit from entering the bearings.

The geared lever feed on the sliding spindle gives the operator a leverage of 20 to 1, so that he may force the machine to the limit of its driving power without undue muscular exertion. The lever is clamped to the stud which carries the pinion engaging with the feed rack. This is an important feature of the design, because the lever may be clamped onto this stud is just the position which makes it most handy for

the workman. It is particularly desirable for this type of disk grinder to be driven by a direct-connected motor, because it is necessary to use a very large and heavy countershaft when belt drive is applied. The large size of the countershaft is mainly due to the fact that it is necessary to provide a drum pulley long enough to accommodate the full longitudinal adjustment of the movable grinder head. The countershaft employed for this size of grinder, when belt driven, is 96 inches long and weighs over 700 pounds. By using motor drive, all of these overhead works are naturally done away with. The important dimensions of the machine are as follows: Maximum opening between disk wheels, 10 inches; floor space occupied, 24 by 58 inches; weight, 2600 pounds.

CINCINNATI GEAR CUTTING MACHINE

Figs. 1 and 2 show front and rear views of the No. 7 Cincinnati automatic gear-cutting machine which has recently

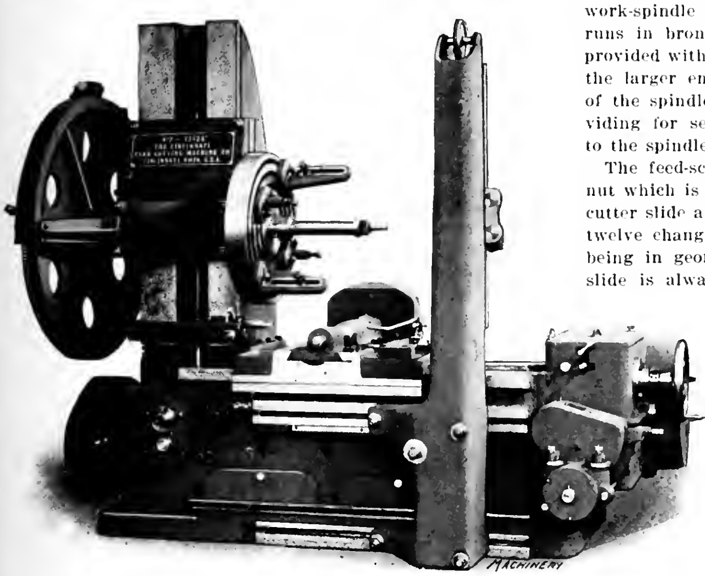


Fig. 1. Front View of Cincinnati Automatic Spur Gear Cutter

been brought out by the Cincinnati Gear Cutting Machine Co., Elam St. and Garrard Ave., Cincinnati, Ohio. This machine is designed for cutting spur gears and has a capacity for gears 72 inches in diameter by 24 inches face, being rated for cast-iron gears up to 1 diametral pitch and steel gears up to 1¼ diametral pitch. This machine is also built to cut gears 84 inches in diameter with the same face width and pitch ratings.

The bed is heavily ribbed and has rectangular guides which afford a maximum wearing surface for the cutter slide. The cutter slide has long and narrow guides provided with a handy tapered gib adjustment; three gibs are used, and as they are all located on the outside, it is an easy matter to make inspections or adjustments. The cutter spindle has both a straight and a taper bearing running in a solid bronze box. The customary bushings are eliminated, thus permitting a much larger cutter spindle to be used. The end of the spindle is No. 13 B. & S. taper and is provided with a squared recess to drive the arbor.

The positive tripping mechanism which is shown in detail in Fig. 3 is controlled by two independent shafts which are operated from the working side of the machine. These shafts are revolved by a crank-wrench; they are easily set and means are provided for holding them positively in place after the desired setting has been obtained. Brass plates are placed directly over the shafts to indicate the direction of movement of the trips. The work saddle is gibbed to the housing in such a way that loosening the clamp bolts to adjust the work does not cause the work-spindle to drop out of alignment. The saddle can be raised or lowered by either hand

Fig. 3. Positive Tripping Mechanism used on Cincinnati Gear Cutter

or power and the elevating screw for the work saddle rests on ball bearings, a micrometer dial reading to 0.001 inch being provided to enable accurate settings to be made. The work-spindle is tapered to provide for taking up wear and runs in bronze bushings. The arbor end of the spindle is provided with a special tapered hole 3.81 inches in diameter at the larger end and tapering ½ inch to the foot. The nose of the spindle is keyseated and tapped for screws, thus providing for securing a faceplate or special chucking devices to the spindle.

The feed-screw is of large diameter and runs in a bronze nut which is shielded from dirt and chips. The feeds for the cutter slide are obtained by a quick change mechanism giving twelve changes from 1 to 13 inches per minute, the changes being in geometrical progression. The return of the cutter slide is always constant. By transposing gears, the cutter spindle can be given six changes of speed ranging from 12 to 68 revolutions per minute, these changes also being in geometrical progression.

The outer work arbor support is one feature of the design of this machine. This support is made extremely heavy and is counterbalanced. A rack and pinion afford a convenient means for moving the support when chucking and taking off work. The faceplate carries two dogs and two jacks that are adjustable around the circular T-slots and radially along slots in the dogs and jacks. A safety stop of simple construction prevents the cutter slide from feeding forward until the indexing is complete, and this stop also prevents the cutter slide from being in-

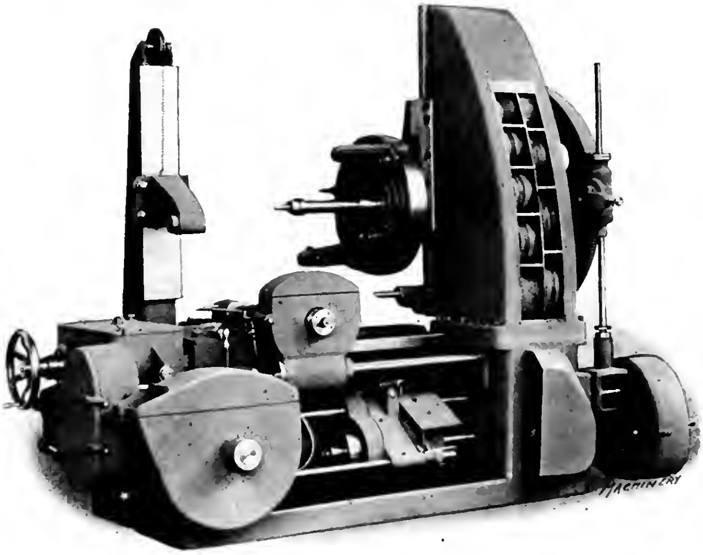
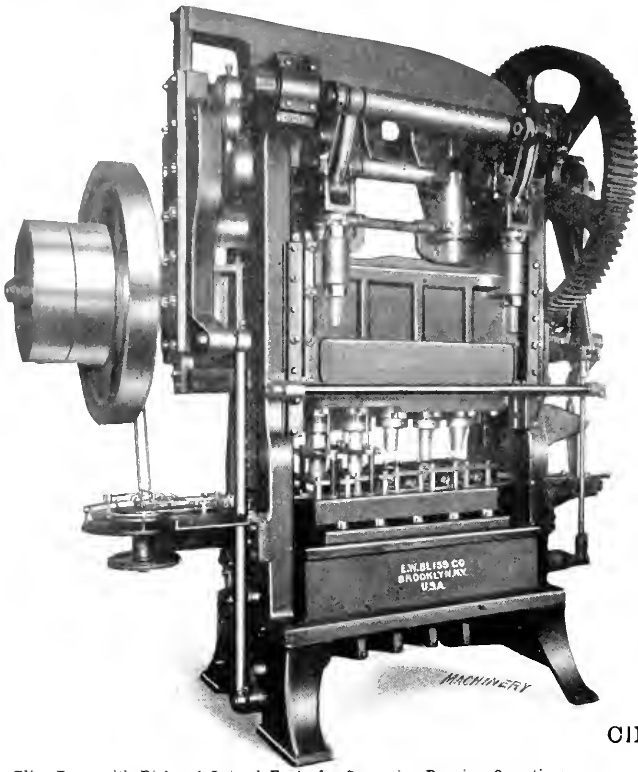


Fig. 2. Rear View of Automatic Spur Gear Cutter

dexed by hand while the cutter is going forward. All of the shafts in the machine are shouldered and can be removed from their bearings without removing the keys and bushings

or threading keys through their slots. The machine indexes all numbers from 4 to 100 and from 100 to 450 with the exception of prime numbers and their multiples. The index wheel is 53 inches in diameter. All of the gearing in the machine is completely enclosed and the main driving gears run in an oil bath. The net weight of the machine is 19,500 pounds.



Bliss Press with Dial and Lateral Feeds for Successive Drawing Operations

BLISS PRESS WITH DIAL AND AUTOMATIC CROSS FEED

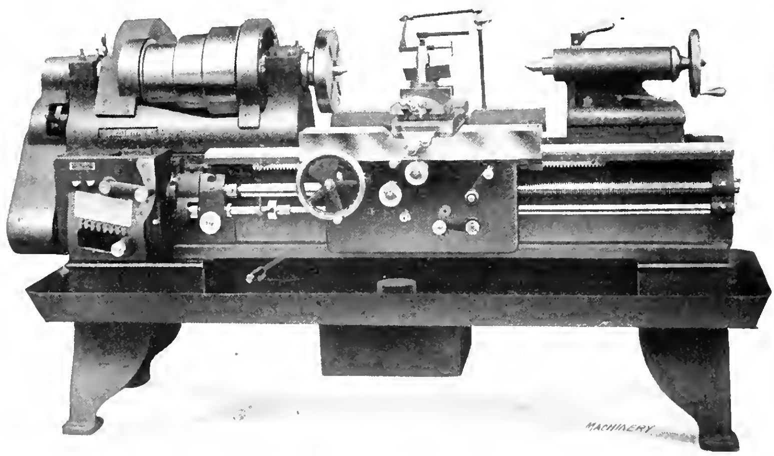
The development which has been made in methods of working sheet metal has led to the design of numerous automatic feed mechanisms for power presses as a means of increasing production. The accompanying illustration shows an automatic feed press which has recently been added to the line of the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for the rapid production of deep drawn, seamless shells, such as lamp and lantern bodies, oil-can bodies, drinking cups and similar articles, which require a series of drawing operations. This press is equipped with a friction dial feed and lateral carrying feed, and has five slides, each of which are independently adjustable. Five operations are performed at each revolution of the crankshaft, from which it will be evident that the output is increased and production costs correspondingly reduced over any method of doing the work in a single-slide, double-action press. Furthermore, handling of the work between operations is eliminated and a considerable saving of space is made possible, due to the fact that one press is doing the work of five single presses.

The operation of the press may be briefly described as follows: Shells which have been cut and formed from the sheet are placed on the revolving disk of the friction dial feed which carries them up and against an automatic stop gage that allows one shell to pass at each revolution of the crankshaft. On passing from the friction dial feed, the shells are gripped by the lateral feed which automatically carries them to the successive dies in which the drawing operations are performed, and finally discharges the finished piece through a chute at the right-hand end of the press. The press operates at thirty-five strokes per minute, which means 100,000 operations in a ten-hour working day.

It will be evident from the preceding description that this method of feeding work to the press does away with the danger which the operator runs in feeding work by hand, as it is merely necessary to place the shells on the revolving dial which carries them into the machine. The lateral feed has two motions—an opening and closing, and a backward and forward motion. This feed mechanism is operated by cams and links from both ends of the machine, the design affording a perfectly parallel feed motion. The bottom knock-out is cam-actuated and driven from the crankshaft through links and levers, the design being such that its travel for each slide may be different according to the depth of the drawing operation which is performed by the slide. The press is equipped with an automatic friction clutch which places its movements under practically instant control of the operator. With this type of press, the number of operations which may be performed simultaneously is only limited by the number that may be performed without annealing the work, so that wider presses having a greater number of slides could easily be used. The approximate weight of the machine with five slides, shown in the illustration, is 25,000 pounds.

CINCINNATI TOOL-ROOM LATHE WITH OIL PAN AND PUMP

The tool-room lathe equipped with an oil pan and pump which is shown in the accompanying illustration has been recently added to the line of the Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. As will be seen from the halftone, the head is driven by a wide three-step cone and double back-gears, and the machine is especially adapted for heavy duty. The quill on the double back-gears is made of steel and both ends are bronze bushed. A sleeve is provided on this quill for shifting the gears from the front of the machine. When desired, this lathe can be equipped with a draw-in chuck, a relieving attachment and a taper attachment, and such attachments can be added to the machine any time that they may be required, after it has been placed in service.



Cincinnati Tool-room Lathe with Oil Pan and Pump

NEWTON 40-INCH COLD SAW

The illustrations show a 40-inch cold saw which has been added to the line of the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine has been designed especially

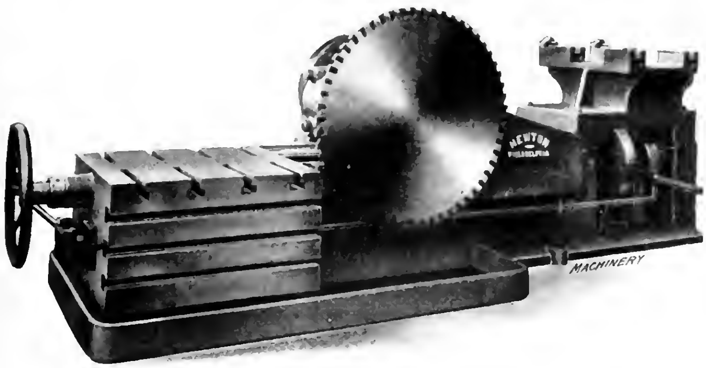


Fig. 1. Newton 40-inch Cold Saw

for use in steel foundries and for sawing operations on chilled rolls. In order to adapt it for severe service of this character, the spindle, pinion shaft and all driving gears are of exceptionally large diameter. All gears are made of alloy steel with the exception of the driving worm-wheel, which is machined from a solid bronze casting. The driving worm is

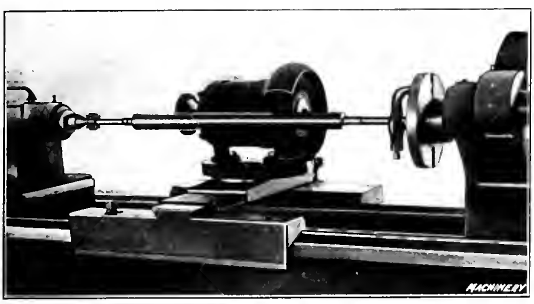


Fig. 1. Forbes & Myers Grinding Attachment in use on External Work

of hardened steel, fitted with roller thrust bearings, and the driving spline shaft is fitted with rotating auxiliary bearings, to protect the stationary bushings from the key splines and also to prevent the escape of oil. All of the bearings are bronze bushed. The spindle revolves in cap bearings and is supported at both ends.

Vertical and horizontal adjustments are made by taper shoes, and the saddle is equipped with a narrow guide bearing on the base to control its alignment and also to save power by preventing the saddle from binding on the base. In addition, the base has three shears to give an ample bearing for the saddle. The gear feed-box which is used provides six changes without requiring the removal of gears. A quick return motion is also provided which may be tripped at any predetermined point and at the end of the stroke in both directions. The entire base of the machine, including the work-table, the ways for the saddle and the extension on which the feed mechanism and motor pads are mounted, is one solid casting. This entire casting has an oil pan cast integral with it which runs all around the base. The top surface of the main work-table has T-slots running at right angles to the direction of travel, the size of the work-table being 32 by 37 inches. The vertical face of the main work-table is fitted with three T-slots in the faced portion, which is 18½ by 37 inches in size. An

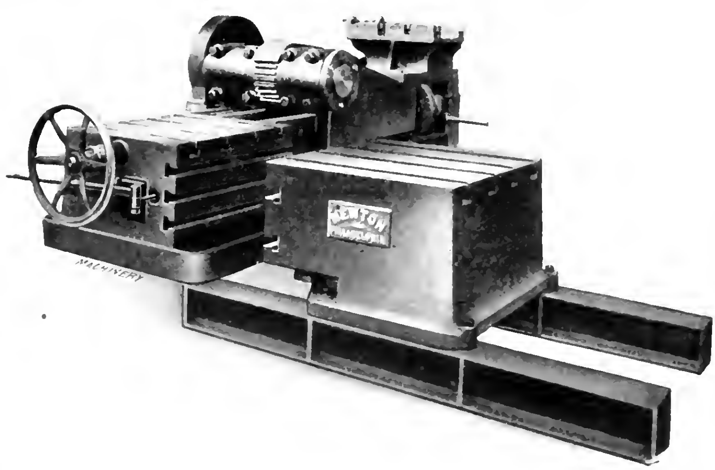


Fig. 2. Side View of Newton Cold Saw showing Auxiliary Table carried on Parallels

auxiliary table, mounted on parallels, has a top surface 36 inches square and a vertical clamping surface 24 inches deep. The use of this table is particularly convenient in handling some classes of work for which a machine of this type is used.

Particular care has been taken to obviate the possibility of "chatter" in this machine, which experience has shown to be more destructive in its effect upon saw teeth than any other defect in a cold saw. With this object in view, the feed-screw has been provided with a bearing at each end to insure having it operate in tension. The feed and fast power return are controlled from either the front or rear of the machine, which is one of the convenient features of the method of operation. A 23-horsepower motor running at 310 to 930 revolutions per minute is used for driving the machine. This motor is mounted on the bracket provided for this purpose, the motor having been removed from the machine at the time the photographs were taken. The motor transmits power to a driving pulley 30 inches in diameter by 10½ inches face.

FORBES & MYERS LATHE GRINDING ATTACHMENT

The grinding attachment for lathes illustrated herewith is a recent product of Forbes & Myers, 172 Union St., Wor-

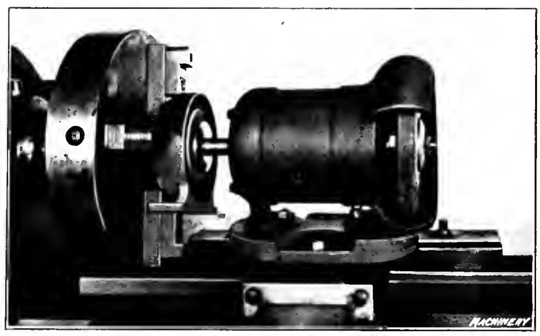


Fig. 2. Grinding Attachment working on an Internal Grinding Operation

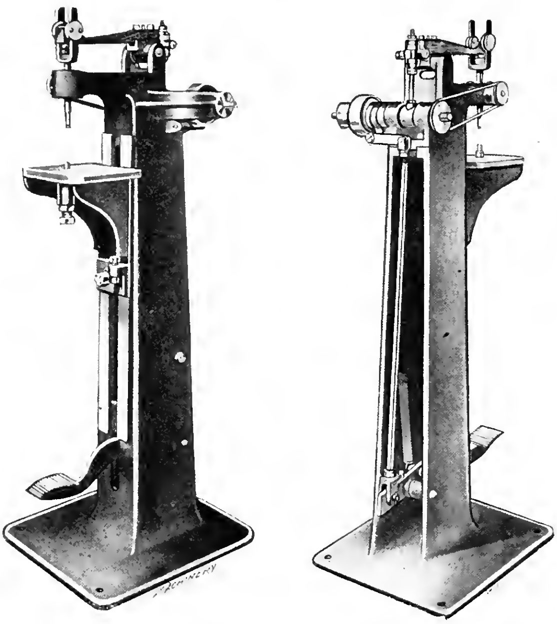
cester, Mass. It will be seen from the illustrations that this attachment is electrically driven, the armature spindle being extended at either end to enable the grinding wheels to be mounted upon it. One large wheel is provided for external work and a small wheel is carried at the opposite end of the spindle for handling internal grinding operations. This attachment is ordinarily mounted upon the tool-slide, or a

raising block made to fit special lathes may be used when such a method is more desirable.

The electric motor will give ¾ horsepower when used intermittently, as in the case of most grinding operations on lathe work. The motor is of the squirrel cage, induction type, a convenient switch being provided for starting and stopping the motor. The design of the motor has been worked out so that it is thoroughly protected against dust and grit by means of a cover which fits tightly around the shaft. The motor has no commutator, brushes, clutches or other parts which are likely to give trouble. The spindle is carried in ball bearings which insure efficient operation. The regular wheel furnished for external work is 7 inches in diameter by 1 inch face, while the internal grinding wheel is 3 inches in diameter by ½ inch face. The grain and grade of these wheels is that which experience has shown to be best suited for general classes of work, but wheels of any make or style will be furnished when so specified.

GRANT ROTARY VIBRATING RIVETER

The No. 2 rotary vibrating riveter, front and rear views of which are illustrated in Figs. 1 and 2, is a product of the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. This machine has a capacity for rivets up to ¼ inch



Figs. 1 and 2. Front and Rear Views of Grant Rotary Vibrating Riveter

in diameter and has been developed for operating in close corners where it is impossible to reach the work with the regular rotating roll riveting machines of this company's manufacture. The spindle of the machine is operated through an eccentric mechanism, which is clearly shown in Fig. 2, motion being transmitted to the riveting spindle by means of a hickory helve. A rubber ball is interposed between the helve and the spindle to absorb vibration. In addition to its vibrating motion, the spindle is positively rotated by means of a worm and wheel. The worm carries a grooved pulley at one end which is driven by a round belt running over a similar pulley on the driving shaft. These pulleys are of slightly different diameters, and it is often found desirable to change them in order to vary the rotating speed of the riveting spindle.

The machine is driven by a one-inch belt which transmits power from a 10-inch pulley on the countershaft to a friction driven pulley on the machine. The pulley on the machine runs free and is engaged by a friction clutch when it is desired to operate the machine. The clutch is controlled by a foot treadle, and when this treadle is released, the pulley is once more allowed to run free, while a brake is automatically applied to the driving shaft to stop the machine almost instantly. There is also a friction stopping device connected with the machine which causes the spindle to stop at its highest point, thus permitting the work to be easily inserted or removed.

SUSPENSION BALL BEARING

Fig. 1 shows an end and sectional view of the type of ball bearing which is manufactured by the Suspension Roller Bearing Co., Sandusky, Ohio, and Fig. 2 illustrates one of these bearings mounted in a lineshaft hanger. The design of this bearing differs considerably from the form of construction which is followed by most manufacturers. Instead

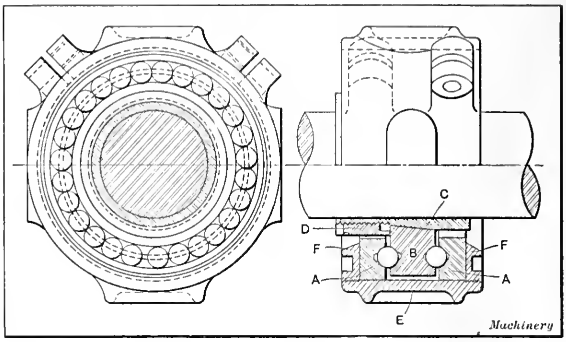


Fig. 1. End and Cross-sectional Views of Suspension Ball Bearing

of having the balls encircled by an outer race with a companion race on the inside, it will be seen that the races of this bearing consist of parallel plates A and B between which the balls are carried in race grooves. The construction is clearly illustrated in Fig. 1, where it will be seen that a collet C surrounds the shaft and holds the inner race on its tapered section. The inner race B is held in position on the tapered collet C by means of the binding nut D. The bearing is assembled in a case E in which the parts are held in place by means of the adjusting nuts F.

The construction of this bearing causes the pressure to be applied to the balls in such a way that they rotate on an axis inclined at an angle of about 45 degrees to the horizontal. In this way, the effect of radial or thrust loads upon the action of the balls is practically the same so that the

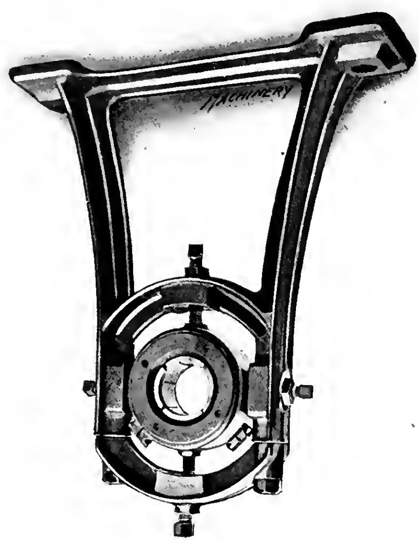


Fig. 2. Suspension Ball Bearing mounted in Lineshaft Hanger

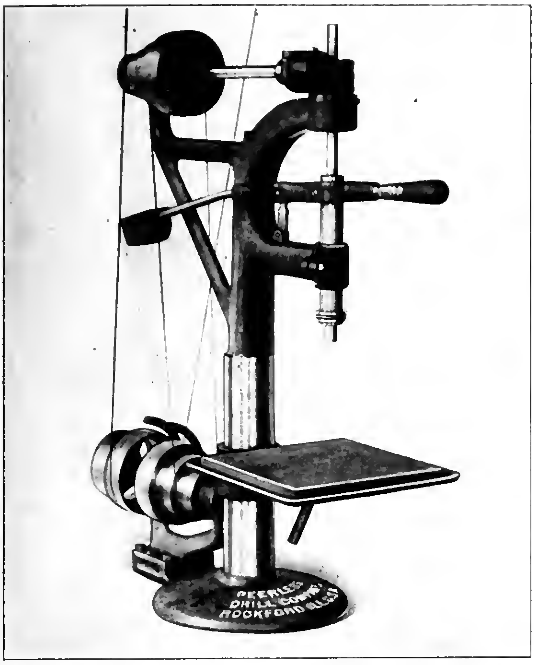
bearing has an equal capacity for supporting either kind of load. The "suspension" principle on which this bearing is designed causes the load to be distributed over all the balls in the bearing.

Fig. 2 shows the bearing supported in the style of hanger which is used for lineshaft service. It will be seen that

this hanger is provided with the usual style of adjusting screws for regulating the alignment of the shaft. The construction of the bearing case is such that it is dirt- and dust-proof and the bearing runs without requiring frequent lubrication. Enough oil is kept in the bearing case to protect the parts from rust, the oil playing little, if any, direct part in the mechanical action of the bearing.

PEERLESS TWELVE-INCH BENCH DRILL

The 12-inch ball bearing bench drill shown in this connection is a product of the Peerless Drill Co., Rockford, Ill.



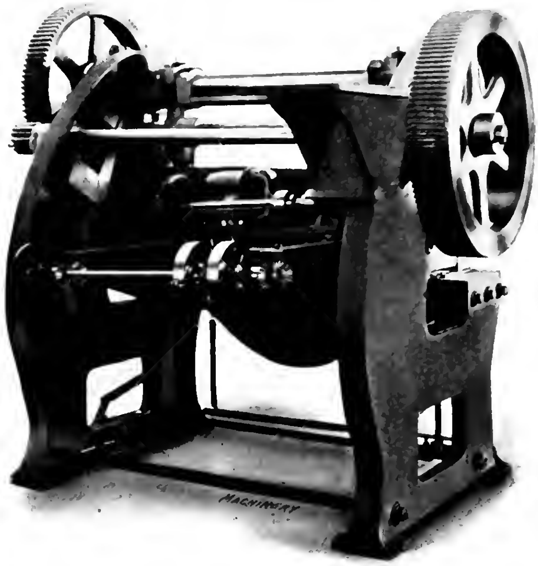
Peerless 12-inch Ball Bearing Bench Drill showing Use of Twine in Place of Driving Belts

It will be seen that this machine is equipped for hand feed, a small steel link being used between the feed lever and the frame of the machine to afford the required vertical movement for the coupling on the drill spindle bushing. The arrangement will be readily understood from the illustration, where it will be seen that the counterweight used on this machine provides for the return of the spindle when the feed lever is released. Spiral gears are used to transmit power from the pulley shaft to the drill spindle, these gears being completely enclosed. The table is of unusually large size for a machine of this type, thus affording plenty of room for any jig that may be used. An oil channel is provided which runs all the way around the table. The machine shown in the illustration is equipped with ball bearings and machines of this type are also built with plain bearings instead of the ball bearings, the style of plain bearings used being made adjustable and self-oiling.

One of these ball bearing drills was recently subjected to rather an unusual test in the manufacturers' shops. Light twine was used in place of the usual driving belts, and with this arrangement a No. 31 drill was driven through a piece of cast iron one inch in thickness in forty-five seconds. During this test the spindle was driven at 1000 revolutions per minute. The ability of the machine to do work when driven in this way shows the high degree of sensitiveness which has been attained by the manufacturer in the bearing construction.

NIAGARA SQUARING SHEAR

The power squaring shear illustrated herewith is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. The important feature of this machine consists of a device for adjusting the back gage by means of an electric motor.



Niagara Squaring Shear with Motor-driven Back Gage Attachment

The motor used for this purpose is mounted on the back web of the bar that carries the upper knife and drives an intermediate shaft which transmits power to the bevel gear shaft by means of straight and crossed belts. The motion of the bevel gears is transmitted to the back gage by means of two feed-screws, and a reversing clutch controlled by a hand lever is provided on the pulley shaft to provide for moving the back gage to the required position. In this way the

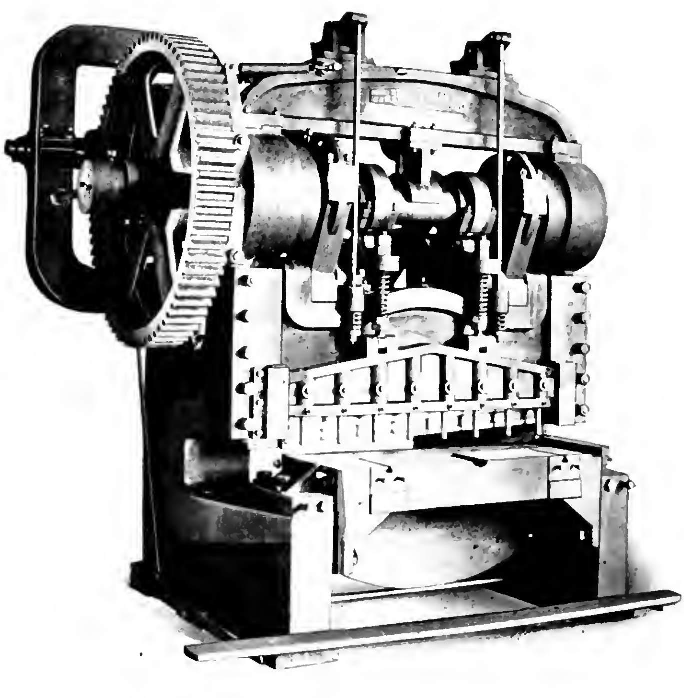


Fig. 1. Left-hand Side of Bertsch Five-foot Gate Shear

width of the stock to be cut off by the machine can easily be controlled. The back gage brackets are fastened to the

cutter bar and there is a graduated scale mounted on one of the arms to facilitate setting the gage. This attachment is of particular benefit where it is necessary to adjust the back gage frequently in order to cut strips of different widths.

BERTSCH FIVE-FOOT GATE SHEAR

Bertsch & Co., Cambridge City, Ind., have recently added to their line the five-foot gate shear shown in Figs. 1 and 2. This machine is adapted for shearing operations on plates up to 1¼ inch in thickness and is built along massive lines to adapt it for heavy work of this character. The shafts are made of forged steel and run in liberal sized bearings. All of the gears in this shear are machine cut. The clutch has steel jaws and a cast-steel switch ring which acts against a hardened tool-steel roller on the plunger. The action of the clutch is automatic and positive. In addition to the table, the machine is built with two heavy cross-tie members bolted to the end housings, one of these cross-ties being at the top and the other at the rear of the crosshead. This design adds greatly to the rigidity of the machine.

The form of hold-down used on this machine does not obstruct the shearing line in any way. The hold-down feet or gags can be easily and quickly disengaged, either for the purpose of removing the top blade or for operating the shear without a hold-down. The removal of the gags does not require the entire hold-down frame and its connections to be removed. It will be seen from the illustrations that the machine is equipped for direct motor drive. A five-foot machine is shown in the illustrations, but machines of this type are built in lengths up to 12 feet and equipped with motor, belt or hydraulic drive.

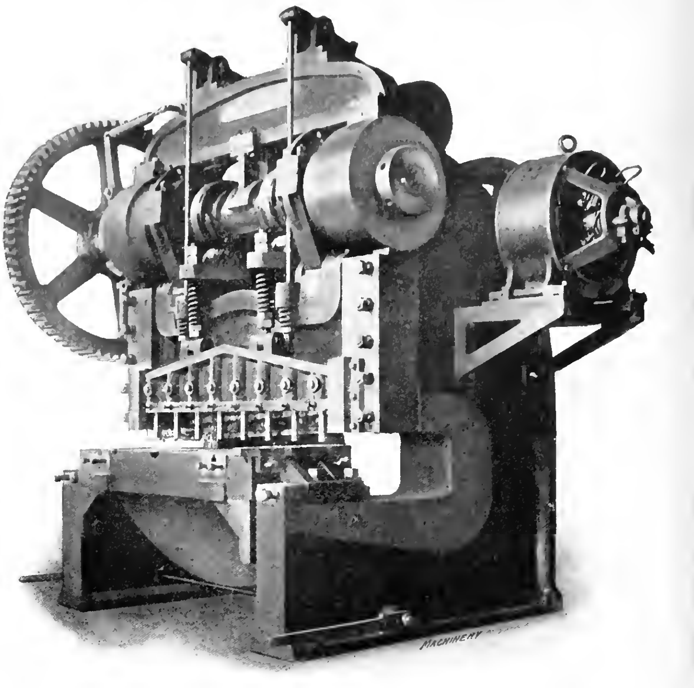


Fig. 2. Right-hand Side of Bertsch Shear showing Application of Motor Drive

NEW MACHINERY AND TOOLS NOTES

Drilling Machine: Canedy-Otto Mfg. Co., Chicago Heights, Ill. A 20-inch drilling machine, the spindle of which is 1¾ inch in diameter and provided with a No. 3 Morse taper hole. Either hand or power feed may be used as desired.

Vertical Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A milling machine especially adapted for milling railway-motor spiders; this machine may also be used to advantage for machining keyseats. In the latter operation only end mills are used.

Improvement on Cowan Transveyor: Cowan Truck Co., Holyoke, Mass. A release check for the Cowan transveyor which enables the operator to release the load independently of the handle. This check lowers the heaviest loads for which the truck is adapted without shock.

Steel Pipe Threading Die: Pipe Machinery Co., Cleveland, Ohio. A pipe threading die which will thread open-hearth steel, Bessemer steel or wrought-iron pipe with equally good results. The die is of the expanding type, the chasers being opened and closed by means of a thread movement in the die body.

Pneumatic Pyrometer: Uehling Instrument Co., Passaic, N. J. An improved type of pneumatic pyrometer adapted for furnishing a continuous autographic record. This instrument is particularly designed for use in connection with blast furnaces and can be provided in the single, double, triple or quadruple form.

Flow Meter: General Electric Co., Schenectady, N. Y. An improved type of meter adapted for measuring flow of steam, water, air and other fluids through pipes. This meter is designed to meet the demand for a strong and serviceable instrument which can be used not only as a testing instrument, but as a stationary meter for the continuous measurement of the flow of either gases, liquids or vapors delivered through the pipes in an industrial plant.

Electric Tachometer: Electric Tachometer Co., Broad and Spring Garden Sts., Philadelphia, Pa. This tachometer was originally designed for use on motor boats, aeroplanes, etc., but has been adapted for use on machine tools. It consists of a small direct-current magneto-generator and an indicating volt meter. The instrument operates on the well-known principle that when a system of coils is rotated within a permanent field, an electric voltage is generated which is proportional to the speed of rotation.

Hydraulic Forcing Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A hydraulic press capable of exerting pressures up to 1000 tons, which has been designed for general forcing work in the machine shop. The largest diameter which can ordinarily be handled between the strain rods of the press is 48 inches. On classes of work where a greater space is required, but where the pressure need not be excessively high, the press may be adapted for handling work up to 84 inches in diameter.

Cutter Grinder: Cincinnati Milling Machine Co., Cincinnati, Ohio. A machine which retains the features of this company's established type of cutter grinder, but in which the design has been modified to make the present type more rigid and to extend its capacity for larger sizes of cutters. The centers swing 10 inches in diameter and have a capacity for work up to 17 inches in length. The table has a longitudinal movement of 16 inches, a vertical movement of 7½ inches and a cross movement of 9½ inches.

Manufacturing Milling Machine: Cincinnati Milling Machine Co., Cincinnati, Ohio. A milling machine designed to handle the class of work for which the Lincoln type of millers has been almost exclusively used. The design of the machine has been worked out along the generally established lines followed in the construction of Lincoln millers, but has been improved in many details. It is made in three different styles which comprise a regular machine having one head and outboard support for the arbor; a duplex miller; and a machine in which the bed has been shortened and the tailstock left off, thus adapting it for face milling operations.

Double-crank Toggle Drawing Press: Ferracute Machine Co., Bridgeton, N. J. The ram is driven by toggles, actuated by a cam groove in a large gear at the left-hand side of the machine, and a yoke connected with the toggle shafts. The arrangement is such that the ram reaches its lowest position and remains stationary while the plunger completes the last half of its downward stroke and makes the first half of the return stroke, thus giving a dwell of 180 degrees to the blank-holders. The press is adapted for producing seamless work as deep as 15 inches; it exerts a pressure up to 500 tons and weighs about 135,000 pounds. Two larger and four smaller presses of the same type are being manufactured by the Ferracute Machine Co.

* * *

Moreau, a Frenchman, has succeeded in developing an aeroplane in which the difficult problem of automatic stability is practically solved. In a recent flight made under military auspices, the aeroplane remained in the air for 35 minutes during which time the pilot did not have to touch any of the steering parts; in fact, Moreau stated before ascending that he would make the entire flight with folded arms, and this condition he fulfilled.

THE EFFICIENCY ENGINEER AND THE CONTINGENT FEE

John Archibald was an efficiency engineer—at least that is what he called himself. There is no question but that he was very efficient in making his presence known whenever he was around. He made a business of placing old-fashioned plants upon a basis where they could double their dividends—at least that is what he said he did, and on the strength of what he said about himself, he was called into consultation by the owners of the Smith & Brown Co., which has done a profitable business for the last twenty-five years. The president thought that there might be something in this new efficiency hobby after all, and it might be worth while investigating.

Thus it came about that one sunny morning Mr. Archibald appeared at the Smith & Brown plant and began taking notes of the very inefficient methods that they were using; and he was quite frank about letting them know that he could see opportunities for improvement right and left. He studied the conditions for a week or so and then he made his report which was to the effect that he saw chances for decreasing costs to the extent of $40,000 or $45,000 a year. He also reported that this improvement could be made if he were hired as efficiency expert and given two assistants of ordinary training and intelligence. (Mr. Archibald's training and intelligence, it is understood by this time of course, was above the average.) He further intimated that his services would be worth $5000 a year, and as his assistants could be hired for very little money, a saving of at least $40,000 a year could be accomplished with an almost negligible initial expense. This report ought to have pleased the Smith & Brown Co., and it undoubtedly did, but the prospects of the coming prosperity somehow burst so suddenly upon the owners that they were unable to decide right away as to what to do. They agreed however, to write to Mr. Archibald within a few days stating their intentions. In a few days Mr. Archibald received the following letter from Mr. J. P. Smith, the president of the Smith & Brown Co.:

Mr. John Archibald,
24 Blank St., New York City.

Dear Sir: We have carefully considered your report regarding the possibilities for increased efficiency in our plant. We think, however, that the compensation which you expect for your services is entirely too modest and is not commensurate with the great saving that your knowledge and ability would accomplish in our plant. We therefore propose that instead of paying you a fixed salary of $5000 a year, as stated in your memorandum, we share with you the entire resulting savings of the first year, after the system which you will install has been put into operation, you receiving one-half of this saving. We think that this arrangement will be entirely agreeable to you and expect to hear from you at an early date. Yours very truly,

J. P. Smith, Pres.

It has always seemed very peculiar to Mr. Smith that he never heard from Mr. Archibald in answer to this proposition. Of course he has a high regard for Mr. Archibald's honesty and personality, seeing that he refused to accept $20,000 for his services when he, himself, had placed a value of only $5000 a year on them. But Mr. Smith's partner, Mr. Brown, who is less of an idealist, suspects that if all efficiency engineers (so-called) were to be paid on the basis proposed by Mr. Smith, there would not be one-half as many of Mr. Archibald's type running around loose as there are—but then, of course, Mr. Brown never believed in this efficiency business anyway, so his opinion is naturally prejudiced. E. O.

* * *

A quick and satisfactory method of coloring drawings requires the use of ordinary wax crayons and gasoline only. Crayon of the color desired is applied and then rubbed with a piece of cloth wet with gasoline until the color is even and extended to the limits desired. If it overruns the lines it can be erased with a pencil eraser. Some colors, particularly the yellows, purples, greens and light blues, produce much better results than others. It is believed that the gasoline dissolves the wax from the crayon, leaving the pigment as an impalpable powder, which when rubbed over the paper colors it uniformly. The method is applicable with equal success to eggshell and smooth drawing papers and to white prints on both paper and cloth.—*Engineering and Mining Journal.*

A BULLDOZER DIE

A very simple but efficient die designed and built by Williams, White & Co. of Moline, Ill., is shown in the illustration attached to one of this company's bulldozers. This die is used to bend stirrups for locomotive springs in one heat. Three strokes are required. The ends of the bar are scarfed and bent around before being placed in the bulldozer die. The first operation is bending the bar to a U shape. This is done in the right hand part of the die. Next one leg

Bulldozer equipped with Die for forming Locomotive Spring Stirrups

of the U is bent at right angles across the top, in the left-hand part of the die; then a piece *A* is removed from the traveling die equal to the thickness of the stock. The incompleted stirrup is now turned over on the same part of the die and the other leg is bent across the top, thus completing the stirrup as shown at *B*. The stock is spring steel, 5/8 inch by 2 inches, and the stirrup when completed is about 6 1/4 inches by 11 inches over all. The machine runs at ten strokes per minute and three strokes are caught in succession for bending a stirrup.

* * *

STEEL FOR PERMANENT MAGNETS

Steel containing 5 1/2 per cent tungsten makes excellent permanent magnets. The steel should be heated above the recalescence point and when quenched should show a fine-grained fracture. After magnetizing a magnet should be "aged" by prolonged heating in boiling water or steam. A short bar magnet tends to lose its magnetism quickly; the coefficient of demagnetization for a bar magnet twenty-five diameters in length is 0.05 while that of a magnet five diameters long is 0.5, or ten times as great. A bar magnet five hundred diameters long is supposed to be permanent. The magnetic force of the best magnets is considered by Prof. S. P. Thompson to be only 60 to 80 per cent of what may be eventually attained.

* * *

MOVING PICTURE TARGETS

New zest has been given to shooting in rifle galleries by the introduction of moving pictures as targets. The apparatus projects animals, birds, vehicles, etc., in rapid motion on the screen, and by ingenious means the marksman is shown how close his shots come to the object aimed at. At least two systems have been developed for registering hits on moving pictures, description of one of which, taken from the *Saturday Evening Post*, is substantially as follows: For the success of the apparatus it is essential that means be provided for stopping the film when a shot is fired. Without such control it would be impossible to determine accurately where the bullet struck and consequently the principal element of rifle-range pleasure would be lost. The sound of the shot stops the film automatically. A delicate microphone that responds to any sound is violently vibrated by the sound of the shot and the vibration causes it to throw on an electric current which puts brakes on the moving picture machine, or in other words to press a button and stop the machine. The stop is almost

PLAIN GRINDING MACHINE

NOTE how quickly and easily the operator can make feed and speed changes without leaving his position, or without shifting belts. To obtain any one of the available speeds or feeds he simply shifts an index slide and moves a lever as far as it will go. Consider what a saving in time this means on manufacturing work. Duplicate pieces having several different diameters can be ground more rapidly, since the correct speed and feed for each diameter can be instantly obtained. When changing from one job to another the speed and feed is also quickly and easily adjusted. Any change of feed can be made without stopping the wheel or table. The operator is also able by the simple movement of a lever to change from a fast feed for roughing to a slow feed for finishing, without disturbing the setting of the feed levers. All changes of wheel speed are made on the machine, by means of split pulleys of various diameters which are readily changed without removing the belt.

RESULT OF THE NEW DESIGN
EASIER OPERATION—INCREASED PRODUCTION

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt a M. Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway, Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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instantaneous. Often the stop comes on the next picture succeeding the one fired at, but as the pictures succeed one another at the rate of sixteen a second, the difference between them is slight and the following picture shows closely enough the location of the illuminated bullet hole in relation to the object fired at.

The construction of the screen is ingenious. It is made of three thicknesses of heavy paper. One thickness of paper unwinds from a roll of paper at the top of the screen and winds up on a roll at the bottom and these rolls are given a slight turn occasionally by an attendant. The other two thicknesses slowly but continuously unwind from rolls on one side and wind up on rolls on the other side, but they travel in opposite directions. A few seconds after the shot has penetrated the sheets, the movements have automatically closed the hole. Back of the screen is an electric light so placed as to be out of the range of shots and still shine through the hole in the sheet and thus disclose its location relative to the arrested picture on the screen.

The chief difficulty met with in the operation of these machines has been to prevent the film from catching fire when stopped. A fan is provided to blow the hot air away from the film when it stops and thus prevent the temperature rising to the igniting point.

* * *

PERSONALS

E. F. Lake, who conducted a metallurgical engineering business in Bayonne, N. J., has moved the same to 1453 Waterloo St., Detroit, Mich.

J. E. MacArthur of the Pierce Arrow Motor Car Co., Buffalo, N. Y., has resigned his position to become superintendent of the Keystone Mfg. Co. of Buffalo.

William H. MacGregor, president and general manager of the National Twist Drill & Tool Co., Detroit, Mich., recently returned from a two months' business and pleasure trip in Europe.

W. G. Dunkley of Salford, Manchester, England, an occasional contributor to MACHINERY, has received the Bachelor of Science degree in engineering at London University as an external student.

A. M. Powell, president of the Powell Machine Co., Fitchburg, Mass., returned from a European trip on the *Laconia* August 19. Mr. Powell made the trip abroad in the interest of the Powell "Hy-Speed-Cut" planer.

John Goetz has been appointed superintendent of the Kempsmith Mfg. Co., Milwaukee, Wis., manufacturer of milling machines. Mr. Goetz was for several years in charge of the company's tool-room and light manufacturing operations.

C. R. Burt has resigned the position of superintendent of the Barber-Colman Co., Rockford, Ill., and becomes factory manager of the Russel Motor Car Co., Toronto, Ontario, Canada, September 1. E. W. Billings, formerly general foreman, succeeds Mr. Burt as superintendent of the Barber-Colman Co., and F. G. Hoffman will have charge of sales of small tools and the machine tool departments.

Prof. Albert Sauveur of Harvard University, Cambridge, Mass., has been awarded the Elliott Cresson gold medal by the Franklin Institute of the State of Pennsylvania, acting through its committee on Science and the Arts, in recognition of his numerous and important contributions to the science of metallography and the influence he has exerted in bringing this science into practical and useful application in the iron and steel industry.

Charles H. Moyer, for twenty years traveling manager of the George V. Cresson Co., Philadelphia, and of its successor, the Cresson-Morris Co., for the last three months, has resigned his position. Mr. Moyer, who is widely known as a specialist in power transmission machinery, was connected with the George V. Cresson Co. since boyhood and held various positions at the works before opening the New York office. He contemplates going into business as a special engineering representative and manufacturers' agent, with an office at 90 West St., New York City.

Dr. W. H. Tolman sailed for Europe July 29. The United States State Department has accredited Dr. Tolman as a delegate to the Tenth International Housing Congress which will meet at The Hague September 8, 1913. He is also the secretary of the American Section of the Congress. Dr. Tolman will go directly to London in the interest of the International Exposition of Safety and Sanitation to be held in New York City next December under the auspices of the American Museum of Safety; while in England he will seek to obtain exhibits, particularly such as will show the work done by the factory inspection section of the Home Office in the prevention of occupational diseases and industrial poisons.

Isaac P. Richards

Samuel Porcher has been appointed purchasing agent of the Pennsylvania Railroad system, succeeding Daniel S. Newhall, who died July 12 after having been in the company's service thirty-one years. Mr. Porcher is a graduate of the University of Virginia and entered the machine shops of the company in 1882. He went through a full shop course and was transferred from the mechanical engineer's office to the office of the superintendent of motive power in Jersey City in 1888. In that year he was appointed assistant engineer, motive power department, United Railroads of New Jersey Division, in which position he remained until 1894, when he was made assistant purchasing agent of the Pennsylvania Railroad Co.

Samuel S. Eveland of the Eveland Engineering & Mfg. Co., Philadelphia, Pa., owner of the Hunter and other tractor truck patents, covering the use of two-, three- and four-wheel tractors with fire apparatus, wagons, trucks, etc., has closed a contract with the Martin Tractor Co., Springfield, Mass., and has become identified with that company. The president of the Martin Tractor Co. is Harry G. Fiske of the Fiske Rubber Co. Under the agreement, all the patents of the Martin Tractor Co. and those transferred by Mr. Eveland are consolidated under one control. The Martin Tractor Co. will immediately erect a factory for the manufacture of tractor trucks for the trade. The Knox Co. of Springfield, Mass. will continue to make them under a license agreement.

* * *

OBITUARIES

Isadore Van Huffel, who has been in the employment of the Dodge Mfg. Co., Mishawaka, Ind., for about thirty-five years, died August 4. For almost twenty-five years Mr. Van Huffel has had charge of the paint and oil department of this company. He was born November 19, 1842, in Belgium, and came to this country forty-one years ago. He resided in Mishawaka ever since his arrival in the United States.

ISAAC P. RICHARDS

Isaac P. Richards, president of the I. P. Richards Co., Providence, R. I., died July 18. Mr. Richards was born in Ashford, Conn., June 15, 1834. At the age of seven, he was put on a farm in Pomfret, Conn., where he worked for eight years for board and clothes. He received a country schooling by doing chores late at night. Later he worked on farms at various places in Connecticut, until at the age of seventeen, he went to Plantsville, working for the Plants Mfg. Co. Returning to the farm for a couple of years, he began, in 1853, to learn the machinists' trade in the shop of Paul Whitin & Son. In April, 1856, he finished his apprenticeship, during which he had received $2 a week, out of which he had paid $1.88 for board. He worked now for two years in Whitinsville, Mass., and in 1858 he went to Providence to work for W. T. Nicholson and later for J. R. Brown & Sharpe. He moved about during the next few years, and in 1864 went back to Whitinsville to take charge of the screw department. In 1867 he was granted a patent for a spindle boylster. In 1869 he patented an improvement in punches for iron and steel, and two years later he went to Providence to manufacture these punches in the machine shop of W. T. Nicholson. In 1885 he built his own shop at 23 Pemberton St., Providence, for the manufacture of punches and dies. The business was incorporated in 1908. The quality of the punches which Mr. Richards manufactured is well known all over the country. His motto was "Quality" and he wanted everybody to live up to it.

COMING EVENTS

September 18-20.—Eighth annual convention of the Federation of Trade Press Associations in the United States, at the Hotel Astor, New York City. W. H. Ukers, chairman of the committee of arrangements, 79 Wall St., New York City.

October 7-10.—Convention of American Society of Municipal Improvements in Wilmington, Del. George H. McGovern, secretary, Chambers of Commerce, Wilmington, Del.

October 10-17.—Eighth annual foundry and machine exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y., last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 13-17.—Annual convention of the American Institute of Metals at Chicago, Ill. W. M. Corse, secretary, Lumen Bearing Co., Buffalo, N. Y.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 19-25.—Seventh annual convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

October 20-26.—Convention of the American Mining Congress in Horticultural Hall, Philadelphia, Pa. James F. Callbreath, secretary, Munsey Bldg., Washington, D. C.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers. Headquarters Engineers Bldg. 29 West 39th St., New York City. Calvin W. Rice, secretary.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty-one museums of safety in Europe, and all these will contribute to the American Exposition.

NEW BOOKS AND PAMPHLETS

Reinforced Concrete Wall Footings and Column Footings. By Arthur N. Talbot. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 67. Price, 50 cents.

Progress Reports of Experiments in Dust Prevention and Road Preservation, 1912. 51 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Washington, D. C., as Circular No. 99.

Investigations of Detonators and Electric Detonators. By Clarence Hall and Spencer P. Howell. 73 pages, 6 by 9 inches. Illustrated. Published by Department of Interior, Bureau of Mines, Washington, D. C., as Bulletin 59.

First Series of Coal-Dust Explosion Tests in the Experimental Mine. By George S. Rice, L. M. Jones, J. K. Clement and W. L. Egy. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin No. 56.

The Determination of Internal Temperature Range in Concrete Arch Bridges. By C. S. Nichols and C. B. McCullough. 101 pages, 6 by 9 inches. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 30.

Theory of Loads on Pipes in Ditches and Tests of Cement and Clay Drain Tile and Sewer Pipe. By A. Marston and A. O. Anderson. 181 pages, 6 by 9 inches. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 31.

Legal Specifications for Illuminating Gas. By E. B. Rosa and R. S. McBride. 31 pages, 7 by 10 inches. Published by Department of Commerce, Washington, D. C., as Bulletin No. 14 of the Technologic Papers of the Bureau of Standards. S.W. Stratton, director.

Determination of Phosphorus in Steels Containing Vanadium. By J. R. Cain and F. H. Tucker. 11 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Bulletin No. 24 of the Technologic Papers of the Bureau of Standards. S. W. Stratton, director.

Logarithms for Beginners. By Charles N. Pickworth. 49 pages, $4\frac{3}{4}$ by $7\frac{1}{4}$ inches. Published in America by the D. Van Nostrand Co., New York City. Price, 50 cents.

This little book gives a more detailed and practical explanation of logarithms and their various applications than is to be found in most mathematical text-books. The present edition is the fourth, and a table of hyperbolic logarithms has been added which will make the work of still greater value.

The Boy Mechanic. 469 pages, $7\frac{1}{2}$ by $9\frac{1}{2}$ inches. 800 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price $1.50.

This work for boys, amateurs and all interested in construction and operation of machinery, scientific apparatus, etc., was compiled largely from the "Popular Mechanics Magazine." Seven hundred articles tell how to construct wireless outfits, boats, camp equipment, aerial gliders, self-propelled vehicles, engines, motors, electrical apparatus, cameras and hundreds of other things. The book is one that will be highly appreciated by the average boy as a birthday or Christmas gift.

Journal of the Municipal School of Technology, Manchester. Vol. 6. Containing a record of investigations undertaken by members of the teaching staff and students of the school. Published by the University of Manchester, Manchester, England.

The volume contains, among other valuable contributions, a paper on cutting tools, by Dempster Smith, which will be found of interest to all concerned with the design and operation of machine tools. The paper reviews the experimental investigations of forces acting on cutting tools of the form best adapted for durability. It also reviews some durability experiments. The paper covers fifty-three pages of the volume and is illustrated with folding charts, diagrams and halftones.

The Gas Engine Handbook. By E. W. Roberts. 323 pages, $4\frac{1}{4}$ by 7 inches. 85 illustrations. Published by the Gas Engine Publishing Co., Cincinnati, Ohio. Price $2.00.

This is the seventh edition of a handbook which was first published in 1900. The new edition is entirely rewritten and the subjects are treated from the standpoint of the latest practice in this field. The book throughout is practical rather than theoretical in its nature. The principles of operation of the various cycles of gas engines are first dealt with, after which the gas engine fuels, the mechanism of the gas engine and the various details of gas engine construction are described. The book is divided into three parts, the first section being mainly descriptive, while the second part deals specifically with the design of gas engines, chapters being devoted to each detail of the engine. Besides the descriptive section and that on design, about fifty pages of the book are devoted to the operation and testing of gas engines, and suggestions are also given for selecting an engine to fit the requirements of the buyer.

NEW CATALOGUES AND CIRCULARS

Ohio Valley Pulley Works, Maysville, Ky. Card advertising "Limestone" pulleys.

T. W. G. Cook, 88-90 Walker St., New York City. Circular advertising presses, dies, molds and patterns.

Production Engineering Co., 1716 Spring Garden St., Philadelphia, Pa. Circular advertising structural steel column crane.

Rockford Iron Works, Rockford, Ill. Folder advertising high-duty Rockford punch presses and illustrating the company's patented automatic brake.

H. Bickford & Co., Lakeport, N. H. Circular illustrating and giving general dimensions of motor-driven boring and turning mills in from 4- to 7-foot sizes.

Adolph Muehlmatt, Fifth Ave. and Elm St., Cincinnati, Ohio. Circular of the "Rex" universal ball vise for tool-makers, die-sinkers, stamp-cutters, mold-makers, etc.

Sprague Electric Works of General Electric Co., 527-531 West 34th St., New York City. Bulletin of motor-driven exhaust fan outfits with direct- and alternating-current motors.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin E-29 (superseding E-24) and 34-B on Duntley electric grinders, heavy-duty portable type and "Chicago Pneumatic" power-driven compressors, respectively.

George Von Rottweiler, chief engineer, Western Metal Products Co., Inc., Waterloo, Iowa. Pamphlet entitled "Draftsmanship and Mechanical Engineering," advertising correspondence school course in mechanical drawing.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue K, 1913, on Brownhoist locomotive crane with grab bucket. The catalogue contains numerous illustrations showing the application of the crane in various industries.

James Rees & Sons Co., Pittsburg, Pa., builder of engines, boilers and steamboats. Catalogue of the various products of the company, showing interesting illustrations of the development of river steamboats in the United States.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34R on enclosed self-oiling, single-stage, steam and belt-driven compressors. Also Catalogue No. 43 illustrating and describing "Rockford" railway motor cars.

National Tube Co., Frick Bldg., Pittsburg, Pa. Booklet on "Kewanee" pipe unions, hose unions, air pump unions, flange unions, union ells, union tees, boiler couplings, ball joints, boiler fittings, brass cocks, check valves, globe valves, etc.

Duryea Motor Co., Saginaw, Mich. Leaflet containing testimonials from various users of the company's product, and also a number of reprints from various publications bearing on the subjects of the two-cycle motor, air-cooling and similar features.

U. S. Electrical Mfg. Co., 459-461 East Third St., Los Angeles, Cal. Bulletin "A" illustrating and describing type "FR" constant speed polyphase induction motors from $\frac{1}{4}$ to 15 horsepower. Also circular showing in line engravings the design of the type "FR" motor.

Dodge Mfg. Co., Mishawaka, Ind. Catalogue D-Z 25 on the Dodge-Zimmer conveyor, intended for economical transportation of raw, finished and waste materials. The catalogue is illustrated with excellent halftones and line engravings showing many different applications of the conveyor.

Berger Mfg. Co., Canton, Ohio. Catalogue of sheet metal products including roofing, siding, eaves troughs, conductor pipe, gutters, ventilators, skylights, metal ceilings, metal furniture, metal lumber, metal stock room equipment, cornices, finials, reinforcing and furring plates, metal lathes, metal shingles, tin plate, metal tile, etc.

Tate, Jones & Co., Inc., Pittsburg, Pa. Circular No. 142 entitled "Fuel Oil Data." The circular contains considerable information for those who use fuel oil, particularly for metal heating, tempering, etc. Much of the data is carefully tabulated, and a great deal of information is given on the heating values of various fuels.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Booklet illustrating and describing electrical equipment for automobiles. Folder of Westinghouse 3-inch meters. Pamphlet entitled "Small Motors," showing their application to washing machines. Circular illustrating and describing squirrel-cage induction motors.

General Electric Co., Schenectady, N. Y. Bulletins Nos. A4093, on Generators for Electrolytic Work; A4124, on Automatic Starters for Alternating-Current Motors; A4130, on Adjustable Speed Direct-current Motors; A4135, on Lightning Arresters for Electric Railways; and A4139, on Central Station Oil Switches of High Rupturing Capacity.

Atlas Ball Co., 203 Glenwood Ave., Philadelphia, Pa. Circular of Atlas ball gages for measuring internal diameters ranging from $\frac{1}{4}$ inch to 2 inches diameter. The gages consist of steel balls, guaranteed accurate within 0.0001 inch and electrically welded to suitable handles. These gages are furnished in various combinations according to the wants of users.

Michigan College of Mines, Houghton, Mich. Year book for 1912-1913 and announcement of courses for 1913-1914. The book, comprising 130 pages, gives a mass of information for prospective students, and a program for the year 1913 and 1914. Complete information is contained regarding admission to the college, either on certificate from accredited schools or by examination.

Lapointe Machine Tool Co., Hudson, Mass. Bulletin No. 13 illustrating and describing the Lapointe broaching machines, and giving, in addition, brief descriptions of work done on these machines, the descriptions being illustrated both with halftones and line engravings. Many interesting illustrations of broaching operations of difficult work are shown, and a table of dimensions of Lapointe standard cutter bars is included.

Garvin Machine Co., Spring and Varick Sts., New York City. Catalogue illustrating and giving the dimensions of wrenchless chucks. In addition, the catalogue contains a number of illustrations with accompanying description relating to the operation of Garvin turret machinery. The chucks are operated on two systems: compressed air and spring power. The air system is recommended as being the most powerful and convenient.

Suspension Roller Bearing Co., Sandusky, Ohio. Catalogue illustrating and describing Boyer suspension ball bearings. The catalogue contains a description of the method of construction of these bearings, calling attention to their advantages and the particular services for which they are suited. It also illustrates hangers provided with these ball bearings and gives tables and dimensions and load capacities of bearings for combined radial and thrust loads as well as for plain and grooved ball thrust bearings.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin U8, superseding Bulletin U7 on standard high-power universal portable electric drills operating on both direct current and alternating current. These drills can run from a lamp socket or power circuit, using either alternating or direct current of the same voltage. It is claimed that they operate satisfactorily on low frequency circuits from 0 to 60 cycles without any special feature or change in winding. These electric drills are furnished in seven sizes, having a capacity in steel ranging from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inch, respectively.

Peck, Stow & Wilcox Co., Southington, Conn. Catalogue 10-A of P. S. & W. tinsmiths' tools and machines, comprising squaring shears, curved shears, slitting shears, scroll shears, parallel shears, circular shears, cornice brakes, folding machines, forming machines, brace and wire benders, grooving machines, turning machines, burring machines, wiring machines, elbow-edging machines, setting down machines, beading machines, swages, stovepipe crimpers and beaders, corrugating machines, gutter machines, double-seaming machines, elbow seam closers, tucking machines, punches, wire feed and cutter, tinners' hand shears or snips, stake-holders, stakes, shear-holders, vises, roofing tongs, cross-lock seamers, hammers, soldering coppers, etc.

TRADE NOTES

Benson Brothers, 51-53 Druitt St., Sydney, Australia, dealers in American tools, would like to receive catalogues from American machine tool builders who are not represented in Australia.

Ferracute Machine Co., Bridgeton, N. J., celebrated its semi-centennial August 16 by a garden party given by President Oberlin Smith and wife at their home "Lochwold" adjoining the works.

Goldschmidt Thermit Co., 90 West St., New York City, announces that the San Francisco office of the company has been removed from 432-436 Folsom St. to 329-333 Folsom St.

MACHINERY

OCTOBER, 1913

WORK HOLDING ARBORS AND METHODS FOR TURNING OPERATIONS

A TYPICAL COLLECTION OF DEVICES ESPECIALLY DESIGNED FOR HOLDING WORK IN THE FAY AUTOMATIC LATHE

THE developments in the design of machine tools during the last ten or fifteen years have brought these machines to a high degree of perfection. Many are provided with features which make great precision possible, and a workman who understands how to get the most out of one of these modern machine tools can produce very accurate work. It should be remembered, however, that no matter how accurate and how well adapted to rapid production the machine may be, if the methods of holding the work are not equally well thought out there is comparatively little gained. As a matter of fact, this point is neglected in a great many machine shops. In a few instances, we find planning departments and efficient tool-designing departments where the methods and appliances to be used in manufacturing are carefully considered. In the majority of shops, however, the workmen, or at best the foremen, are left to devise for themselves the methods by which the work is to be held in the machines. In the few cases where the workman is unusually ingenious, this may be of advantage, but it is seldom possible for the man at the machine to consider both the accuracy required and the rapidity of production with anything like the care that can be done by a designer especially detailed to do this work.

Therefore, it is becoming generally recognized that in order to take advantage of the full capacity and adaptability of modern machine tools, it is necessary that the work-holding and machining methods be worked out by designers of equal ability to those who actually design the machine. In the following article a few methods will be shown for holding different classes of work for turning and facing operations in the lathe. The arbors and devices shown were designed under the direction of Mr. Ralph E. Flanders of the Jones & Lamson Machine Co., Springfield, Vt., for use in the Fay automatic lathe; but as far as the methods for holding the work are concerned, they may be employed with equal advantage in any engine lathe, and are therefore capable of wide application. The tooling arrangements shown in each case are, of course, especially adapted to the Fay automatic lathe with its front and rear tool-holders, but by means of a special tool-block many engine lathes could be rigged up to perform the work in a similar manner. These tooling arrangements will probably suggest other machining methods.

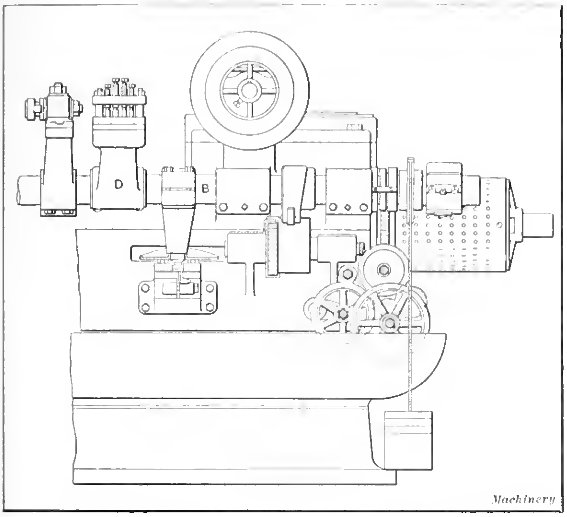

Fig. 1. Rear View of Head End of Fay Automatic Lathe

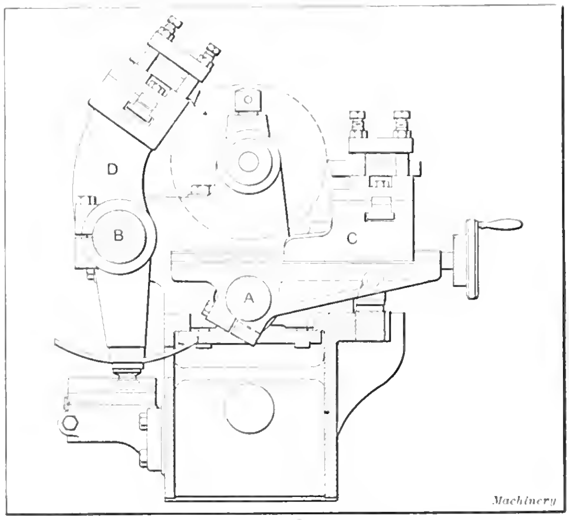

Fig. 2. Cross-sectional View of Fay Automatic Lathe

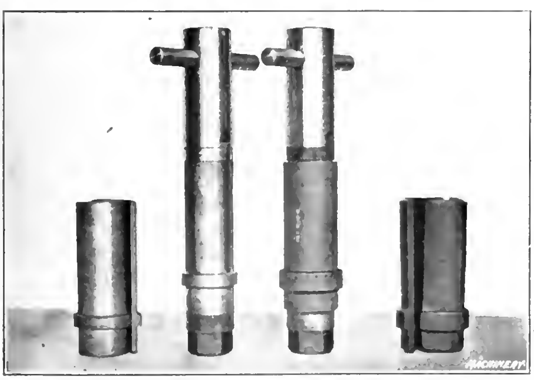

Fig. 3. Half-bushings to be machined and Arbor used for holding them while turning Outside

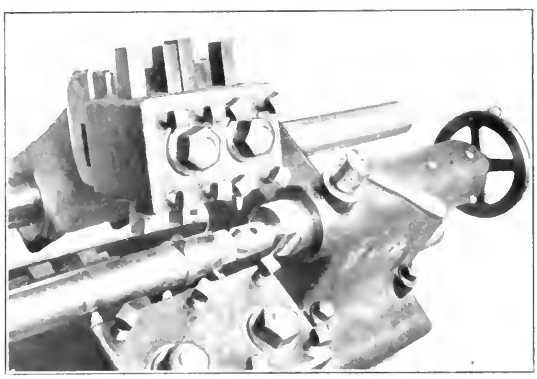

Fig. 4. Tools illustrated in Detail in Figs. 3 and 5 set up on Fay Automatic Lathe

Principles of Arrangement of the Fay Automatic Lathe

In order to make the following article intelligible in so far as the arrangement of the tools is concerned, it will be necessary to refer briefly to the construction of the Fay automatic lathe. (A general description of this machine was

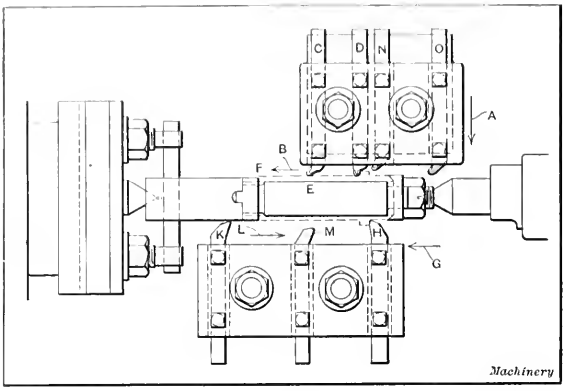

Fig. 5. Tool Arrangement for turning Half-bushings shown in Fig. 3

published in the June, 1909, number of MACHINERY.) The line engraving Fig. 1 shows a rear view of the head end of the machine; Fig. 2 shows a sectional view. The main or work-spindle is driven by worm gearing from a cone pulley mounted

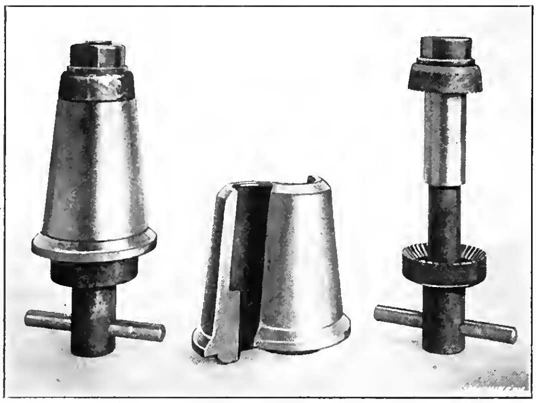

Fig. 7. Arbor for turning Tapered Bushings and Work for which it was designed

at right angles to it. A series of cams is provided for controlling the cutting tools, and by means of a clutch mechanism operated by adjustable dogs, the cam-shaft may be given a slow feeding movement or a rapid idle movement over any

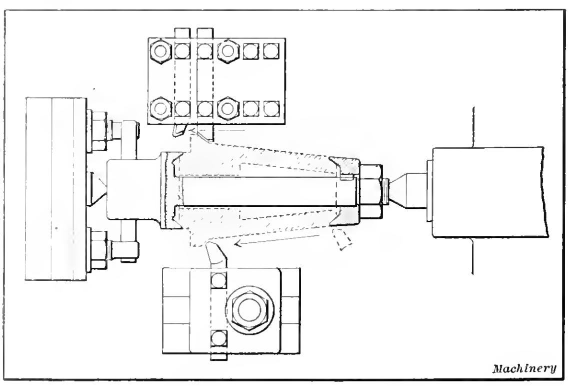

Fig. 9. Finishing Tool Arrangement for Bushings shown in Fig. 7

portion of the periphery of the cam. Two heavy bars, *A* and *B*, extend the full length of the machine and on these the various carriages and tool-holders are mounted. Each of these bars is controlled by a cam both as regards the longitudinal and the rocking movement about their axes. The rocking movement of the front tool-holder *C* is caused by templets or cam surfaces on the slide or former bar at the front of the bed on which the outer end of the carriage rests. These templets may be given any desired shape which will be copied by the tool as the carriage is fed longitudinally.

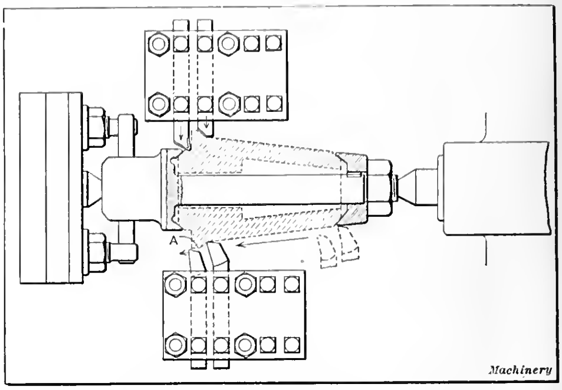

Fig. 6. Method of holding Tapered Bushings shown in Fig. 7

The carriage may also be held stationary and the former bar carrying the templet may be fed to the right or left, thereby causing the tool to feed directly in or out at right angles to the axis of the work. The main tool bar is operated

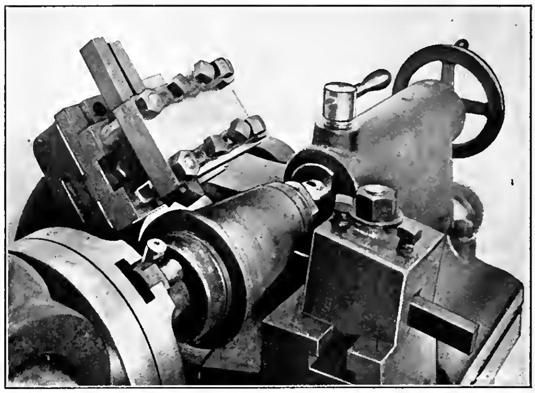

Fig. 8. Tools shown in Detail in Figs. 6 and 7, set up on Fay Automatic Lathe

longitudinally by an internal cam surface within the cam drum shown to the right in Fig. 1, and the tool slide at the rear is rocked by a cam beneath the headstock. It will be understood from this description that the front tool-block *C*

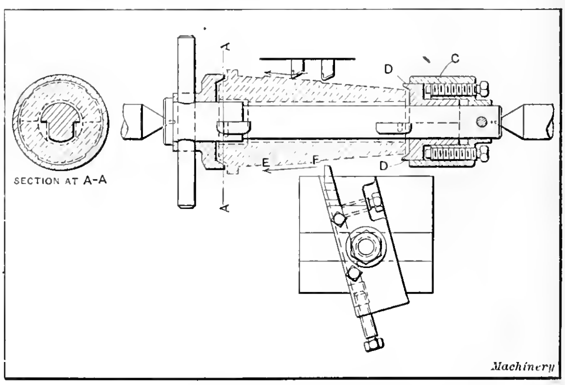

Fig. 10. Arbor for holding Tapered Bushings with Rough Ends

is especially adapted to straight turning, taper turning and forming operations, while the rear tool-holder *D* is intended for operations requiring the tool to be fed in toward the center of the work after which, of course, the tool-bar can be fed longitudinally for ordinary straight turning operations.

Arbors for Holding Bushings made in Halves

The arbor shown in Fig. 3 is used for holding the type of half-bushings illustrated while turning the outside. When performing this operation, it is necessary that the bushings be so held that the parting line comes exactly in the center, so that the two halves are interchangeable. At the same time, they must be held so that the outside will be true with the inside, which has already been finished by a formed convex milling cutter. When the inside has been finished, the two halves are clamped to an arbor and the ends are finished to a beveled surface by a hollow mill. The half-bushings are then ready to be placed on the arbor shown in Figs. 3 and 5, where they are held in place by beveled collars slightly corrugated on the tapered surfaces to form an effective drive. By holding the bushings in this manner the whole of the outside can be finished at one setting. The rear tool-block carries the roughing tools and is first fed inward in the direction of arrow *A*, Fig. 5, and then to the left in the direction of arrow *B*. The roughing cut is divided

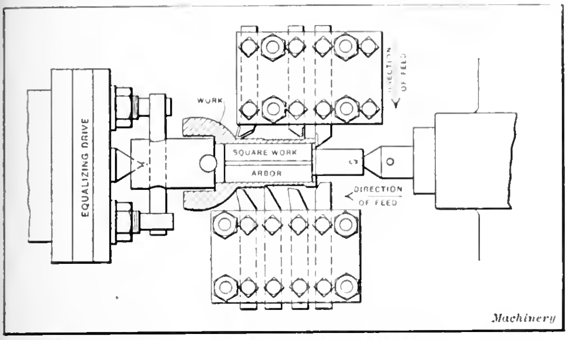

Fig. 11. Turning Work carried on Arbor passing through Square Broached Hole

between the tools *C*, *D*, *N*, and *O*, so that the tool slide needs to feed from *E* to *F* only in order to complete the roughing cut. The tool *N* roughs out the top of the shoulder on the bushing, while the tool *O* roughs out the part of the bushing to the right of the shoulder.

The finishing tools are held in the front tool-holder. Tool *H* is first fed in the direction of arrow *G*, finishing one end of the bushing, and then tool *K* is fed in the direction of arrow *L* to finish the other end of the bushing; at the same time, tool *M* finishes the collar or shoulder shown. The roughing is entirely completed before the finishing cut begins. The finishing cut on the long surface to the left on the

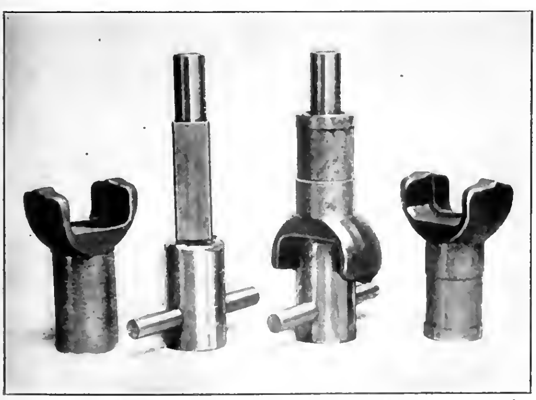

Fig. 12. Square Arbor for carrying Work with a Square Broached Hole

bushing is done by one tool *K* and not by two tools as in the case of the roughing cut, because if two tools were used for finishing it would be difficult to avoid a slight mark on the turned surface at the point where the two cuts meet. Fig. 4 shows the work and tools as arranged in the machine.

In Fig. 6 is shown an arbor used for holding a tapered bushing while finishing the outside; the bushing is shown in Fig. 7, and Fig. 8 shows the work and tools set up in the machine. In this case the hole in the bushing, which is made in halves as in the preceding case, is rough. The joint between the two halves must, however, come exactly in the center of the finished bushing so that the two halves may be interchangeable. The first operation is to plane the joints; then the two halves are clamped together and the ends are finished by a hollow mill to form a bevel bearing for the clamping collars of the arbor. When milling the ends, the joint must be held central in a jig especially designed for the purpose. The half-bushing is then clamped on the arbor shown in Fig. 7, the beveled surfaces of the collar and shoulder holding it true. Fig. 6 shows the arrangement of the roughing tools, the arrows indicating the direction in which they are fed. The front and rear tools are in action simultaneously. The front tools are guided by a taper former on the former bar. In the roughing operation the small surface at *A* will, of course, be turned on a taper, but this will be corrected by the finishing operation, the tooling arrangement for which is shown in Fig. 9. In this case the tools in the back tool-holder finish the short taper on the shoulder and

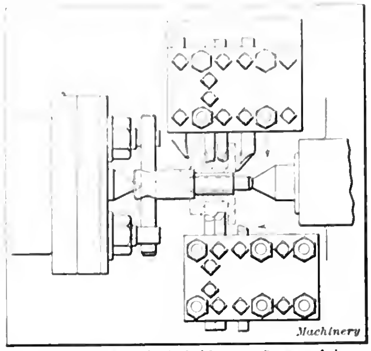

Fig. 13. Gear Blank held on a Square Arbor

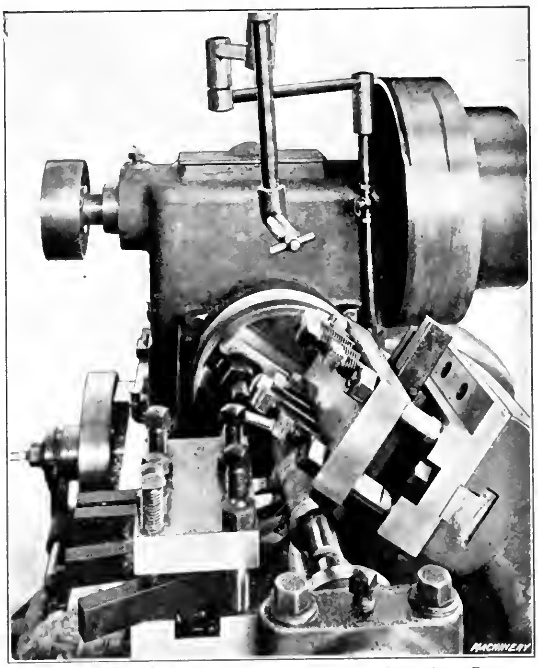

Fig. 14. Turning Work carried on a Square Arbor in a Fay Automatic Lathe

the top of the projection. The long taper surface of the bushing is finished by the tool held in the front tool-holder. Arrangements are made for relieving the tool on the return.

Fig. 10 shows another tapered bushing made in halves, which is turned on the outside before the inside is finished. Here the ends are not finished because other means are available for holding the work so as to locate the joint in the center of the finished bushing. There are lugs on the inside of one of the half-bushings, which bear against shoulders on the arbor, as shown by the section to the left. After the two halves are finished by planing, the half provided with the lugs is first placed on the arbor so that the lugs bear against these shoulders, which insures a correct location. As the ends are rough, the clamping arrangements must be made to

take care of any adjustment necessary to provide a full bearing. A bushing *C* is therefore provided within which slide two half-bushings *D*, operated by adjusting screws. By means of these screws each half of the bushing to be turned

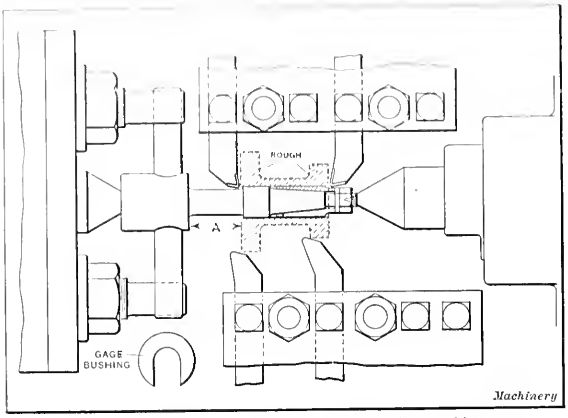

Fig. 15. Example of Work held on Expanding Bushing

can be clamped tightly against the collar at the other end of the arbor; at the same time the joint in the center will be held in correct relation to the center of the arbor. The roughing cut is divided between the two tools in the rear tool-

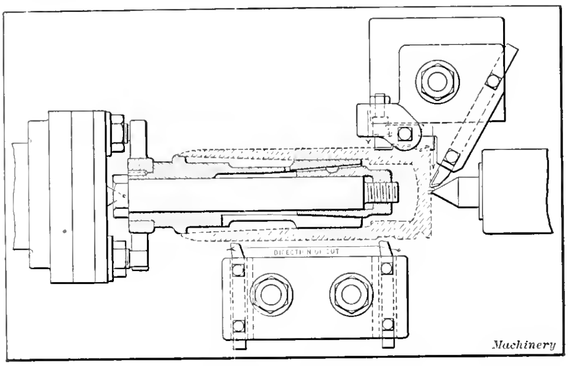

Fig. 17. Combination Threaded and Expanding Arbor for holding Shrapnel Shell in Lathe

holder and the finishing is done by the tool in the front tool-holder. Only the short surface from *E* to *F* is finished.

Holding Work with Square Holes

A piece of work with a square broached hole by which the

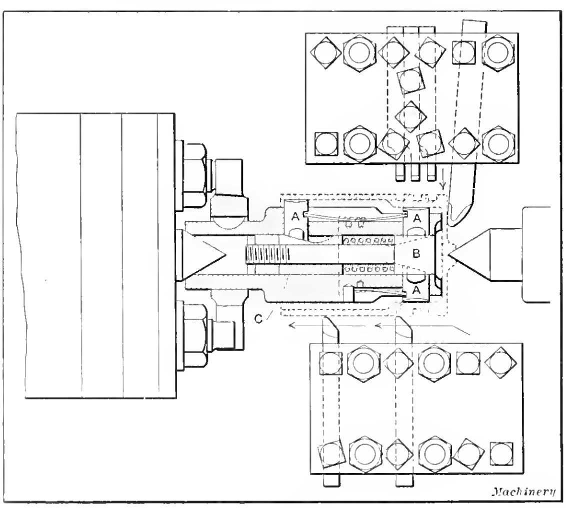

Fig. 19. Arbor for holding Pistons to be turned

piece is held on a square arbor is shown in Fig. 11. In this case the cutting is all done in one direction so that it is unnecessary to provide for clamping the work for endwise motion. An illustration of the piece of work and the arbor, also showing the work in place on the arbor, is given in Fig. 12. The tools, as inserted in their respective holders, are shown in place on the machine in Fig. 14.

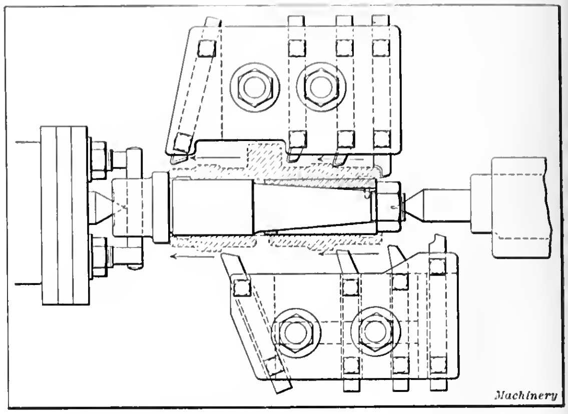

Fig. 16. Another Method of clamping Work on Expanding Bushing

Fig. 13 shows a simple method for holding a gear blank with a square hole. The hole in the blank is first bored, after which the piece is roughed all over except on the large diameter and on the face next to it, as it is held by these

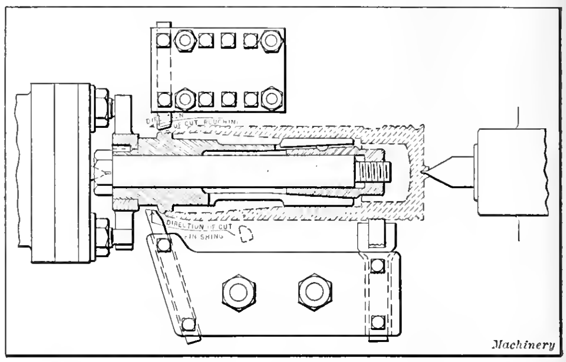

Fig. 18. Tool Arrangement for turning Shrapnel Shell Point and knurling Groove at Closed End

surfaces in the turret lathe. Then the hole is broached, two keyways being provided at the same time, after which the piece is placed on the arbor, the keys being driven in just tight enough to hold it in place. The tooling arrangement

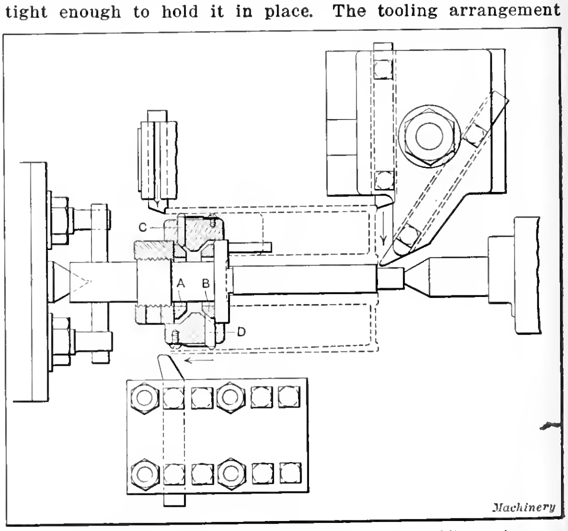

Fig. 20. Method of supporting Pulley from Inside while turning

used for finishing the surfaces is shown in the illustration.

When a piece of work is to be finished on the Fay automatic lathe, or in any lathe with multiple tools and fixed stops,

it is necessary that the endwise location of the work be always the same; hence when work with a round hole is to be finished, it cannot be held on an ordinary arbor with a slight taper unless the hole is so accurately finished that the piece will come to a driving fit at a given place on the arbor, in which case the point to which the work is to be driven

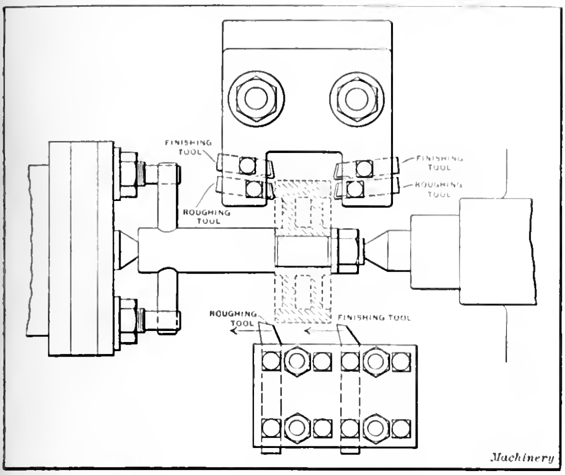

Fig. 21. Example of Arbor designed to hold Two Pieces of Work at One Time

may be determined by means of a simple gage which acts as a stop. As a matter of fact, some firms make it a point to machine the holes in work of this kind so accurately that the work can be driven onto an arbor and come to a driving fit at a given point. This can almost always be done with bronze bushings, as there is enough elasticity in this material to permit the pieces to be forced down to a certain

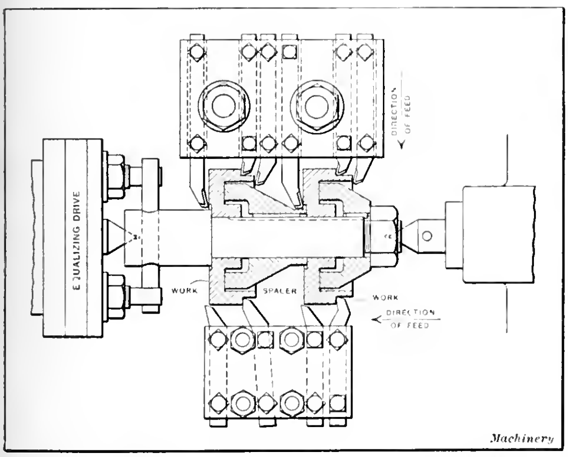

Fig. 22. Example of Two Pieces clamped on Arbor, illustrating Use of Spacer

position. With this method of holding, both ends of the work can be faced, as there are no clamping arrangements to obstruct the path of the tools.

Holding Work by Means of Expanding Bushings

One of the simplest methods for holding work with a finished hole is by means of expanding bushings. This method makes it possible to chuck the hole in a drill press and still hold it at a given position on an arbor without obstructing the ends of the work, and in such a way that both ends of the work can be faced. In the case shown in Fig. 15 the hole was too long to fit a split bushing the entire length, as the thickness of the bushing would have been rather excessive at one end, or else the taper would have had to be made too small; therefore part of the arbor is turned straight and to fit the hole in the gear blank to be turned. In order to insure that the piece be placed in the same position longitudinally each time, a gage bushing, an end view of which is shown in the lower left-hand corner of the illustration, is used to gage distance A. The piece of work is dropped onto the arbor and secured loosely against the gage; then the gage is withdrawn and the nut is tightened to hold the work firmly in place. The arrangement of the tools for finishing this piece is clearly indicated in the illustration.

In Fig. 16 is shown another example of an arbor for clamping work by means of a split bushing. The work here shown is an armature bearing box. No gage is necessary in this case, as the work is located by a shoulder at one end of the arbor, only one end of the work being faced off. The roughing is done by the tools in the rear tool-holder and the finishing by the tools in the front holder. Another interesting method of holding work while machining is shown in Fig. 17. The work here shown in position on the arbor is a shrapnel shell. The work is threaded on the inside at one end and can thus be screwed onto a threaded portion of the arbor. The end of the arbor is split and provided with an expander. The rear tool slide holds the roughing tool which

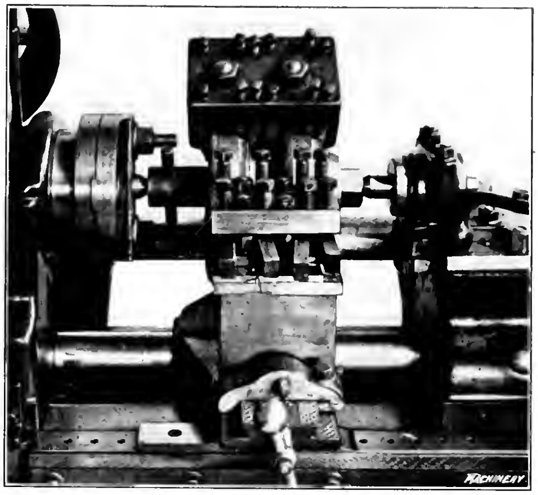

Fig. 23. Two Pieces of Work on Arbor mounted in Fay Automatic Lathe

faces the end, and also a forming tool which comes into a surface free from scale that has been roughed off by one of the tools in the front slide. The direction of the cut of the tools in the front slide, first inward, then parallel, and then slightly outward, is shown by the arrow. Fig. 18 shows

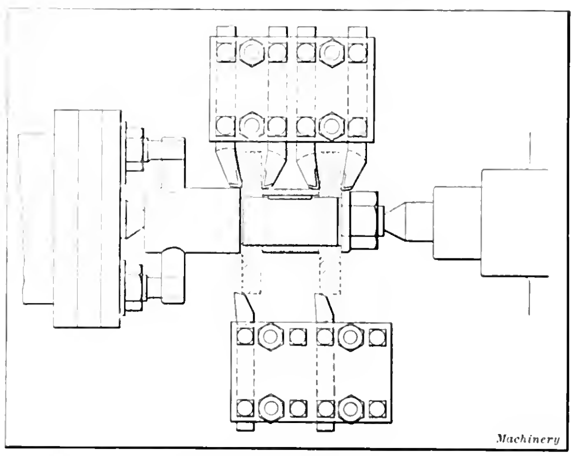

Fig. 24. A Simple Case of Two Pieces of Work held on an Arbor with Spacer between them

the arrangement of the tools for roughing and finishing the tapered end of the shell and for knurling a groove at the closed end. In this case a special grooved former must be used in place of the taper attachment of the machine at the rear. When the front tool at the left has completed its cut the finishing tool-holder drops in, permitting the tool to the

right to perform the knurling operation. In this case a former is clamped to the former bar of the machine.

Supporting Thin Work from the Inside

The most interesting holders for work that is to be machined in the lathe are, perhaps, those that are arranged to support thin work from the inside. In Fig. 19 is shown one example of a piston held by an equalizing arrangement. This arrangement is applicable only to pistons which are not to be ground. The usual method is to bore a hole for a short distance inward at the end of the piston and then drill the wrist-pin hole. The bored portion is used for locating the work in position by means of a stud through the wrist-pin. The method shown in the present illustration, however, permits the work to be done in one operation without any counterboring, and with the assurance of an even thickness of metal all around the piston. One end of the piston is centered in a centering machine. If the piston is heavy it may be held by the outside during this operation. If the metal is thin, it is preferable to center it with reference to the inside, holding the work in a jig like the fixture used in the machine. The holding device consists of three plungers *A* at each end of the piston, which slide in slots cut in the head of bolt *B* and in collar *C*, and which thus both center the work and support it on the inside. In the case of small pistons only two plungers are used at the closed end, because

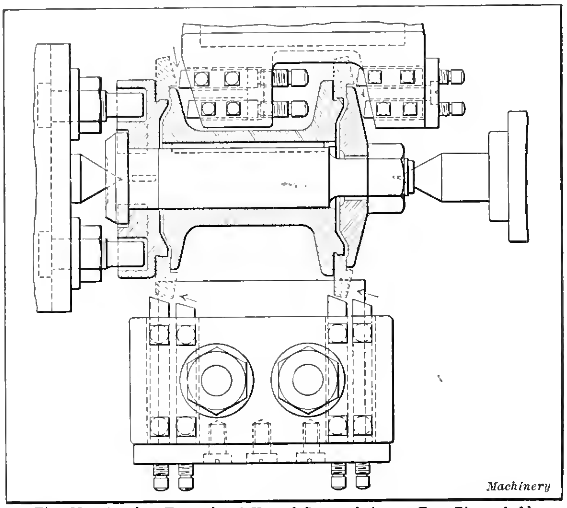

Fig. 25. Another Example of Use of Spacer between Two Pieces held on the Same Arbor

there is not enough room for three on account of the bosses for the wrist-pin. The bolt with the tapered slot is tightened by means of a nut having a slot in it, which can be reached from the end of the arbor when the fixture is taken out of the machine, by means of a special screwdriver. The tooling arrangement shown in the illustration is that provided for roughing the piston. The two tools in the front holder divide the roughing cut between them so that the feed motion needs to be only one-half of the length of the piston.

Fig. 20 shows a method used for supporting the overhanging rim of a long pulley. In this case the pulley is centered by the hole which fits the arbor, and the support must simply act as an equalizer. As will be seen, two floating collars, *A* and *B* are provided which are tapered on one side. This tapered side bears against pins *C* and *D*. As the collars are perfectly free to locate themselves with relation to the arbor, it is evident that the pressure on the pins (of which there are three for each collar) will be the same, and there will be no tendency to throw the work out of center, but to merely support it with equal pressure at the six bearing points.

Holders for Two Pieces of Work

In many instances it is possible to hold two pieces on the same arbor, thus practically cutting the time of machining in half. The simplest illustration of this is probably that shown in Fig. 21, where two gear blanks which have been faced on one side and have had the holes bored, are clamped together and faced on the other side and turned on the outside. The arrangement of the tools is of interest; the arrows shown give the direction of the feed and indicate the method of procedure. Fig. 22 shows another case where two pieces held on the same arbor are machined at the same time. A spacer is provided between the two pieces so as to locate the one to the right in position, the one to the left being located against a shoulder on the arbor. In order to use this arrangement for location, it is necessary for the work to have shoulders finished on two sides and also that the finishing be done accurately enough so that it can be used for locating

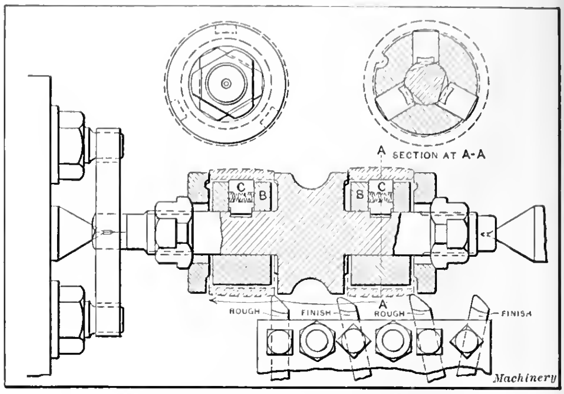

Fig. 26. Arbor for holding Two Pieces of Work which must be supported from the Inside

the two pieces. In this case both the clamping collar and the spacer are keyed to the arbor to make the drive more positive. In Fig. 23 this job is shown set up in the machine.

In Fig. 24 is shown another case of clamping two pieces using a spacer between them. It is evident that if the two sides of the hubs of the gear blanks had not previously been machined, this method could not be used as the gear blank to the right would not come in an accurate position to permit being machined by the tooling arrangement indicated.

In Fig. 25 is shown still another example of holding two pieces by means of a spacer. Here the roughing and finishing are done at the same time. The tools in the rear and front holders operate simultaneously, the taper attachment being used for the rear holder. A taper former is used on the former bar for the front tool-holder. Fig. 26 shows an especially interesting arrangement for holding two pieces and for sup-

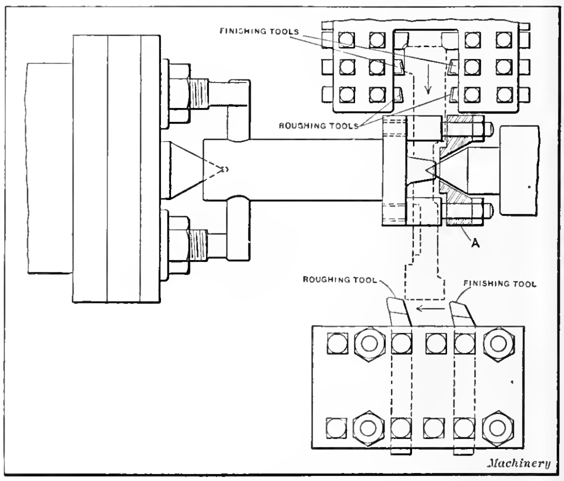

Fig. 27. Arbor for holding Small Flywheel while machining the Rim

porting the thin walls of the bushings while machining. In this case the ends and the inside of the bushing are rough. The only difficulty that was met with was to machine them without distorting them on account of the thinness of the metal. The bushings are both centered and supported by the rough inside surface. For this purpose bushings *B* are provided on the arbor. These bushings hold plugs *C* which are prevented from falling out of their seats by springs

when the pieces to be machined are to be removed from the arbor. The arbor itself is provided with three flat spots or bearings, as shown in the sectional view at the top. These act as cam surfaces when the arbor is turned and force the plugs outward, thereby centering and supporting the work on the inside. This arbor shows a different method than those shown in the previous examples for holding two pieces at once. Here the middle portion of the arbor is solid and provided with three bearing points on each side for the work. Then collars are provided at each end of the arbor with nuts for clamping the work. One disadvantage is present with this arbor. The dog at the driving end must be removed to take off the pieces nearest to the head. In practically all the other cases shown a driving pin driven into the arbor can be used, as the work is removed in the other direction.

Method of Holding a Narrow Flywheel

Fig. 27 shows an interesting method for holding a narrow flywheel for a motorcycle while machining the sides and the face. It is necessary to hold this piece in such a manner that it is not thrown out of true sidewise. At the same time the sides of the rim must be left partially free for machining. The difficulty of holding the rim true is due to the fact that the hole in the wheel is very short and provided with a short taper. If an arbor is made which projects through, it will be so small in diameter that it is likely to break off under a heavy cut, particularly if threaded on the end. The method by means of which this difficulty was overcome is shown in the illustration. The arbor is made with a projecting tapered end into which the tail center enters, and an equalizing collar *A* is provided which presses the wheel onto the tapered end of the arbor. One of the studs by means of which the equalizing collar is held against the end of the shoulder of the arbor acts as a drive for the flywheel by bearing against a central fin of the drop-forging. The studs pass through openings in the web of the wheel.

These examples indicate in a general way the various types of holding devices that are likely to be required in turning operations. While they do not cover special cases, they show principles that can generally be applied. It is apparent that if devices of this kind were more generally provided, the full advantage of the facilities offered by modern machine tools could be better realized. In cases of interchangeable manufacture, the arbors and methods of arranging the tools and operations can hardly be left to the decision of each individual workman, as there is much to be gained by a thorough study of the subject by those who give their entire attention to work of this character. E. O.

* * *

ADJUSTABLE FIXTURE FOR HOLDING IRREGULAR SHAPED WORK

Irregular shaped castings which must be machined, often present no apparently good means of holding by ordinary gripping appliances for drilling, shaping or milling. An ex-

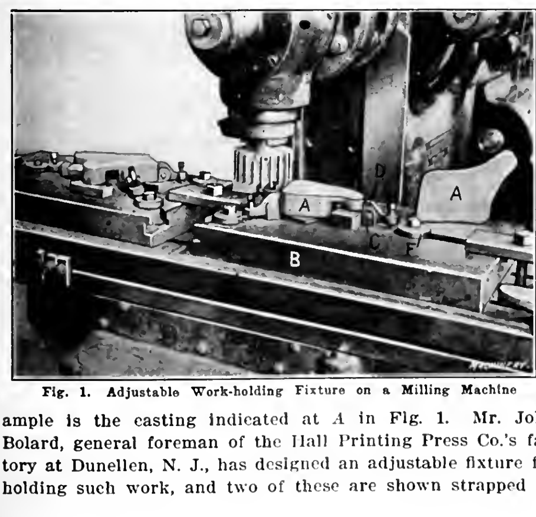

Fig. 1. Adjustable Work-holding Fixture on a Milling Machine

ample is the casting indicated at *A* in Fig. 1. Mr. John Bolard, general foreman of the Hall Printing Press Co.'s factory at Dunellen, N. J., has designed an adjustable fixture for holding such work, and two of these are shown strapped on the milling machine table in Fig. 1. The fixture consists of a base block *B*, which is T-slotted, three slots radiating from a central point. In each of these slots is fitted a gripping dog, illustrated in detail in Fig. 2. The base block *C* of the dog is slotted to receive jaw *D*, which is fulcrumed on a cross-pin. In the tail of the dog is threaded a set-screw *E*, and by turning in this set-screw the jaw is caused to "bite" inward and downward at the same time, firmly gripping the casting and forcing it down on the table. A back-stop *F* is bolted behind each dog so that there is no chance for slipping away from the work.

In Fig. 1 an efficient method of using this type of fixture is shown. Two fixtures are in use, and while the cut is being taken across one of the castings the second fixture is

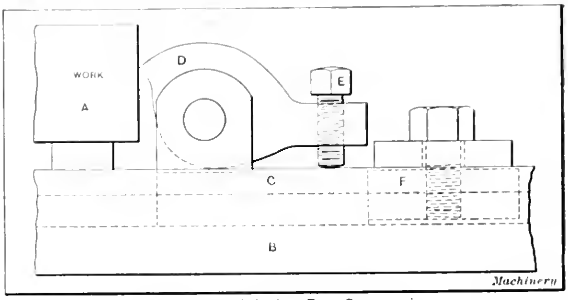

Fig. 2. The Gripping Dog Construction

being loaded and made ready for the milling operation. Similarly when a cut on the second casting is under way the casting previously milled is removed and a new piece inserted. It is only necessary to loosen one dog for removing the work. C. L. L.

* * *

"SWAT THE FLY" IN THE DRAFTING-ROOM

The common house fly is becoming recognized as one of the most deadly enemies of the human race. He is a carrier of germs of many diseases and filth of every kind. Experiments conducted in England with marked flies showed that they travel long distances and that sources of contagion may be far removed from the homes of those who become infected through them. "A single fly caught in a refuse can in a suburb of London gave no fewer than 116 colonies of bacteria and ten colonies of fungi, the germs being all collected from the bristles of the insect's legs and body or on its proboscis, as gathered while feeding on the refuse in the can. Flies are active carriers of tuberculosis, ophthalmia, anthrax cholera, infantile diarrhea, etc." Flies are pests in the drafting-room. They not only trouble the draftsmen, but feed on India ink, and have been known to damage tracings by sucking up the inked lines before they become dry. An instance showing how the fly may be responsible for errors in dimensions was recently brought to our attention. A drawing had been made with the dimensions 12", but when sent into the shop the dimension had mysteriously changed to 1.2". Investigation showed that a fly was responsible for the "decimal point." The moral is "swat the fly" in the drafting-room, but, better still, screen the drafting-room to prevent fly-specked drawings and to preserve the health of the draftsmen.

* * *

TWENTY-FOUR-HOUR TIME SYSTEM

A twenty-four-hour time system was recently introduced in France and is said to have given rise to some curious results. One of the troubles the Frenchmen have met with is the striking of the hour. It is apparently not practical to have clocks strike twenty-four strokes or thereabouts in succession because of the difficulty of counting. Numerous peculiar proposals have been made to avoid this trouble, for example, using a double chime, one bell for units and one for tens, the two bells to have different tones. It would seem that it would be feasible to permit the clocks to continue to strike in the same way as hitherto, as this could hardly cause confusion, but that does not seem to suit the French time reformers.

APPLICATIONS OF ELECTROMAGNETIC TRIPPING DEVICES

MECHANISMS WHICH PREVENT DAMAGING MACHINES OR PRODUCING DEFECTIVE WORK

BY GEORGE M. MEYNCKE*

In designing automatic machinery or automatic feeds for standard machines, the designer often faces the problem of providing a suitable device that will make his machine absolutely fool-proof and reliable. This is particularly true in the case of automatic machines where one operator looks after several units. While it is not claimed that purely mechanical means cannot accomplish the same results which are secured through the use of electromagnetic tripping devices, the mechanisms would necessarily be so complicated—as compared to the electrical devices described in this article—that they would be a source of endless trouble, if not impractical. Another advantage of the electrical devices lies in the fact that they may be used as a check on the accuracy of preceding operations and thus avoid finishing pieces of work that are defective. The application of electricity to automatic machines may be regarded as a complication in itself, but this is far from being the case if these tripping devices are properly applied.

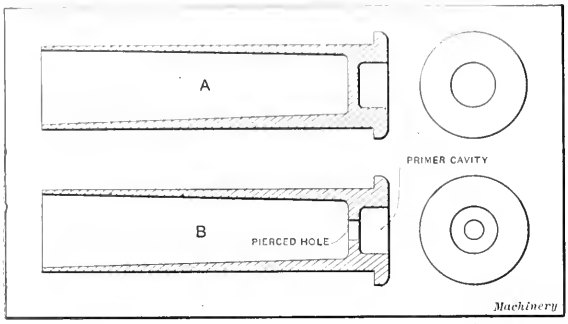

Fig. 1. Cross-sectional Views of Shell before and after piercing Primer Hole

The following examples are typical applications of electromagnetic tripping devices to automatic machines, and by studying these designs the reader will readily appreciate how similar tripping mechanisms could be applied to other classes of machinery; he will also appreciate how these devices put a check on the operation of the machines to which they are applied. In most of these examples, the tripping devices constitute part of attachments for standard machines that were converted into "automatics," thus dispensing with the necessity of an operator for each machine. Electricity performs the vital part of the work; it takes the place of the eyes of the operator and is far more satisfactory than eyes because electricity is more nearly infallible.

Fig. 1 shows a metallic cartridge shell A as it is received by the machine which pierces the primer hole, and a shell is illustrated at B on which the piercing operation has been performed. After the hole has been pierced, the primer is inserted in the primer cavity by the machine. These operations are performed on a standard Waterbury-Farrel cartridge primer. The shells were formerly placed on dial pins by hand and indexed under the crosshead for piercing and inserting the primer; they were then removed from the dial pins automatically. An improvement was made in the method of operation by applying an automatic feed mechanism to place the shells on the dial pins, but this did not dispense with the necessity of an operator for each machine, as there are three possible conditions that may result in the production of imperfect work: First, the feed mechanism might fail to deliver the shell to the dial pin, or the supply of shells might become exhausted, while primers would continue to feed and thus be wasted. Second, the piercing punch might break and the machine would then continue to place primers in the cavities of shells which had not been pierced, and such shells would obviously be useless. Third, the primer feed might fail to work properly, or the supply of primers might become exhausted.

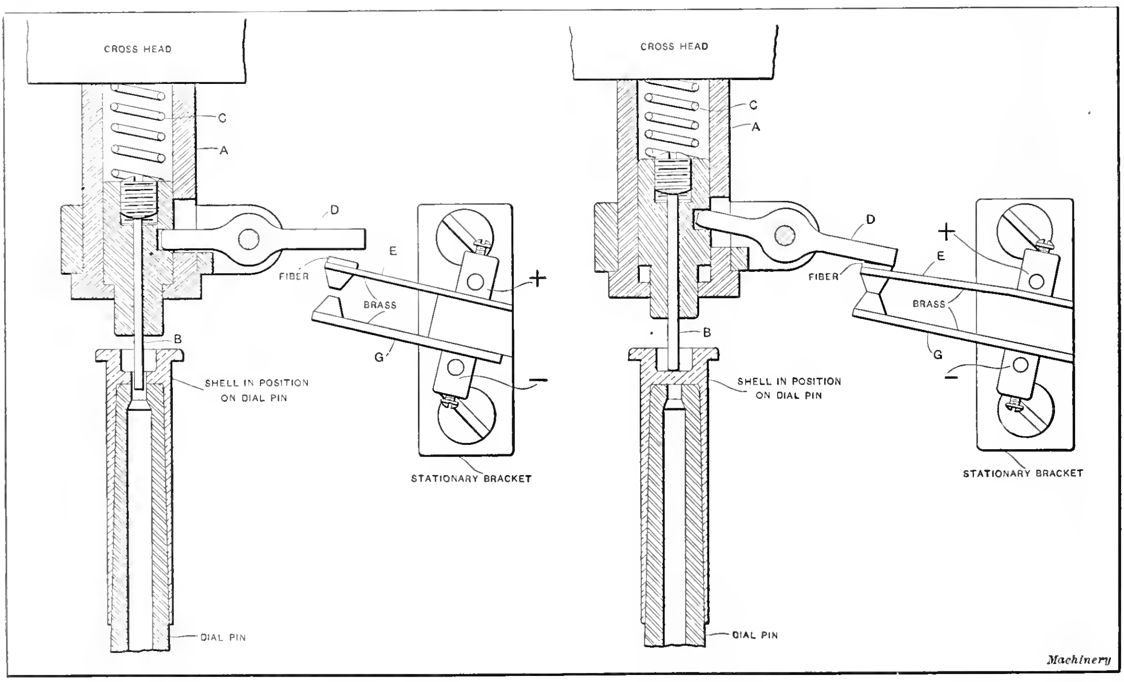

Fig. 2. Tripping Device which acts in Case of Failure of Punch to pierce the Shell, as shown in Right-hand Illustration

The application of a suitable electromagnetic tripping mechanism to this machine now takes care of all of these contingencies. First, we will consider the possibility of the feed mechanism failing to deliver a shell to the dial pin. Referring to Fig. 3 it will be seen that the shells are carried on index points of the dial which carry them under the punch A. If a shell is in its place on the dial pin it con-

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tracts the spring *B* when the ram descends, but should the mechanism fail to deliver a shell to the pin, the sleeve *G* passes down over the dial pin and pushes the upper contact *D* of the tripping mechanism down upon the lower contact *E*. This closes the electrical circuit and stops the crosshead on the up-stroke. The contacts are fastened to the frame of the machine and the method by which the tripping mechanism operates will be described in detail later. The way in which the piercing operation is safeguarded by the electromagnetic tripping mechanism is illustrated in Fig. 2. The punch holder *A* is located at the index point immediately after the completion of the piercing operation. If a shell is pierced, the pin *B* descends through the hole in the shell, as shown at the left-hand side of the illustration; but if the piercing operation does not take place, the punch is held in the position indicated in the right-hand illustration, thus contracting the light spring *C* and throwing the lever *D* against the contact *E*. This closes the electrical circuit and causes the machine to be stopped so that shells cannot have primers inserted in them when the primer hole has not been properly pierced. The failure of the machine to feed a primer into the primer cavity of the shell is guarded against by the mechanism illustrated in Fig. 4. The design

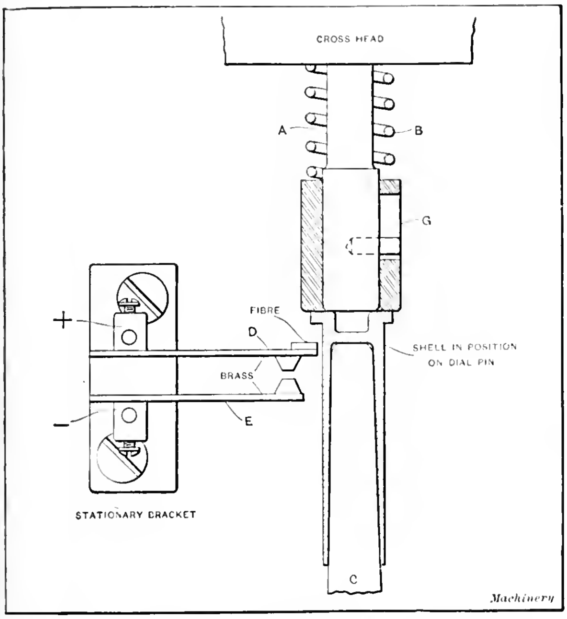


Fig. 3. Tripping Device which acts when a Shell has not been placed on Dial Pin

of this tripping mechanism is practically the same as that used to control the piercing operation and will be readily understood without further description.

Fig. 5 illustrates a press which is used for assembling the brass cups *A* and *B*, the cup *A* being inserted in the cup *B*. These cups are held in hoppers on each side of the machine from which they are taken by notched dials. The cups *A* are dropped into holes in the machine dial which passes over the dial carrying the cups *B*. We will not go into the method by which the machine operates here, it being sufficient merely to state that a plunger descends in such a manner that the cup *A* is forced into place in cup *B*. It will be readily seen that several conditions may occur that will result in loss or damage, *i. e.*, the feed mechanism could fail to deliver either one or both cups to their respective dials, or it could deliver them to the dials in an inverted position. Fig. 5 illustrates how either the absence or inversion of either or both cups is detected by an electromagnetic tripping device which automatically stops the machine until the error has been corrected. The punch *C* is located at an index point preceding the assembling punch and is carried by a bracket which is fastened to the crosshead. In the case of an inverted cup, the punch *C* is held on the bottom of the cup and pulls the rod *G* down through the action of the pinion, which engages with rack teeth cut in the rods *C* and *G*. The descent of the rod *G* causes the contact closer *F* to pull down the upper electrical contact until it closes the circuit and causes the machine to be stopped. The right-hand illustration shows a detail of the punch and die when the feed mechanism has failed to deliver a cup to the dial plate. In this case, the upper electrical contact is pulled

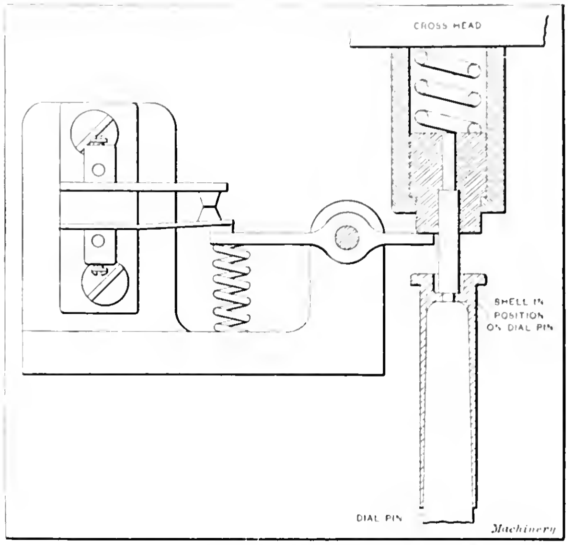


Fig. 4. Trip which prevents passing on a Shell without a Primer

down by the contact closer *H* and causes the machine to be stopped as previously described.

Fig. 6 shows the electromagnetic tripping device used on the machines referred to in the preceding paragraphs. In this illustration, the tripping device is shown in place on a power press equipped with a Horton clutch. The design and contraction of the tripping mechanism will be more readily understood by referring to Fig. 7, which shows an end and

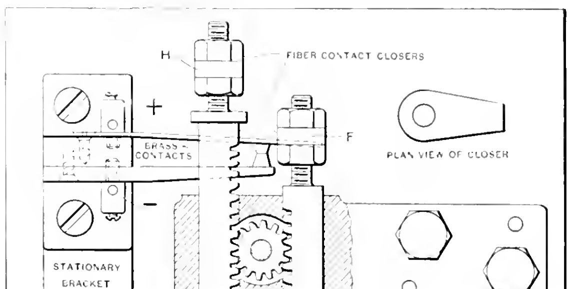


Fig. 5. Trip used on Machine for assembling Shells A and B

cross-sectional view. This tripping mechanism is self-contained and can be applied to any style of press or type of machine. It will be seen that the bracket *A* carries the magnet *B*, pole-piece *C*, and levers *D* and *E*. The brass pole *G* is wound with No. 14 double-covered wire and the lead wires are carried off through the back of the spool. The

brass pins H help to support the pole-piece C and provide adjustment for different widths of air gap which should be as small as possible. In order to start the press, the lever E is pulled down. This pulls out the flywheel clutch (see Fig. 6) and allows the spring J to pull the lever D over the hardened knife-edge, thus setting the pole-piece C at the proper working distance from the magnet. The inside dimensions of the device are given in Fig. 7, and when the magnet is energized by two dry cells, it gives an initial pull or jerk of from twelve to fifteen pounds. As the dry cells are used on open-circuit—except for the fractional part of a second during which the contacts meet—they have a long life.

The initial pull provided by an electromagnet of this kind varies with the material used for the magnet and pole-piece. Where cast iron is used, the pull of the magnet can be calculated by the formula:

$$NI = 3000\ Z\ \sqrt{P \div D}$$

in which N = number of coils of wire on spool (ampere-turns);
I = current in amperes;
P = pull in pounds;
Z = air gap in inches;
D = diameter of plunger in inches.

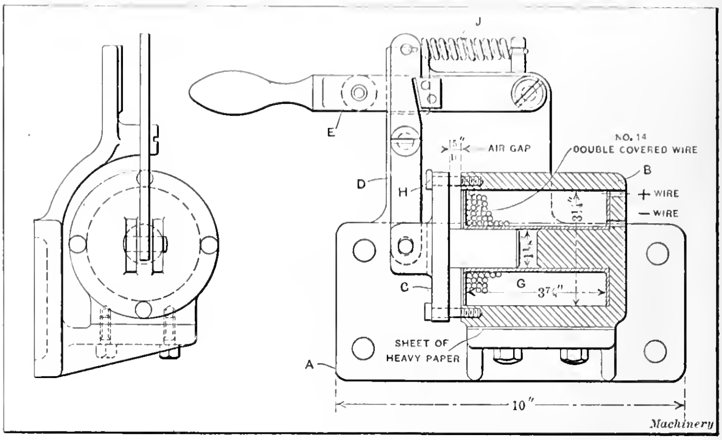


Fig. 7. End and Cross-sectional Views of Electromagnetic Controller

The electromagnet shown in Fig. 7 was designed to give a pull of fifteen pounds, and it will be seen that $Z = 5/16$ inch and $D = 1.125$ inch. Then $NI = 3000 \times 5/16\ \sqrt{15 \div 1.125} = 3423.19$ ampere-turns.

Assuming that there are 375 turns of wire on a spool, the amount of current required will be found to be $\frac{3423.19}{375} = 9.14$ or, say, ten amperes. Two good dry cells connected in series will average fifteen amperes during their useful life and give a considerably higher current when new. As ten amperes is sufficient to enable the electromagnet to do the work required of it, it will be seen that an ample factor of safety is provided. When designing devices of this kind, moving wires and moving contacts should be avoided and the mechanism should be made as simple as possible. The dry cells should be used on open circuit, the contacts carefully insulated from the machine and covers provided for contacts and terminals.

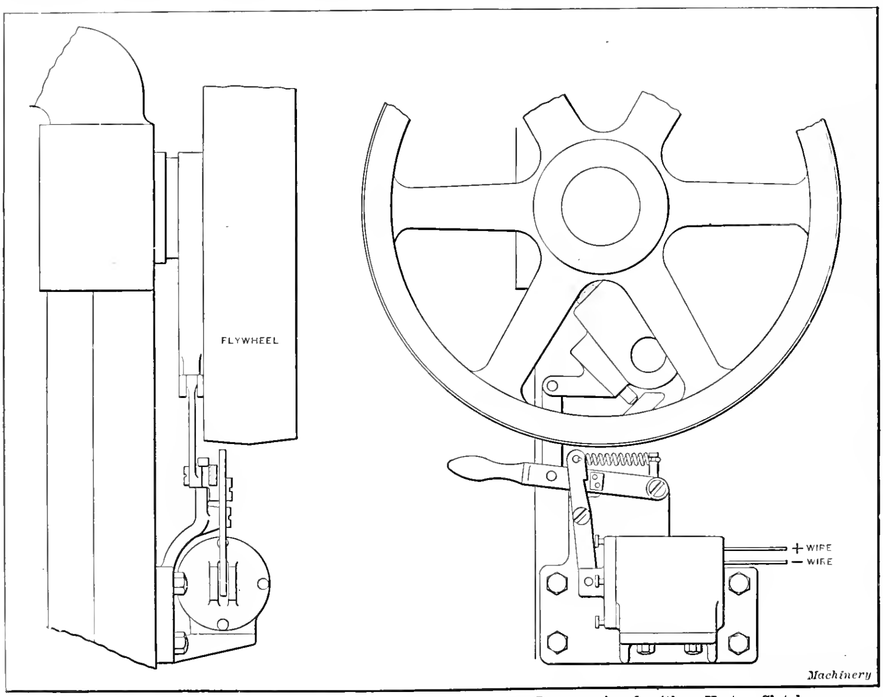


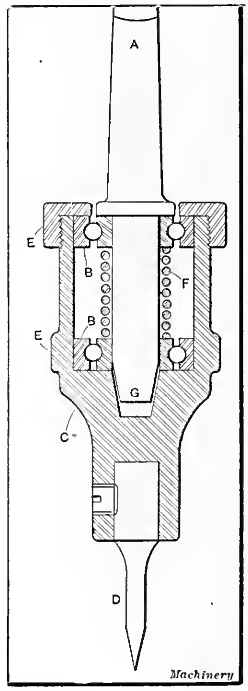
Fig. 6. Electromagnetic Tripping Device applied to Power Press equipped with a Horton Clutch

FRICTION DRIVEN POWER SCREWDRIVER

BY W. ALTON

The following is a form of screwdriver that will be found useful where there are a large number of screws to be put into parts that are small enough to handle under a drill press. It consists of an arbor with a taper shank A fitted to the drill press spindle in which it is desired to use the tool. The opposite end G of the arbor is tapered to fit a corresponding recess in the body C of the tool. The arbor runs in ball bearings B, the outer race of the left-hand bearing being a sliding fit in the body C and the inner race of the right-hand bearing being a sliding fit on the mandrel. The tapered clutch end G of the mandrel is kept out of engagement when the tool is not in use by the spring F.

The body of the tool can be stopped to engage the screwdriver D with the slot of the screw by grasping it around the knurled portions E, but in practice this is hardly necessary as the screwdriver will usually engage the screw if fed down on it. A further advantage is that the clutch will release when the screw is driven in. This tool is easily made and will be found a time saver in doing the class of work for which it was designed.



Screwdriver used in Drill Press

MACHINE FORGING—6

DIES AND METHODS EMPLOYED IN THE FORMING, WELDING AND UPSETTING OF MACHINE AND ENGINE PARTS

BY DOUGLAS T. HAMILTON*

The forming and welding operations illustrated and described in the following represent some of the interesting applications of upsetting and forging methods to the production of locomotive and car parts. Three methods of welding parts are given, which practically covers the entire range handled. Mention is also made of the important part filled by bulldozers and steam hammers in the production of many parts, and of their close connection as manufacturing auxiliaries to the forging machine.

Fig. 70. Miscellaneous Examples of Lap-welding and Forming Operations accomplished on a 6-inch Ajax Universal Forging Machine

Miscellaneous Lap-welding and Forming Operations

The miscellaneous welded and formed parts shown in Fig. 70 were secured in the Chicago shops of the C. & N. W. Railway through the assistance of A. L. Guilford, manager of the Chicago office of the Ajax Mfg. Co. The forging dies and tools shown in the following illustrations constitute a few of the many interesting examples to be found in the shop mentioned, and represent the results of the endeavors of T. E. Williams, master smith, to decrease the cost of forged engine and car parts. All of the examples shown in Fig. 70 were produced on the 6-inch Ajax universal forging machine shown in Fig. 71.

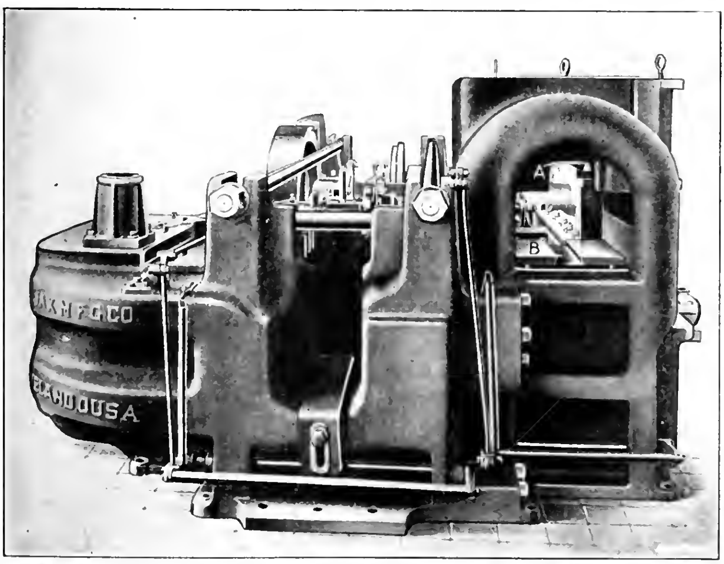


Fig. 71. Six-inch Ajax Universal Forging Machine used in the C. & N. W. Railway Shops for making the Forged Parts shown in Fig. 70

Universal Type of Upsetting and Forging Machine

The universal type of upsetting and forging machine shown in Fig. 71 has a much greater range of possibilities for producing machine-made forgings than the regular upsetting and forging machines previously described. This machine has the features common to the regular forging machine in combination with those of a powerful vertical press operated independently of the other part of the machine. The universal forging machine is designed especially for forming such forgings as require squeezing, punching or trimming operations either before or after upsetting. This often makes it possible to prepare and complete large upsets and difficult shaped forgings in one handling, and thus utilize the initial heat.

In construction, it consists mainly of a double-throw crankshaft from which are operated two header slides—one for the standard upsetting mechanism and the other for the vertical press. The upper die-holder *A* of the vertical press is operated by two heavy steel side links, the lower ends of which connect with eccentrics on an oscillating shaft. This die-holder is provided with means of adjustment so that the squeezing dies can be brought together or separated as requirements demand. The lower member of the dies used in this auxiliary part of the machine is held on the stationary die-holder *B*.

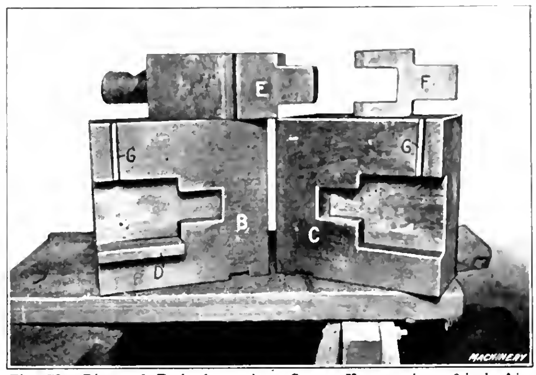


Fig. 72. Dies and Tools for making Spring Hangers in a 6-inch Ajax Universal Forging Machine

Dies and Tools for making Spring Hangers

An interesting example of the utilization of scrap metal for making engine parts is the spring hanger *A*, Fig. 70. This part is made from old arch bars 1 by 4 by 5 inches, with the dies and tools shown in Fig. 72. Six blocks cut off from the arch bars are piled together and riveted as shown at *A* in Fig. 73, the old holes in the arch bars serving as a means for riveting them together. This is done to hold the separate blocks in place while a welding heat is being taken. After the parts have reached the proper temperature they are taken to the universal forging machine shown in Fig. 71, and placed between squeezing dies held in the vertical press. The machine is then operated, welding the pieces together and converting them into a solid block as shown at *B* in Fig. 73.

After the separate pieces have been welded and shaped, the solid block is again taken to the furnace and heated to a welding temperature. Then it is removed and placed between the opposing faces of the gripping dies *B* and *C* shown in Fig. 72, these being held in the forging machine shown in Fig. 71. The stationary gripping die *B* is provided with the shelf *D* on which the heated block is placed, this serving to hold it while the dies are coming together. As soon as the dies close on the work, plunger *E* advances and displaces the stock in

*Associate Editor of MACHINERY.

such a manner as to form the tail on the end of the forging *F* by simply forcing the center portion of the block back into the rear impressions in the gripping dies. This is accomplished in one heat, and when the piece is removed from the dies it is finished complete. Vent holes *G* are provided in the opposing faces of the dies to allow the excess metal to escape.

Another example of a spring hanger forging is shown at *B* in Fig. 70, the dies and tools used being shown in Fig. 74. The first operation in the production of this spring hanger is drawing the 2-inch wrought-iron bar *A* down to the shape shown at *B* in Fig. 75 in a Bradley steam hammer. This piece, after being drawn down is heated and placed in a bulldozer, where it is bent into a U-shape as shown at *C*, the heaviest part of the piece being located at the bent end. The one-inch hole is punched through the bent end at the same time that the work is being formed. The body or shank of the hanger is made from a 1 by 4-inch piece of round edge iron *D* which is swaged down on a 4-inch forging machine to $1\frac{3}{4}$ inch round for a length of about 7 inches on one end, as

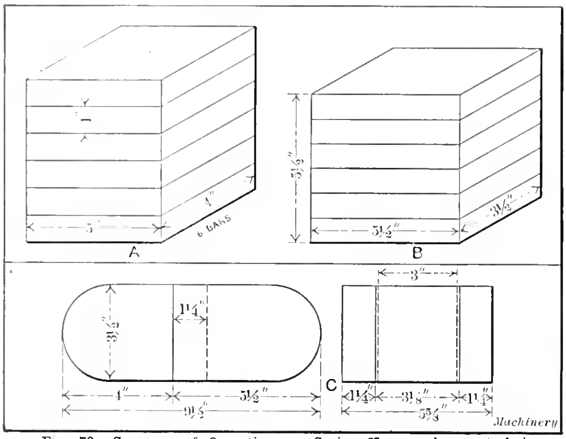


Fig. 73. Sequence of Operations on Spring Hanger shown at A in Fig. 70 and also in Fig. 72

shown at *E*. The bar is then heated, placed in the forging machine and upset to 2 inches in diameter in order to completely form the reinforced portion on the flat part, and at the same time reduce the end to one-inch in diameter by $2\frac{1}{4}$ inches long. The reduction on the end of the bar is accomplished with the plunger held in the ram of the machine.

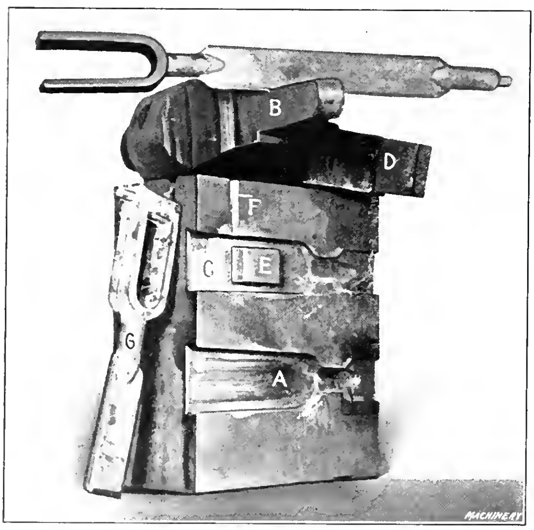


Fig. 74. Dies and Tools used in making Spring Hanger shown at B in Fig. 70—also illustrating Pin Welding Operation

The loop *C* is now placed on the reduced end of the rod as shown at *G* and is riveted cold, just enough to hold the two pieces together while a heat is being taken. The work is then raised to a good welding heat, and is quickly placed in the lower groove *A* (see Fig. 74) of the dies held in the 6-inch forging machine shown in Fig. 71, where the work is formed by plunger *B*. The reason for doing this work in a 6-inch forging machine is that the plunger travel necessary is 14 inches, and this would be impossible on a smaller machine than that having a 6-inch capacity. This 14-inch travel, of course, is after the dies have been closed on the work. After the two pieces are welded together as shown at *H* (Fig. 75) a block *a* of 2-inch square iron 3 inches long is placed in the

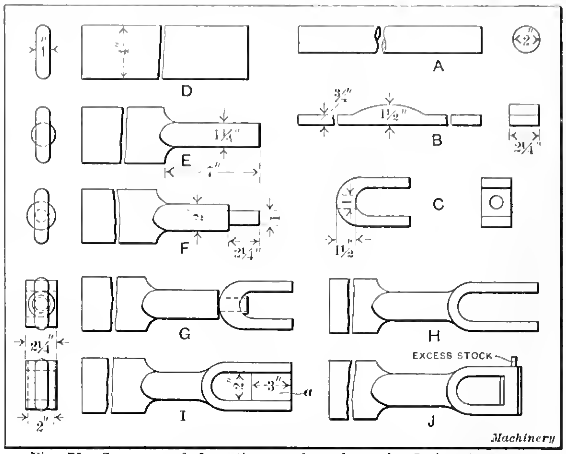


Fig. 75. Sequence of Operations performed on the Spring Hanger B shown in Figs. 70 and 74

U-end of the forging as shown at *I* and a welding heat taken. The work is then placed in the upper groove *C*, Fig. 74, of the dies and as the plunger *D* advances it upsets the forging to the proper shape around the embossed center portions *E*, the excess metal flowing up through the vent holes *F* provided in the gripping dies. The finished forging is shown at *J* in Fig. 75.

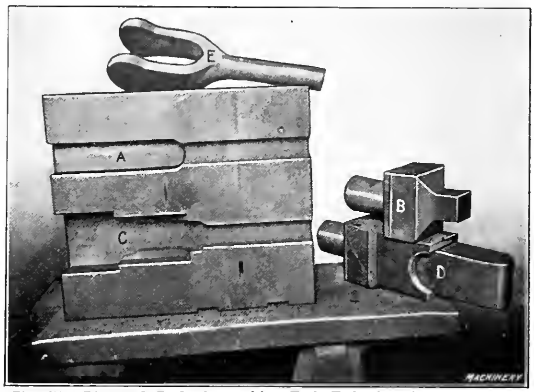


Fig. 76. Dies and Tools for making Fork End of Main Driver-brake Pull Rod shown at D in Fig. 70 in a Forging Machine

Still another type of spring hanger which is completed in the forging machine is shown at *C* in Fig. 70. This is made from a rectangular bar of wrought iron which is first lapped over and then welded, after which the eye end is formed to shape on the forging machine. The square hole is rough-formed by the vertical press of the universal forging machine shown in Fig. 71, and is then finished in the upper impression in the dies held in the horizontal part of the forging machine. No material is removed to form the square hole, the metal simply being expanded, increasing the width of the bar.

Dies and Tools for making Fork End of Main Driver-brake Pull Rod

The fork end of the main driver-brake pull rod shown at *D* in Fig. 70 is made from a $2\frac{1}{4}$-inch bar of round wrought iron which is first squeezed down flat on one end until the flattened end is 3 inches wide by 14 inches long. This operation is handled in the vertical head of the machine shown in Fig. 71. A piece of $\frac{1}{2}$ by 3 by 14-inch wrought iron is laid on the flattened portion of the bar (both pieces, of course, being heated) so that they can be stuck together by the dies held in the vertical head of the universal forging machine, thus holding them while the welding heat is being taken. The next step in the production of this fork is to increase the diameter of the rod from $2\frac{1}{2}$ to 3 inches square. This opera-

tion is accomplished in the upper grooves A of the dies shown in Fig. 76, using the plunger B for upsetting. The 3-inch squared end is now split for about 9 inches of its length with suitable tools held in the vertical head of the machine, and at the same time is opened up slightly. The piece is then taken

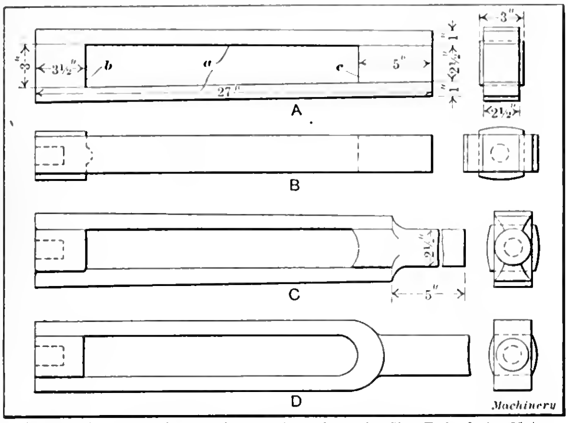


Fig. 77. Sequence of Operations performed on the Slot End of the Main Driver-brake Pull Rod shown at E in Fig. 70

to the furnace and heated, after which it is placed in the lower grooves C of the dies, and with one blow of plunger D is brought to the final shape as shown at E.

Dies and Tools for making Slot End of Main Driver-brake Pull Rod

The slot end of the main driver-brake pull rod shown at E in Fig. 70 is made as shown in Fig. 77 from two pieces a of

Fig. 78. Butt-welding Bottom Connecting-rods in an Ajax Forging Machine in the Collinwood Shops of the L. S. & M. S. Railway

1 by 2½-inch flat bar iron 27 inches long, one piece b of 3-inch square iron 3½ inches long, and one piece c of 2½-inch square iron 5 inches long. The two pieces a are clamped by a pair of tongs on the end where the block c is located and a welding heat is taken on the other end. The work is then removed from the furnace by the tongs and quickly placed in the top groove of the dies. The machine is operated and as the plunger, which has a punch on its front end, advances, it punches a hole in the work and displaces the stock, forming a boss on each side as indicated at B. The position of the tongs on the work is then reversed and the other end of the forging is heated, after which it is swaged to 2½ inches in diameter for a distance of 5 inches on this end to the shape shown at C. This operation is handled by the gripping dies which are provided with circular grooves located between the upper and lower impressions. The forging is again heated and placed in the lower impressions of the dies, the round part entering the plunger. The machine is then operated, forming the forging to the shape shown at D.

Butt-welding Bottom Connecting-rods

In the fifth installment of this article, which appeared in the September number of MACHINERY, it was mentioned that butt-welding is seldom accomplished on forging machines, owing to the difficulty generally experienced in successfully making this type of weld. The bottom connecting-rods shown in Fig. 78 and also at F in Fig. 79, are produced satisfactorily by butt-welding in the Collinwood Shops of the L. S. & M. S. Railway, so that a description of the method used in handling will no doubt be appreciated. The stock for the forked ends A, Fig. 79, is sheared off from a bar of 2½ by ¾-inch wrought iron and bent to a U-shape in the bulldozer. The center portion of this connecting-rod is made from 1¾-inch round wrought-iron bars which are also sheared to the required length before coming to the forging machine.

The U-shaped pieces A and bars B are now placed in the furnace G, Fig. 78, where they are heated to a welding temperature. The operator then removes a rod and also a U-shaped piece and butts them together as indicated in the illustration; he then places the pieces which are stuck together in the impressions in the gripping dies C and D, Fig. 79, and operates

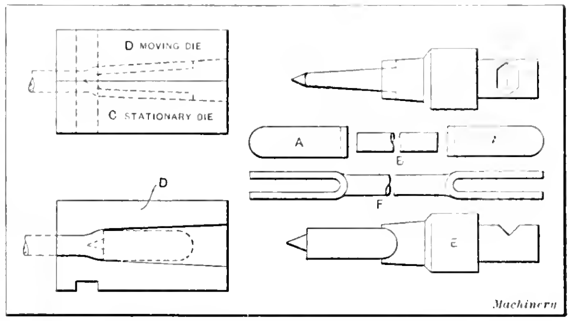


Fig. 79. Illustrations showing Sequence of Operations in the Butt-welding of Bottom Connecting-rods, shown in Fig. 78

the machine. Now as plunger E, which has a pointed end, advances it forces itself through the fork into the round stock, thus intermingling the grain of the material and insuring a solid weld. To prevent scale from forming on the pieces to be welded, a small jet of compressed air is made to play on them just before and while the machine is operating.

After welding, the work is removed from the gripping dies and placed between suitably shaped forming dies held in the side shear H, Fig. 78. The machine is then operated, forming the U-shaped end to the proper shape, after which the piece is thrown down in the sand to cool off (see I, Fig. 78). After all the rods have been completed in this manner, the other or straight end is placed in the furnace and the procedure followed that was previously described. The completed bottom connecting-rods are shown at F in Figs. 78 and 79, respectively. To prove that this type of weld was satisfactory, numerous tests were made to break it at the welded joints.

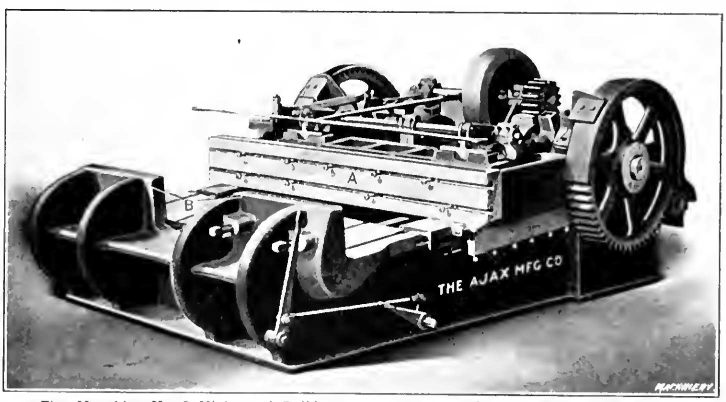


Fig. 80. Ajax No. 7 High-speed Bulldozer—an Important Adjunct to the Forging Machine

This was not accomplished until the testing machine registered a pull of 74,000 pounds, which is equivalent to a tensile stress of approximately 30,000 pounds per square inch. As the tensile strength of wrought iron seldom exceeds 48,000 pounds

per square inch, it will readily be seen that this type of weld would be satisfactory for the general run of forged work.

Bulldozer as an Auxiliary to the Upsetting and Forging Machine

Considering that so many parts completed on the forging machine can be handled successfully only when partially formed by the bulldozer it may not be out of place to include a short description of this type of machine. Fig. 80 shows the type of bending and punching machine known as the bulldozer, which is used so extensively as an auxiliary to the forging machine in the manufacture of many forgings.

The construction of this type of machine is simple, consisting primarily of a moving crosshead A which carries one member of the forming dies, the other member of the forming dies being held against the toes B of the machine. The operations are accomplished by the forward travel of the crosshead, the work as a general rule being completed in one travel of the head. Of course while the machine is fairly simple in construction and operation, many types of interesting forming tools are used. However, it will be impossible to go into this subject fully in this article, as it is necessary to confine our attention more particularly to the forging machine rather than to its auxiliaries.

The forming tools for the bulldozer can generally be made cheaper and more conveniently from cast iron, especially when they are provided with hardened steel plates where any friction takes place—that is, those parts of the tool which actually do the forming or shaping should, as a general rule, be reinforced with hardened steel plates. This enables the tools to be renewed very cheaply, as the plates when worn out can be replaced by new blocks of steel. The roller type of tool which is carried and operated by the crosshead is the best for saving material and power when it is possible to use this type. However, the type of tool to use depends largely on the shape to be formed and other requirements. In all cases where hot punching or cutting is done, high-speed self-hardening steel should be used for the working members of the tool.

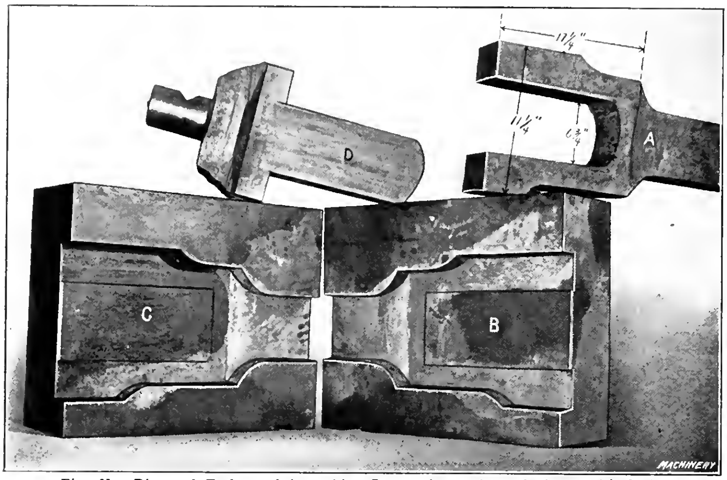


Fig. 81. Dies and Tools used in making Locomotive Main Rods in the 6-inch Ajax Universal Forging Machine

Tools for making Engine Main and Side Rods in the Forging Machine

The locomotive main rod shown at A in Fig. 81 is the largest piece of work ever handled in a forging machine in the Chicago shops of the C. & N. W. Railway. The main rod is first roughed out under a steam hammer and the end split before it is brought to the forging machine shown in Fig. 71. The roughing out of the slot and the finish-forming in the forging machine are done in one heat. In the forging machine the work is gripped by the dies B and C and is upset and formed to shape by the plunger D.

Another good example of heavy forging accomplished in the Ajax 6-inch universal forging machine is the locomotive side rod shown at A in Fig. 82. This side rod is made from square stock drawn down to the required size under the steam hammer, and is upset and formed on each end in the forging machine shown in Fig. 71. The gripping dies, only one of which is shown at B in Fig. 82, are used for forming the end C of the rod. It requires two operations to complete this end. The first operation is performed in the lower groove D of the dies and consists in rough-forming the slot with the plunger E. The work is then placed in the upper groove F and completely formed to shape by means of plunger G.

The other end H of the side rod is upset and formed to shape by another set of dies—only one of which is shown at I. The rod, which is heated to a welding temperature, is placed in the impressions in the gripping dies and is upset and formed to the required shape by means of the plunger J. These two examples of machine forging illustrate very well the adaptability of the forging machine to locomotive manufacture.

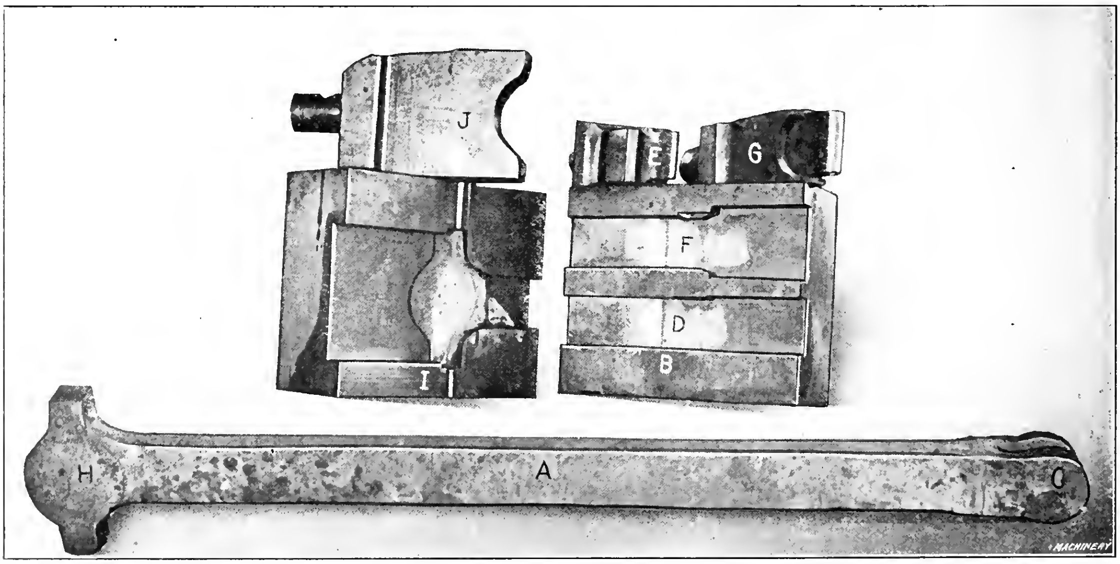


Fig. 82. Dies and Tools used in the Ajax 6-inch Universal Forging Machine for making Locomotive Side Rods in the C. & N. W. Railway Shops

HANDLING A LARGE TURRET LATHE JOB

At the shops of the United States Light & Heating Co., Niagara Falls, N. Y., some very interesting turret lathe work is handled on Warner & Swasey machines. One of these jobs in particular is unusual because of the extreme size of the work, and the number of tools in the set-up. The tool set-up is shown in Fig. 1, and the piece in question is illustrated in Fig. 2 which shows the work in section and the chuck in side elevation. This is an aluminum casting, being a mounting frame for an electric starter for automobiles. The casting is 18 inches in diameter over-all, and is machined on ten surfaces. These surfaces are finished with eight tools, all of which cut simultaneously.

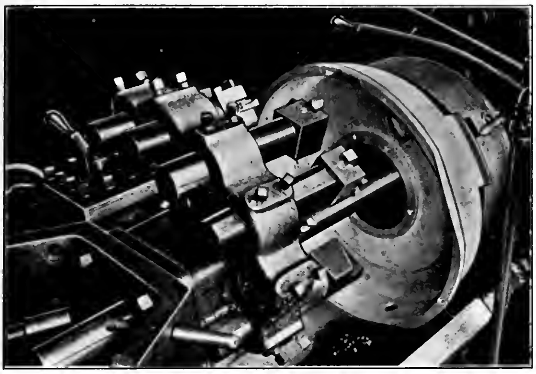


Fig. 1. A Turret Lathe Job and the Special Tools employed

The entire machining is accomplished without indexing the turret so that the operation is very simple after the tools have once been set up. Referring to Fig. 1, it may be seen that five of the tools are supported from the special turret bracket, which is, in turn, bolted to one of the turret faces. The sixth tool is mounted on a boring-bar that is supported from the turret, and the seventh and eighth tools are held in the front carriage of the turret lathe. On account of the size and thinness of the walls of the casting, it is somewhat difficult to support it, and the gripping is done from the inside of the central hole, as shown in Fig. 2.

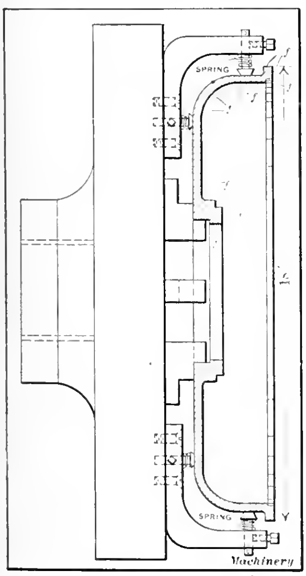


Fig. 2. How the Piece was held to eliminate Vibration

The machining of a casting or shell with thin walls is always productive of chatter. As chatter is one of the chief causes of the dulling of tools, it is important to reduce it to a minimum. This is done by providing spring pins that extend from four brackets supported from the chuck body and spaced equidistantly around the casting. From each of the brackets two pins extend, one against the back and the other against the side of the casting. After the piece has been chucked, allowing the pins to bear against the work, setscrews are tightened, thus backing up the work securely and supporting it while being turned. These pins serve to obviate the vibration which would otherwise occur. Two of the sets of spring pins and brackets are illustrated in Fig. 2, but do not appear in Fig. 1. For a cutting lubricant "Magic" compound is used with excellent results.

The work was formerly performed upon a large engine lathe, and the output was but ten pieces per day when done in this manner. On the Warner & Swasey 3-A machine, however, the output is seventy-five pieces per day, and the production is more accurate. C. L. L.

* * *

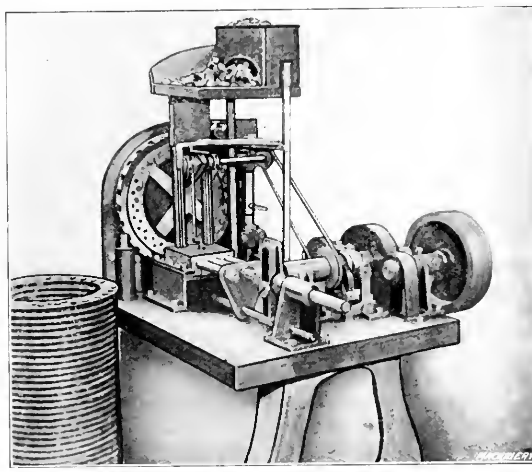
INSERTING CORKS IN CLUTCHES

BY H. F. HINES*

The illustration shows a semi-automatic machine for inserting corks in the steel disks of multiple automobile clutches. These disks have fifty-six holes 7/16 inch in diameter, the holes being staggered as shown in the partially filled disk mounted in the machine. The corks used for these clutches are 11/16 inch in diameter before they are compressed to be forced into the disk.

The operation of the machine may be briefly described as follows: The disk is placed on the revolving head of the machine and located by two small plungers, after which it is securely clamped in position. The locating plungers enter holes on opposite sides of the disk and when the corks are inserted in these holes they push the plungers back. The head which carries the disk is automatically indexed by means of a lever and pawl. This index mechanism is actuated by a cam on the crankshaft, the head being indexed after each stroke of the plungers which press the corks into the disk.

The corks are placed in a hopper at the top of the machine which delivers them to two feeding chutes, small wire brushes being provided to force the corks through the chutes into the slides in which the plungers operate. As the corks drop in front of these plungers on their forward stroke, they are driven through tapered bushings which reduce their diameter from 11/16 to 7/16 inch—the size of the holes in the disk. As the fit of the corks in these bushings becomes tight, it causes the slide to be pushed up against the disk, and as the plungers continue their forward stroke, they force the corks into place. As soon as the plungers start on their return stroke, a small catch pulls the slide off the ends of the corks which project from the disk and thus allows the disk to be indexed by the time the plungers have reached the end of their return stroke and are ready for the next operation.



Special Machine for inserting Corks in Automobile Disk Clutches

It will be seen from the illustration that the crosshead which carries the plungers is operated by a crank on the end of the main driving shaft, the action of the machine being controlled by a foot treadle which operates a clutch on the driving shaft. The machine will continue to run as long as the treadle is held down, but stops at the end of the first return stroke which is made after the treadle has been released. The machine runs at about forty strokes per minute, and as two corks are inserted at a time a disk is completely filled in about forty seconds. The efficiency of the machine is indicated by the fact that it has made a record of filling four hundred disks in 9 hours 20 minutes, requiring the insertion of 22,400 corks.

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THE DUTIES OF A FOREMAN

Just exactly what the duties of a foreman are depends, of course, largely upon the conditions in various shops. In some, he may be selected largely because of his mechanical knowledge and of his ability to direct the work from a mechanical point of view. In others, the work may be of such a nature that his mechanical qualifications are of minor importance, but his general executive ability is of greater value. It is certain, however, that the foreman should not be selected because of his ability as a clerk; and yet in many shops a large proportion of his time is occupied by work that is purely clerical: making out reports, keeping records, filling in and signing stock orders, etc. In fact, he does work which could and should be done by men who do not possess his qualifications for mechanical training or executive ability, leaving him free to devote himself to the greater task of managing his department.

It is in line with good management, whether it be "scientific" or otherwise, to relieve superintendents and foremen of their clerical work and permit them to devote their time and energy to running their departments and to obtaining the highest efficiency. It is poor policy to save the pay of an ordinary clerk at the expense of having the whole department, where scores of men are employed, run in a haphazard way. There are too many cases where this condition exists, and there are even so-called "well managed" shops that require their foremen to spend nearly half of their time in doing work that a clerk receiving one-third the pay could do with equal efficiency.

* * *

PANAMA-PACIFIC INTERNATIONAL EXPOSITION

The Panama-Pacific Exposition to be held in San Francisco in 1915 promises to be an event of unusual international importance, notwithstanding the fact that Great Britain and Germany have refused to participate. It will mark the beginning of a new period in the world's commerce. The diversion of ocean trade through the Panama Canal will undoubtedly have a profound effect on the commerce of the world in general and that of the United States in particular.

World's fairs have been promoted freely during the past twenty years and such enterprises have undoubtedly been overdone in Europe, but it should be remembered that none of those held during the past five years has had the international significance of the event to occur in 1915. This exposition will bring the East and the West closer together, open new avenues of trade and broaden those already open. The liberal policy of the exposition management with regard to small exhibitors in permitting a number to club together and exhibit in one space with all the rights and privileges of independent exhibitors should encourage many to show their products, who under the ordinary conditions of exhibition at world's fairs would not or could not do so.

The exhibition will be on a vast scale. The machinery building alone will have nearly eight acres of floor space. All parts of the building will be served by adequate crane facilities, and electric current both alternating and direct, and gas and water will be available in all parts of the building. Compressed air and steam will be provided adjacent to the gas and fuel section, and general illumination will be provided by the exposition company. Eastern manufacturers interested in developing trade in the Pacific coast states will largely embrace the opportunity to make their products known and at the same time become personally acquainted with the conditions of Western and Oriental business.

* * *

A GERMAN VIEW OF SCIENTIFIC MANAGEMENT

It has been said that one must go to Germany to see American systems of factory management carried out to their full possibilities and logical conclusion. It has also been said that when the Germans begin to adopt the scientific management system developed in America they will organize their factories along these lines much more rapidly and efficiently. The reason given for this is that the German people, on account of their temperament and training—their military services and consequent habits of obedience to superiors—would fit into a system of scientific management much more readily than would Americans. While no doubt there is considerable truth in these assumptions, prominent Germans themselves do not believe that the "millennium" of scientific management will arrive very quickly. Prof. Schlesinger, who presented a paper on this subject at the joint meeting of the Society of German Engineers and the American Society of Mechanical Engineers at Leipzig the past summer, dwelt on the point that no matter how well adapted a people may be to work under this system, the great difficulty of securing properly trained managers for installing the new system and operating factories under it will always exist. He pointed out that a system of management properly carried out along the lines laid down by Taylor requires managers and engineers of unusual ability. Not only must they be well trained, both in the theory and practice of their line of business, but they must, in addition, be exceptional students of human nature and keen observers of human traits. This is a point of great importance and one which is often overlooked. People speak of scientific management as though it were something that could be bought and sold in the market, that can be accepted or left alone, as they please, but it is not so. Scientific management can be logically and properly installed and carried on only by men of exceptional qualifications; and it is not a system which anyone can adopt and install at will. This is probably the reason for the many alleged failures of this type of management reported; and also for the misunderstanding and misconception of the system itself.

Scientific management is by no means an entirely new development, although it was worked out in more minute details and given more prominence, as well as a name, by Mr. Taylor and others who have taken up his work; but the principles of scientific management have been applied in many of the well managed factories in this and other countries for years, and the extent to which these attempts in the past were successful as systems of management depended on the personal factor—on the manager. And so it will continue in the future. Men with the peculiar capacity for leading other men along definite, well-thought-out and systematic lines will succeed with scientific management, while those who have not this ability will fail, and will have to be satisfied with getting along in the conventional way.

PRICE-CUTTING VS. PRICE-MAINTENANCE

The recent decision of the U. S. Supreme Court, that selling a patented article for less than the specified retail price does not constitute an infringement of the patent, removed a bulwark behind which much of the fixed-price business of the country was established. The decision is one viewed with satisfaction by those who realized that the use of the patent privilege to fix prices was a serious, if not a dangerous, abuse of the law. But the price-cutting likely to result in retail trades from the removal of the means for holding retailers to fixed prices may work much injury. Louis D. Brandeis, the well-known lawyer, active in progressive legislation, has published a protest against price-cutting and a plea for the maintenance of the fixed-price principle when not coupled with monopoly. An extract from his statement which follows is of general interest:

> There is no improper restraint of trade when an independent manufacturer in a competitive business settles the price at which the article he makes shall be sold to the consumer. There is dangerous restraint of trade when prices are fixed on a common article of trade by a monopoly or combination of manufacturers.
>
> The independent manufacturer may not arbitrarily establish the price at which his article is to sold to the consumer. If he would succeed he must adjust it to active and potential competition and various other influences that are beyond his control. There is no danger of profits being too large as long as the field or competition is kept open; as long as the incentive to effort is preserved; and the opportunity of individual development is kept untrammeled. And in any branch of trade in which such competitive conditions exist we may safely allow a manufacturer to maintain the price at which his article may be sold to the consumer. Competition is encouraged, not suppressed, by permitting each of a dozen manufacturers of safety razors or breakfast foods to maintain the price at which his article is to be sold to the consumer.
>
> By permitting price-maintenance each maker is enabled to pursue his business under conditions deemed by him most favorable for the widest distribution of his product at a fair price. He may open up a new sphere of merchandising which would have been impossible without price protection. The whole world can be drawn into the field. Every dealer, every small stationer, every small druggist, every small hardware man can be made a purveyor of the article, and it becomes available to the public in the shortest time and the easiest manner.
>
> Price-cutting of the one-priced trademark article is frequently used as a puller-in to tempt customers who may buy other goods of unfamiliar value at high prices. It tends to eliminate the small dealer who is a necessary and convenient factor for the widest distribution; and ultimately, by discrediting the sale of the article at a fair price, it ruins the market for it.

Price-cutting is one of the most efficient means of establishing monopoly in retail trade. The dealer who offers to sell a well-advertised fixed-price article at or below the wholesale price does so for an ulterior purpose. The sale of the advertised article is limited and the constant effort is to induce customers to buy other and "just-as-good" articles yielding a larger profit. Competition having been destroyed by price-cutting methods, the field is open for high prices and the abuses that invariably follow the establishment of a private monopoly.

* * *

Machine contractors who bid on work for the government find that the law requiring that all government work done under contract must be carried through by men working on the eight-hour day basis necessitates their placing much higher bids upon the work. Two years ago the successful bidder on a lot of 5000 3-inch cast-iron shells was awarded the contract on a bid of eighty cents each, his men being employed on the ten-hour day basis. Recently when bids were received for a similar lot of 5000 of these shells to be made to the same specifications, the lowest bid was one dollar and forty cents each, and it is claimed that the increased figure of the last bid was largely due to the fact that the work must be done on the eight-hour day basis.

POINTS ON BROACH-MAKING

BY FRANKLIN D. JONES*

Broaches have a series of teeth that successively cut the work to the required form, and naturally the proportioning of these teeth is one of the most important features of broach design. While the design of a broach, aside from its general shape or form, depends largely upon its intended use, there are certain features which apply to broach-making in general. One of the first things to determine is the pitch of the teeth, or the distance from one tooth to the next.

Pitch of Broach Teeth

As a general rule, the pitch P (see Fig. 1) should increase as the length of the hole increases to provide sufficient space between the teeth for the chips. The pitch of the teeth

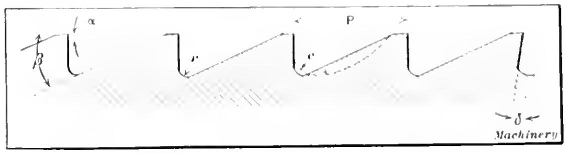

Fig. 1. Diagram illustrating Pitch, Clearance Rake and Filleting

for broaching under *average* conditions can be determined by the following formula, in which P = pitch of teeth and L = length of hole to be broached:

$$P = \sqrt{L \times 0.35}$$

This formula expressed as a rule would be: *The pitch of the teeth equals the square root of the length of the hole multiplied by the constant 0.35.* For example, if a broach is required for a square hole 3 inches long, the pitch of the teeth would equal $\sqrt{3 \times 0.35} = 0.6$ inch, approximately.

Of course a given pitch will cover quite a range of lengths, the maximum being the length in which the chip space will be completely filled. The constant given in the preceding formula may be as low as 0.3 for some broaches and as high as 0.4 for others, although the pitch obtained with the value 0.35 corresponds closely to average practice. When a broach is quite large in diameter, thus permitting deep chip spaces in front of the teeth, the pitch might be decreased in order to reduce the total length of the broach. On the other hand, if the work is very hard and tough, a coarser pitch might be advisable in order to reduce the power required to force the broach through the hole. If the pitch is too fine in proportion to the size of the broach, there may be difficulty in hardening, owing to the fact that the fine teeth will cool much more rapidly than the broach body, thus

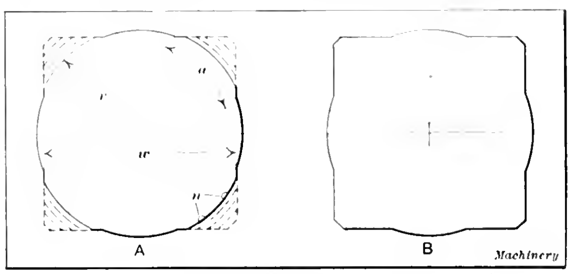

Fig. 2. Diagram illustrating Distribution of Tooth Cuts in broaching a Square Hole

producing severe strains which tend to crack the teeth, especially at the corners. If the teeth are too closely spaced, so much power may be required for drawing the broach through the work that there is danger of pulling the broach apart. In general, the pitch should be as coarse as possible without weakening the broach too much, but at least *two teeth should be in contact* when broaching work of minimum length.

Depth of Cut per Tooth

The amount of metal that the successive teeth of a broach should remove, or the increase in size per tooth, depends largely upon the hardness or toughness of the material to be broached. The size of the hole in proportion to its length

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also affects the depth of cut, so that it is impossible to give more than a general idea of the increase in size per tooth. Medium-sized broaches for round or square holes usually have an increase of from 0.001 to 0.003 inch per tooth for broaching steel, and approximately double these amounts for soft cast iron or brass. Large broaches up to 2 or 3 inches may have an increase of from 0.005 to 0.010 inch per tooth Obviously, the depth of cut is governed almost entirely by the nature of the work. For example, a small broach for use on brass or other soft material might have a larger increase per tooth than a much larger broach for cutting steel. If the amount of metal to be removed is comparatively small and the broach is used principally for finishing, the increase per tooth may not be over 0.001 inch even for large broaches.

The diagrams *A* and *B*, Fig. 2, show a common method of broaching square holes in the hubs of automobile transmission gears, etc. Prior to broaching a hole is drilled slightly larger in diameter than the square width. The first tooth on the broach is rounded considerably and cuts a long circular chip, as indicated at *a*, and the following teeth form the square corners by removing successive chips (as shown by the dotted lines) until the square is finished as at *B*. As will be seen, the first tooth has the widest cut, the chip width *a* greatly decreasing toward the finishing end of the broach. Hence, if this hole were finished with a single broach, it would be advisable to vary the sizes of the teeth so that the depth of cut gradually increases as width *a* decreases. It is good practice to nick some of the wide teeth as indicated at *n*, in order to break up the chips, as a broad curved chip does not bend or curl easily. In case two or more broaches are required, the first broach of the set may have a uniform variation in the radii *r* of different teeth, but the depth of cut should be less than for the following broaches which remove comparatively narrow chips from the corners of the square. Several end teeth, especially on the last broach of a set, are made to the finish size. This feature, which is common to broaches in general, aids the broach in retaining its size and tends to produce a more accurately finished hole.

Testing Uniformity of Teeth

When testing a broach to determine if all the teeth cut equally, first use a test piece not longer than 2 × pitch of teeth. Pull the broach through and note the amount of chips removed by each tooth; then "stone down" the high teeth and test by drawing through a longer piece, and, finally, through the full length required. If a broach is warped much, or is otherwise inaccurate, some teeth may take such deep cuts that the broach would break if an attempt were made to pull it through a long hole on the first trial.

Clearance Angles for Broach Teeth

The clearance angle *a* (Fig. 1) for the teeth of broaches is usually very small, and some broaches are made with practically no clearance. Ordinarily there should be a clearance angle varying from 1 to 3 degrees, 2 degrees being a fair average. A common method of providing the necessary clearance is as follows: All the lands of the hardened broach are first ground parallel and then they are "backed off" slightly by means of an oilstone. Just back of the narrow land (which may not be over 1/32 inch wide) there is a clearance of 2 or 3 degrees, machined prior to hardening.

The clearance space required for the chips depends upon the length of the hole and the depth of the cut. When the cut is light, and especially if the material to be broached is tough, thus making it necessary to use as strong a broach as possible, the clearance space should be proportionately small. The fillet at the base of each tooth should have as large a radius *r* (Fig. 1) as practicable and the grooves between the teeth should be smooth so that the chips will curl easily. A curved clearance space, similar to that indicated by the dotted line *c*. is superior to the straight slope, although not so easily machined. The front faces of the teeth are sometimes given a rake δ of from 5 to 8 degrees so that the broach will cut more easily and require less pressure to force it through the holes.

Steel for Broaches

Three kinds of steel are used for making broaches: namely, alloy steel, carbon steel and, to some extent, casehardened machine steel. Carbon-vanadium tool steel is especially adapted for broaches. This steel differs from the high-speed steels in which vanadium is also used in that it does not contain tungsten or chromium, but is simply a high-grade carbon steel containing a certain percentage of vanadium. The addition of vanadium to carbon steel imparts certain qualities, the most important of which are, first, the higher temperature to which the steel can be heated without coarsening the grain (thus permitting a greater range in temperature for hardening without spoiling the tool), and second, the tough core which makes the broach stronger and more durable than one made of regular high-carbon steel. The makers recommend hardening carbon-vanadium steel at a temperature varying from 1350 to 1425 degrees F., the temperature depending somewhat upon the size of the tool. The steel is then drawn to suit conditions, the drawing temperature generally being about 460 degrees F. This particular brand of steel will not harden in oil.

Regular carbon steel that is used for broaches should have from 1.00 to 1.10 per cent carbon. To prevent the steel from warping excessively, the broach should be annealed after the teeth have been roughed out. A successful method of hardening to prevent excessive warping is as follows: After machining the broach and before hardening, heat to a dark red and allow the broach to cool while lying on a flat plate, then heat to the hardening temperature and harden in the usual manner. This method, which is applicable to all tool steels, reduces warping to a minimum and is of especial value when hardening slender broaches.

Straightening Hardened Broaches

Broaches that have been warped by hardening can be straightened at the time the temper is drawn. Place the broach on two wooden blocks on the table of a drill press equipped with a lever feed, and insert a wooden block in the end of the drill press spindle. Heat the broach with a Bunsen burner until the hand can barely touch it; then apply pressure to the "high" side. Continue heating (as uniformly as possible) and bending until the broach is straight, but complete the straightening operation before the broach has reached a temperature of about 350 degrees F., so that the drawing temperature will not be exceeded. With this method the heat required for straightening is also used for drawing the temper, the broach being removed and quenched as soon as the tempering temperature is reached. The temperature is judged by brightening some of the teeth throughout the length of the broach and watching the color-changes as the temperature increases.

* * *

THE COUNTRY BLACKSMITH AND THE AUTOMOBILE

The rapid increase of automobile users in the agricultural districts has brought to the country blacksmiths a class of repair work which many are poorly fitted to handle. The ordinary horseshoer has little conception of the proper procedure to follow when called upon to straighten a bent channel section frame, for example, and much time and hammering are expended in accomplishing what proper heating and a few successful blows would otherwise quickly perform. The result is high cost for unsatisfactory repair work.

The country blacksmith should become familiar with the peculiarities of beam sections generally and with the construction of gas engines, frames, wheels, crankshafts, clutches, springs, etc. He should, in short, become an all-around mechanic of good judgment and quick action if he is to embrace the opportunity offered to the shops in good locations. The opportunity for the progressive man in many localities is golden. He must equip his shop with a few machines and apparatus not required for horseshoeing and repair of farm machinery, but the returns will amply reward him for the investment.

INSPECTION TESTS FOR CINCINNATI GEAR-CUTTING MACHINES

METHODS OF TESTING ALIGNMENT OF DIFFERENT PARTS WHILE GEAR-CUTTING MACHINES ARE BEING ASSEMBLED

The accuracy required for gearing necessitates a very close inspection of gear-cutting machines when erecting and of the machining operations of various parts. In most cases where gears are found to be defective, the fault lies in the imperfect machining of the gear blank rather than in the machine itself. As it is difficult to turn a gear blank so that it will run absolutely true after it has been removed from the mandrel and put back again in a reversed position, it is not strange that imperfect gears are commonly due to inaccurate blanks or improper mounting on the gear-cutting machine. When the blanks are accurately machined and properly mounted so as to avoid springing while being cut, gears can be finished very accurately in a properly built machine.

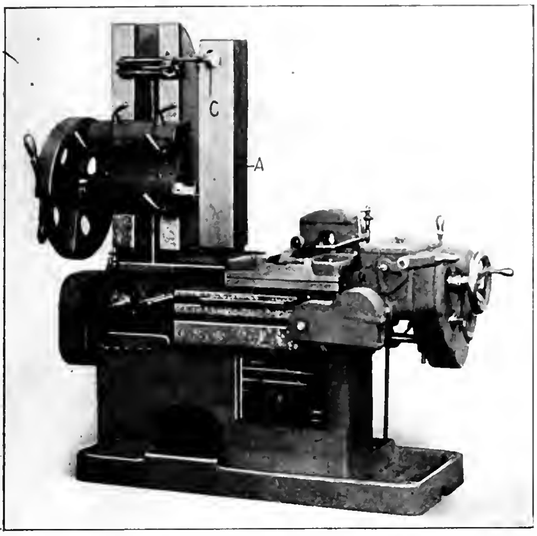


Fig. 1. Testing Position of Spindle-head Column relative to Base

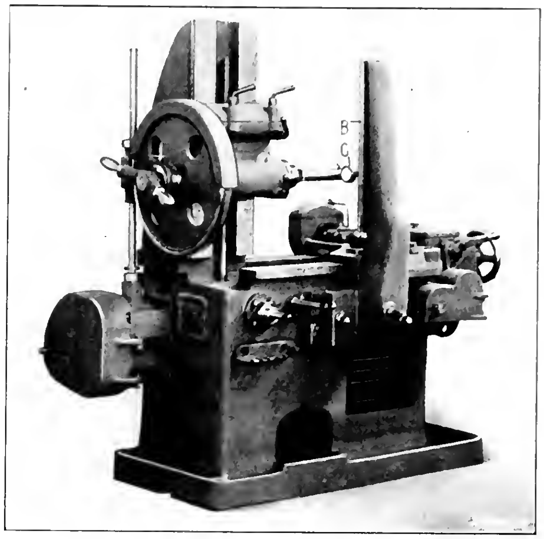


Fig. 2. Testing Parellelism of Faces of Outer Support and Housing

The illustrations shown herewith indicate the methods employed by the Cincinnati Gear Cutting Machine Co. Cincinnati, for testing the alignment of different parts while the gear-cutter is being assembled. The top of the machine bed is used as the foundation from which the tests are started. Upon this accurate surface a square column A is placed, as illustrated in Fig. 1. The sides of this column are parallel and perpendicular to the broad base which rests upon the ways. By turning this column and using its different sides, it is possible to determine accurately whether the face of the housing is perpendicular to the bed, the dial indicator C being placed upon the housing both at the top and bottom. When the housing is found to be perpendicular, the next inspection (shown in Fig. 2) is to determine the parallelism of the face of the outer support B with the housing face. The indicator C is attached to the spindle and the test is made by traversing the spindle-head vertically and noting any variation as indicated by the dial gage.

The hole in the work-spindle is next tested, as shown in Fig. 3, to determine whether it is concentric with the outside of the spindle and also whether its axis is parallel with the bed. The accuracy of the hole is determined by inserting the test-bar D in the spindle and revolving the latter while the dial gage is in contact with the bar. On the bottom of the indicator stand there is a block which comes against the inside edge of the bed, so that by placing the indicator in different positions along the top of the bed the parallelism of the spindle (as shown by test-bar D) can be determined.

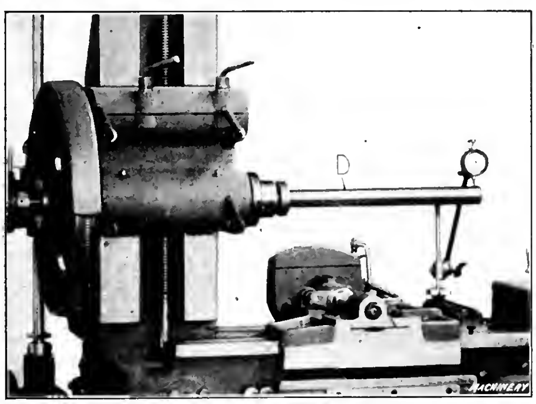


Fig. 3. Testing Concentricity of Hole in Work-spindle

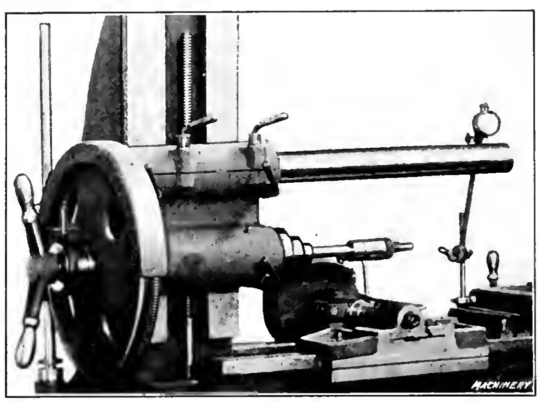


Fig. 4. Testing Alignment of Over-arm

The tests for the over-arm and centers that are used when cutting small gears are indicated in Figs. 4 and 5. These tests are similar to that employed for the work-spindle and are self-explanatory. After the truth of the work-spindle is determined, it is used as a tram, as shown in Fig. 6, to see if the ways of the cutter-spindle slide are at right angles to the work-spindle. A special angular surface-plate E is inserted in the dovetail ways and the indicator C is attached to an arbor and is swung from one side to the other by turning the spindle, thus bringing it into contact with op-

posite ends of the surface plate. The cutter-arbor is tested as shown in Fig. 7 to determine whether it is parallel with the top of the bed and also whether it runs concentric with the cutter spindle. In making this test, the indicator base rests upon the top of the bed, as shown.

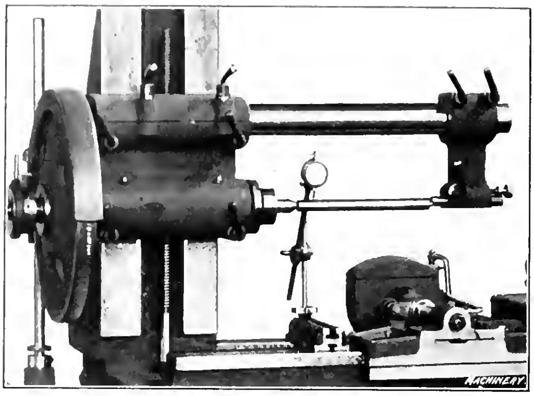


Fig. 5. Testing Centers used when cutting Small Gears

The test of the elevating screw is illustrated in Fig. 8. This is effected by using different blocks of a known length and comparing these blocks with the readings on the dial of the machine. The test indicator is first brought into contact with one of the blocks B and its dial is set at zero. The

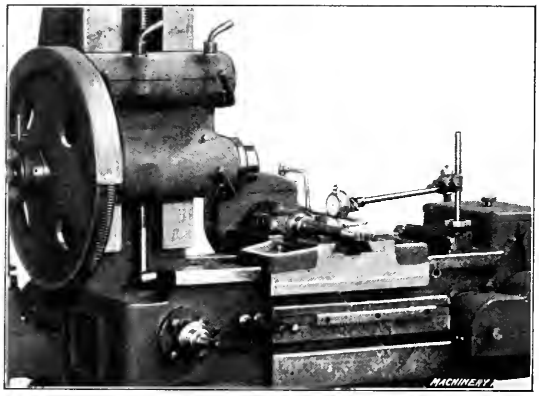


Fig. 7. Testing Accuracy of Cutter-arbor with Spindle and Bed

spindle-head is then elevated a distance equal to the difference between the length of block B and the next one to be used. The longer block is then placed under the test indicator and any variation of the pointer from zero shows the error in the elevating screw. The outer supporting arm for the

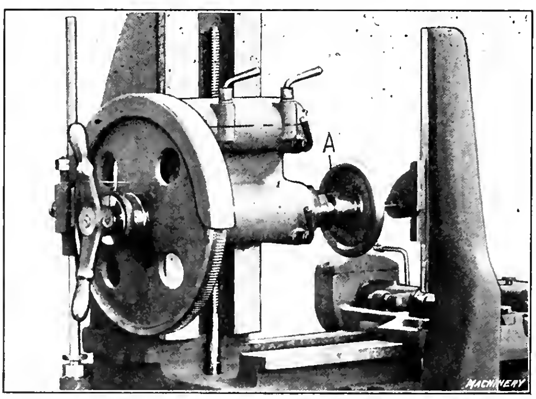


Fig. 9. Finish-boring Outer Supporting Arm in Alignment with Spindle

work-arbor is rough-bored prior to erection, but the finish-boring is done as shown in Fig. 9. The work-spindle and boring-bar are revolved by a small motor (not shown) belted to the index wormwheel which is temporarily converted into a pulley by placing a rim over it. The feed of the cutter-bar is effected by holding wheel A stationary. The truth of the bored hole is tested as illustrated in Fig. 10.

The method of testing the accuracy of the index wormwheel is shown in Fig. 11. Two disks D and D_1 are placed

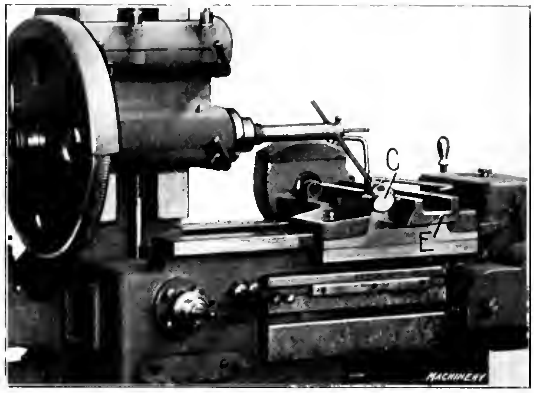


Fig. 6. Determining if Cutter-spindle Slide is at Right Angles to Spindle

side by side on a "floating" arbor. This floating arbor compensates for any slight error in the periphery of the disks, and by means of a knife-edge scriber fine lines are scratched across these two disks. This is done with the machine belted for use, and the operation is practically the same as if a

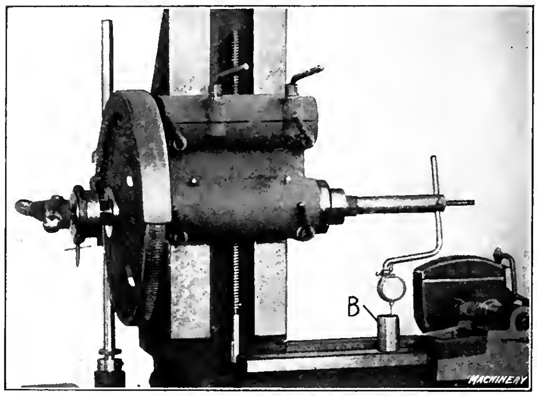


Fig. 8. Testing Accuracy of Elevating Screw

gear were being cut. After the disks have made a complete revolution, one of them is revolved half a turn in order to double any indexing error that may exist. As these disks are 18 inches in diameter, the error found in this way would be the same as though a 36-inch solid disk were used. After

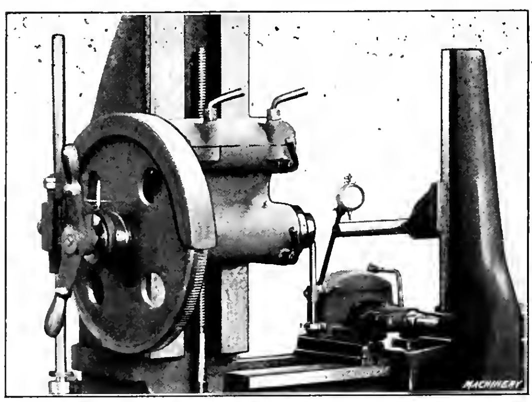


Fig. 10. Testing Bored Hole in Outer Supporting Arm

one disk is turned a half revolution, a comparison is made with the lines on the stationary disk by the aid of a microscope and a thin strip of metal upon which there are a thousand lines to the inch. Under the microscope, the thou-

sandth inch appears almost like one-sixteenth inch, so that very slight errors are easily observed.

An accurate means of setting the cutter centering device is shown in Fig. 12. A disk D having an included angle of 60 degrees is placed on the cutter-arbor and another disk D_1, notched to a corresponding angle, is placed on the work-arbor.

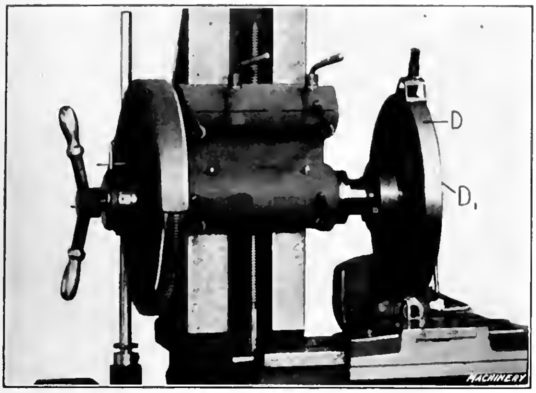


Fig. 11. Testing Accuracy of Indexing Wormwheel

The disk on the cutter-arbor is adjusted to such a position that all light is excluded between it and disk D_1 on the work-arbor; then the latter is reversed and if the light is still excluded this indicates that the disk on the cutter-arbor is central with the work-arbor and it is then used for setting the center gage. F. D. J.

* * *

Engineers who have returned from Spitzbergen after constructing the Norwegian Government's wireless station express the view that the natural resources on the islands are much more valuable than is generally supposed.

RATCHET WHEELS FOR FEED ROLLS

BY SIDNEY C. CARPENTER*

When selecting ratchet wheels for the feed rolls of power presses, the diameters of the rolls on the machine and the feed of the stock which is required are usually known, and the problem is to select a suitable wheel from the assortment in stock and then to determine the number of teeth on this wheel which corresponds with the required feed. For this purpose, the writer has compiled the diagrams shown herewith and has found that they save a considerable amount of time when a problem of this sort comes up. A complete list of the wheels that can be used for a given feed may be quickly obtained by following the vertical line corresponding with the required feed. As an example, let us suppose that a feed of 1.4 inch is required with feed rolls $2\frac{1}{2}$ inches in diameter.

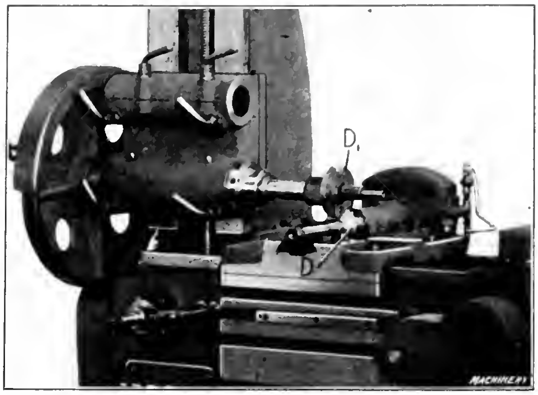
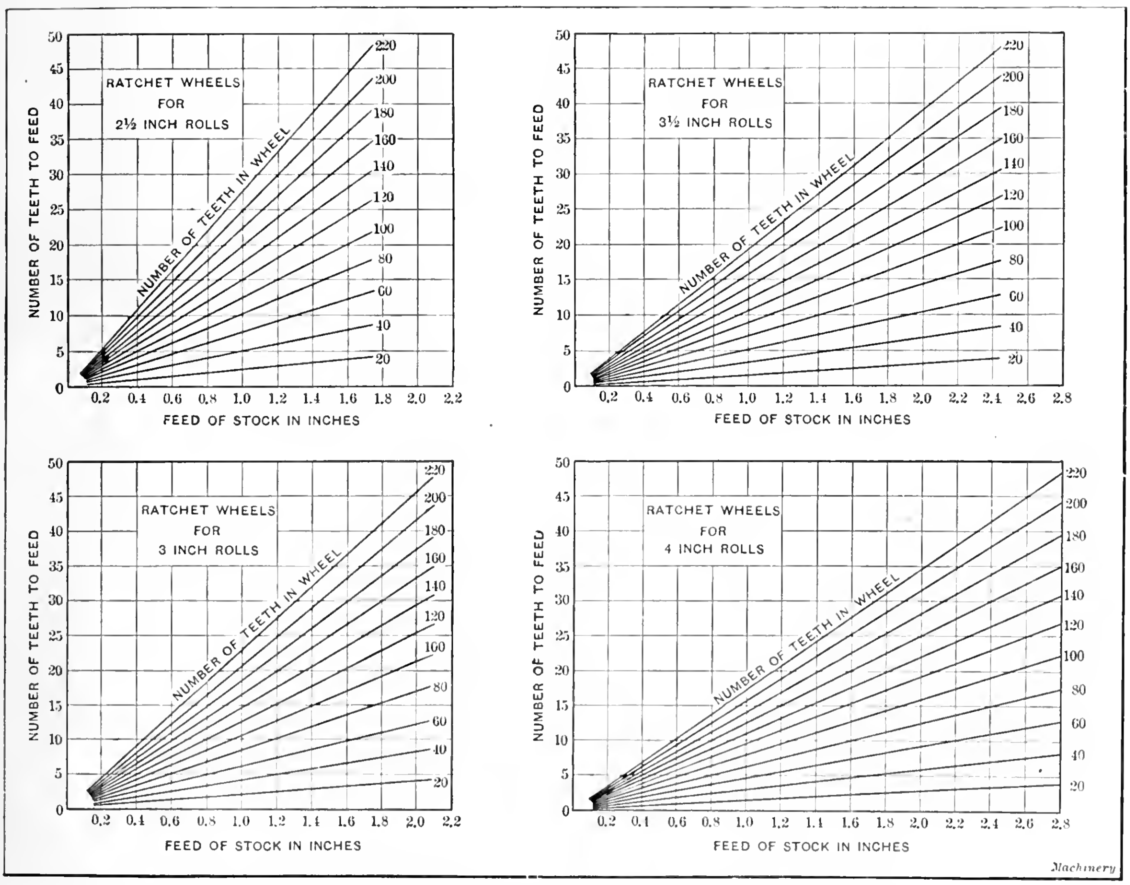


Fig. 12. Accurate Method of setting Cutter-centering Device



Diagrams showing Ratchet Wheels for a Given Feed with Rolls of the Size indicated

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Following the vertical line from 1.4 on the diagram for $2\frac{1}{2}$ inch rolls—referring at each diagonal to the "number of teeth to feed" column at the left-hand side of the diagram—the following list of wheels is quickly obtained:

Wheel	Feed
40	7 teeth
80	14 "
120	21 "
160	28 "
200	35 "
220	39 "

If double pawls are used, half teeth can be read directly from the diagram.

A leading press manufacturer gives the practical limit for the feed of the stock as 0.7 of the diameter of the roll, which figures out about 0.22 of the number of teeth in the ratchet wheel. The limit for the different wheels in the diagrams is based upon this proportion. If a larger feed is required, gearing may be interposed between the ratchet and the rolls to give the required result. The diagrams give the principal relation between the feed of the stock in inches, the number of teeth in the wheel, and the number of teeth to feed for feed rolls of $2\frac{1}{2}$, 3, $3\frac{1}{2}$, and 4 inches in diameter. They are figured from the following formulas:

$$F = \frac{tC}{T} \qquad T = \frac{tC}{F} \qquad t = \frac{TF}{C} \qquad C = \frac{TF}{t}$$

in which C = circumference of feed roll;
T = number of teeth in ratchet wheel;
t = number of teeth to feed;
F = feed of stock in inches.

Similar diagrams for other sizes of feed rolls can be easily figured from these formulas.

* * *

SHOP PROBLEMS INVOLVING THE USE OF THE PRONY BRAKE FORMULA*†

BY J. H. CARVER‡

A convenient form of the prony brake formula is:

$$\text{H. P.} = 0.000016\ TN$$

where H. P. = horsepower transmitted;
T = twisting moment $(P \times R)$;
N = number of revolutions per minute.

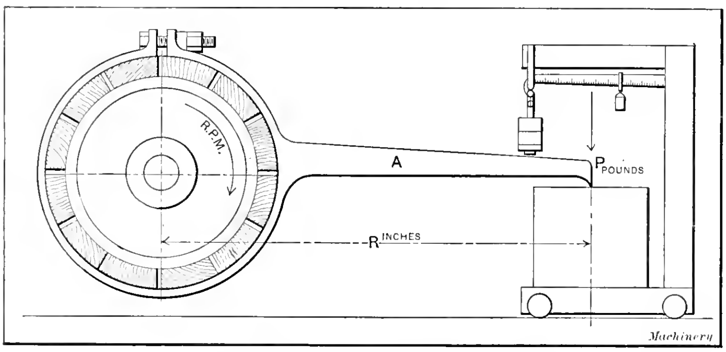

Diagram used in deriving Prony Brake Formulas

It is derived from the accompanying illustration, where it will be evident that if arm A makes N revolutions per minute, then a point R inches from the center travels $\frac{2\pi RN}{12}$ feet per minute. If P pounds are registered on the scale beam, the amount of power being developed is:

$$\frac{2\pi RN}{12} \times P = 0.5236\ PRN \text{ foot-pounds per minute.}$$

Therefore, as 33,000 pounds acting through a distance of one foot in one minute means one horsepower, then the horsepower transmitted is:

$$\text{H. P.} = \frac{0.5236\ PRN}{33{,}000} = 0.000016\ PRN \qquad (1)$$

Where it is convenient to use the twisting moment, $T = PR$, then:

$$\text{H. P.} = 0.000016\ TN \qquad (2)$$

In many instances, problems arise where the following formulas may be used to good advantage.

$$T = \frac{63{,}000 \text{ H. P.}}{N} \quad (3) \qquad N = \frac{63{,}000 \text{ H. P.}}{T} \quad (4)$$

$$P = \frac{63{,}000 \text{ H. P.}}{RN} \qquad (5)$$

These are derived from the equations:

$$\text{H. P.} = \frac{0.5236\ PRN}{33{,}000}$$

$$PR = T = \frac{33{,}000 \text{ H. P.}}{0.5236\ N} = \frac{63{,}025 \text{ H. P.}}{N}$$

(Neglecting 25 in the numerator.)

The following examples explain the use of the diagrams presented in the current Data Sheet Supplement.

$$\text{H. P.} = 0.000016\ PRN \qquad (1)$$

$$\text{H. P.} = 0.000016\ TN \qquad (2)$$

A hand-operated geared crane has a crank on each end of its driving shaft. Two men each exert a pressure of 50 pounds at a distance of 24 inches from the center of this shaft and turn it at 70 R. P. M. for a short period. If operated by a motor, what horsepower is necessary? T = twisting moment or torque of motor = 100 × 24 = 2400 inch-pounds.

Then H. P. = 0.000016 × 2400 × 70 = 2.68 H. P.

Using Diagram No. 1 and starting downward from 70 R. P. M. to the 100-pound diagonal and then moving to the right, stopping at the 24-inch line, and then downward gives 2.7 H. P. Therefore, allowing a possible 50 per cent overload on the 2.7 H. P. shows that a 4 H. P. motor is necessary, 5 being the nearest probable commercial rating obtainable.

$$T = \frac{63{,}000 \text{ H. P.}}{N} \qquad (3)$$

A motor pulley 20 inches in diameter is running at 500 R. P. M. Find the torque of motor when it is delivering 20 H. P. Using Diagram No. 2, start at 20 H. P. upward to the 10-inch diagonal; then move to the left, intersecting the vertical coming down from 500 R. P. M. at a point on the 250-pound diagonal. This point of intersection shows 250 pounds pressure on a 10-inch radius or a torque of 2500 inch-pounds.

$$N = \frac{63{,}000 \text{ H. P.}}{T} \qquad (4)$$

What speed is necessary for a shaft having a twisting moment of 16,000 pounds to give 70 H. P. (20 × 800 gives T, the twisting moment.) Start from 70 H. P. at the bottom of Diagram No. 3 and stop at the 20-inch diagonal; then moving to the left to the 800-pound line and upward shows 275 R. P. M. as speed necessary. (Figures show 275.6 R. P. M.)

$$P = \frac{63{,}000 \text{ H. P.}}{RN} \qquad (5)$$

It is required to find the tooth load on a 35 H. P. motor pinion running at 600 R. P. M. where the pitch diameter of the pinion is 12 inches. On Diagram No. 3, starting upward from 35 H. P. to the 6-inch diagonal, then moving to the left, intersecting the vertical downward from 600 R. P. M. shows approximately 610 pounds load. (Figures give 612.5 pounds.)

A scale used in connection with a prony brake registers 200 pounds. The lever arm is 5 feet long and the speed of the gas engine being tested is 600 R. P. M. What horsepower is being transmitted? Using Diagram No. 4 and starting downward from 600 R. P. M., stopping at the 200-pound diagonal, then moving to the right to the 60-inch line and downward again, gives 115 horsepower.

* With Data Sheet Supplement
† See also "Calculating Horsepower from Dynamometer Tests," August, 1911, engineering edition.
‡ Address: Care of General Electric Co., Schenectady, N. Y.

HARDENING AND TEMPERING STEEL

A REVIEW OF THE GENERAL REQUIREMENTS AND CHARACTERISTICS OF QUENCHING AND TEMPERING BATHS

While there have been many articles published regarding the hardening and tempering of steel and the furnaces used, there is but little detailed information available regarding the baths used for these operations. The time has long since passed when each hardener had his own carefully guarded secrets regarding the composition of quenching baths. On the other hand, the time has also passed when it was a common belief that to harden a piece of steel it was only necessary to cool it off more or less rapidly in almost any kind of cooling medium; it has been found that the cooling mediums for hardening and the heating mediums or baths for tempering do, after all, play quite an important part both as regards economy and the efficiency of the tools treated. It is the intention in this article to outline the methods which have proved most successful, and to give the compositions of baths which from long experience in connection with hardening operations have proved to give the best all around results and to be the most economical; in many cases they have not been the cheapest in initial cost, but nevertheless are most economical because of the better results obtained with the tools treated and the greater length of time that the baths could be used before deteriorating. A description of such receptacles—cooling tanks and tempering furnaces—for the treatment of steel as have proved to be the best for all around purposes has also been included.

For the sake of convenience the subject will be divided into four distinct parts as follows: (1) Baths used for cooling (quenching). (2) Baths used for tempering (drawing the temper after hardening). (3) Some tests and analysis of baths referred to under (1) and (2). (4) Receptacles and furnaces used in quenching and tempering.

Characteristics of Quenching Baths

No matter what the composition of a quenching bath, to insure uniform hardening the temperature of the bath must

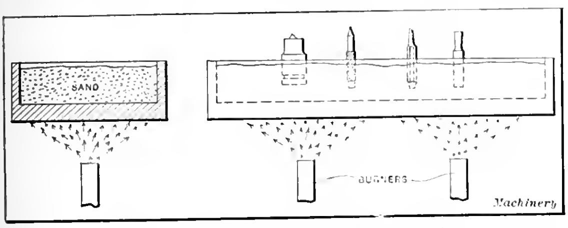

Fig. 1. Arrangement used for Sand Tempering

be kept constant, so that successive pieces of steel or tools quenched will be acted upon by baths of the same heat. The necessity of a uniform temperature for a quenching bath will be readily understood by reference to ordinary water for a cooling bath; everyone having any knowledge of the subject knows that a tool quenched in such a bath at room temperature will come out much harder than if quenched when the water is at the boiling point. In fact, it is well known that one way of partially annealing steel is by plunging it at a red heat into hot water. The same difference in hardness will result when using any quenching bath at different temperatures, and hence no actual and dependable data can be obtained unless means are taken for keeping these baths at a uniform heat.

When using quenching baths of different composition the tools quenched will vary in hardness. This is due mainly to the difference in heat-dissipating power of the different baths. Thus a tool hardened at the same temperature in water and brine will come out harder when quenched in brine; the greater the conductivity of the bath the quicker the cooling. The general opinion, today, is that the composition of a quenching bath is of small importance as long as the bath cools the pieces rapidly. Those who have made a study of the subject have found different opinions regarding the same quenching bath by different users, and a good many quenching fluids have been condemned owing to improper heating and in many cases to improperly built furnances. As an example may be cited an oven furnace with which the user once had trouble. Owing to faulty construction of this furnace, more air was let into the heating chamber of the furnace than could be taken care of by the fuel oil; after having condemned first the steel and then the quenching bath, and then trying one quenching bath after another with the same results, it was suggested that the "heating" did not look just right, and an expert was called in to find out what the trouble was. After much experimenting with

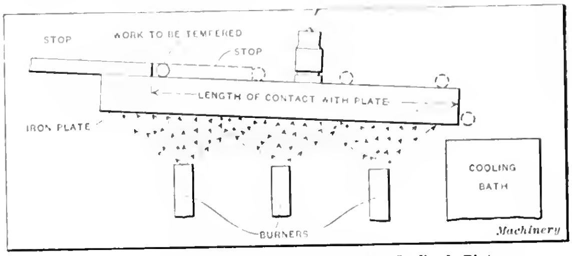

Fig. 2. Tempering Arrangement utilizing an Inclined Plate on which the Objects roll down

the burners and the furnace itself good results were finally obtained. The difficulty seemed to be that the oxygen of the air attacked the steel and formed oxide of iron on the surface of the tools, which consequently had a soft scale on the outside.

Those who are skeptical as to there being any difference in the effect on steel of cooling baths of different composition will readily admit that it is advantageous to use baths free from oxygen and from ingredients that tend to oxidize. Quenching baths should be uniform; good tool steels of high carbon are very sensitive to differences in both water and oils. Water for hardening tool steel should be soft; entirely different and very unsatisfactory results will be obtained when using hard water. While different quenching oils show less difference in the results obtained, vegetable and animal oils will give somewhat different degrees of hardness depending upon the sources from which they are obtained. One cannot be too careful in the selection of water, as it is likely to contain many impurities. If it contains greasy matters, it may not harden steel at all, whereas if it contains certain acids, it will be likely to make the tools quenched in it brittle and even crack them.

List of Quenching Baths

(1) Water—soft—preferably distilled; good tool steel should require no mixture added to pure water. (2) Salt added to water; will produce a harder "scale" than if quenched in plain water. (3) Sea (salt) water—the keenest natural water for hardening. (4) Water as under (1), containing soap. (5) Sweet milk.* (6) Mercury.* (7) Carbonate of lime.* (8) Wax.* (9) Tallow.* (10) Air—mostly used for high-speed steel; mere exposure, however, is in many cases and on many steels not sufficient to produce hardness and an air blast is necessary, as this furnishes cool air in rapid motion. (11) Oils† such as cottonseed, linseed, whale, fish, lard, lard and paraffine mixed, special quenching oils, etc.

The following list of oils and names of firms supplying them is given for the sake of convenience. The firms mentioned are reliable and their oils have been thoroughly tried out in comparison with other makes and have proved to be superior; opinions may, of course, differ in this respect and no doubt there are many oils that have not been tried that may be as good.

Cottonseed oil—Union Oil Co., Providence, R. I.; Underhay Oil Co., Boston, Mass.

* Generally used for special purposes only.
† A small quantity of sal-ammoniac added to the oil bath has a tendency to make the tools come out clean from the bath.

Linseed oil—Spencer Kellogg & Sons, Inc., Buffalo, N. Y.

Whale oil—no difference found between two different kinds.

Fish oil—only one kind tried.

Lard oil—W. B. Bleecker, Albany, N. Y.; E. F. Houghton & Co., Pittsburg, Pa.

Paraffine oil—Underhay Oil Co., Boston, Mass.

Special quenching oil—E. F. Houghton & Co., Pittsburg, Pa. Very good and cheap. While this may possibly deteriorate somewhat faster than some of the others mentioned it will prove very economical.

The order of the intensity with which various cooling baths will harden steel of about 0.90 to 1.00 per cent carbon is as follows: Mercury, carbonate of lime, pure water, water containing soap, sweet milk, different kinds of oils, tallow and wax. In all cases, except possibly the oils, tallow and wax, it must be remembered that the tools become harder as the temperature of the bath becomes lower.

Baths used for Tempering

The object of tempering is to reduce the hardness and to remove internal strains caused by sudden cooling in quenching. The composition of a tempering bath is of little importance compared with that of a quenching bath when considering the effect upon the pieces treated. Aside from the operator's convenience and possible bad effects upon his health, the different baths used for this operation must be considered with regard to initial cost, lasting quality, effects on finish, etc.

While oil is the most widely used medium for tempering tools in quantities, other means and methods are employed, especially by those who have tools in small quantities to temper, when the expense of installing and running an oil tempering furnace would not be warranted. Of these methods we first find the one used by the old-style tool hardener of only partly cooling the tool when quenching it, then quickly withdrawing it, polishing off the working surface, and then letting the heat which remains in the tool produce the required temper as judged by the color. If the tool has a shank, it is good practice to heat part of the shank also and quench the working part of the tool only, in which case this part can be cooled off thoroughly; the heat remaining in the body or shank of the tool will do the tempering, which also in this case must be judged by the color.

The sand bath is another frequently used medium for tempering, the sand being deposited on an iron plate and heated; by the use of this method a piece to be tempered can be given different tempers throughout its length, as, for example, rivet hole punches; these are placed endwise—bottom down—in the sand about two-thirds projecting outside the sand into the air (see Fig. 1). It is readily seen that the nearer the bottom of the sand bath, the higher the heat, and the punch so placed, when tempered right, will have the bottom soft—a deep dark blue—the neck a very dark straw, and the working part of the punch on top a light straw color; thus there is a gradual increase in hardness from the bottom up. Pieces so drawn must previously have been polished, and the temper is judged by the color. When the pieces have attained the right color they are, of course, cooled off, generally in water or oil. A plate without sand similarly heated can also be used, but it is not as satisfactory.

A plate arranged as shown in Fig. 2 will be found very convenient when drawing small, round pieces. The pieces are rolled on the inclined plate which is heated as indicated. The length of time the work is in contact with the plate can be regulated by adjusting the amount of the incline, as well as the location of the "stop." This arrangement can also be used for such work as punches, etc., in which case the plate, of course, should stand level and not in an inclined position.

Another frequently used tempering medium is hot air, the temper in this case also being judged by the color. For this method of tempering special furnaces should be employed in order to get uniform results. This method is used more especially for small and light work in quantities and where the color has to be bright and clear. While all of these methods have the advantage of enabling one to actually see the temper given to tools treated, the oil tempering bath is the one mostly used owing to its economy.

The two main points to be considered when using an oil tempering furnace are: first, to have the heat uniform throughout (not hotter where the burners or flames are in contact with the walls of the furnace); and second, to leave the pieces to be tempered in the oil long enough to have attained the heat of the oil throughout when taken out. The first point can be taken care of, as far as possible, by proper construction of the furnace; the second can best be taken care of by immersing the pieces to be tempered in the oil before starting to heat, and letting the pieces remain in the oil and be heated with it to the temperature required. In such a case, one should, of course, have more than one furnace, or else after each operation take the hot oil out and refill the tank with cold. The method described is very much better than the one frequently used of immersing the pieces in a bath which already has the required temperature and then letting them remain long enough to attain the heat of the bath throughout, as a furnace yet has to be designed which will maintain a uniform heat for even as short a time as is required for this operation. Furthermore, it is not necessary that a piece to be tempered be held in the bath a certain length of time at the required temperature; the temperature desired need only be maintained long enough to insure that the piece has been evenly heated throughout.

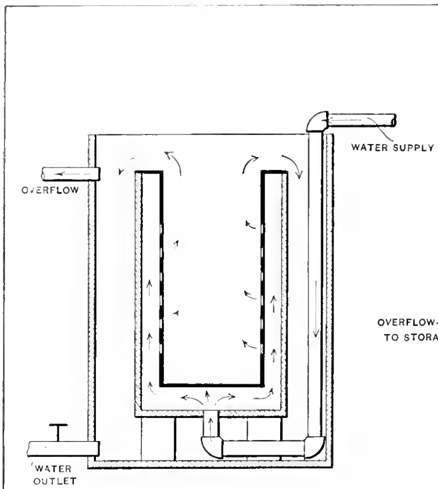

Fig. 3. Water or Brine Tank for Quenching Baths

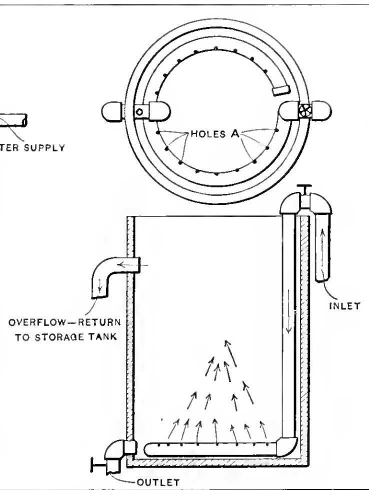

Fig. 4. Another Type of Water or Brine Tank

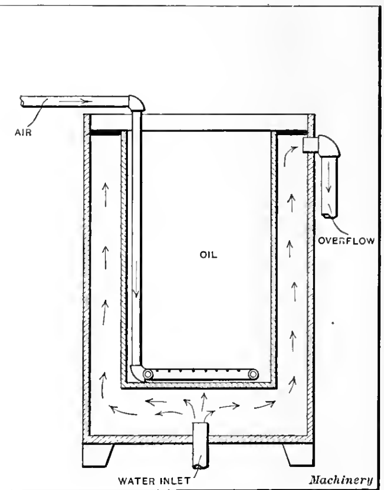

Fig. 5. Oil-quenching Tank with Water circulated in an Outer Tank

When tempering to high heats, or, rather, when tempering to higher heats than the flash point of any tempering oils (650 to 700 degrees F.*) some other tempering fluid than oil must be used. Lead is the one usually employed. As it is impossible when using lead to let the pieces to be tempered be heated up with the lead, they must be immersed at the predetermined temperature and kept there until heated evenly throughout to the same temperature as the lead. It is claimed by many that it is easier to maintain a uniform heat in a lead bath than in an oil bath, but it has been found that,

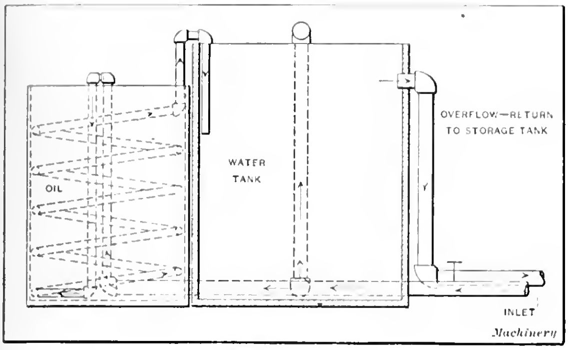

Fig. 6. Water and Oil Tank Combined

owing to the lead not circulating as readily, the temperature may vary considerably in different parts of the bath, and hence it is not very reliable.

Salt is another medium frequently employed for tempering heats between 575 and 875 degrees F. Salt fuses at 575 degrees F., but when immersing the pieces to be tempered the salt will immediately solidify around the cold pieces. When these are heated to 575 degrees, the salt will melt and the pieces should be withdrawn. This is not reliable, however, as the pieces, especially if large, will not have had time to be heated through before the salt melts. If a higher temper

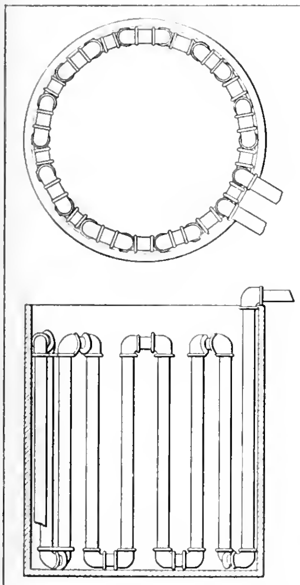

Fig. 7. Ordinary Type of Quenching Tank

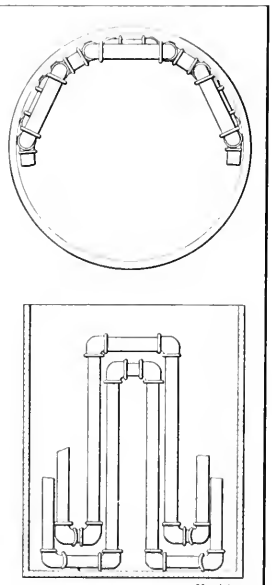

Fig. 8. Oil-quenching Tank with Water and Steam Coils

is required, it is, of course, only necessary to let the pieces remain in the bath and get the readings of the heat from a pyrometer. In all these methods, it is questionable if it is good practice to suddenly immerse cold pieces to be drawn into baths of such high temperatures. When a lower temper is required, and an oil tempering bath or furnace is not available, alloys of lead and tin can be used for as low heats as 400 degrees and of lead and antimony for 500 degrees. However, this involves the inconvenience of keeping a large number of different alloys on hand, if it is desired to vary the temper heats. The following table for different alloys which melt at the temperatures given was compiled by Mr. O. M. Becker.

Lead	Tin	Melting Temperature, Degrees F.	Lead	Tin	Melting Temperature, Degrees F.
14	8	420	24	8	480
15	8	430	28	8	490
16	8	440	38	8	510
17	8	450	60	8	530
18.5	8	460	96	8	550
20	8	470	200	8	560

The oils for tempering baths specified below are given for the sake of convenience only; the statements are based upon the findings of thorough experiments. There may, of course, be many other oils just as good that have not been tried.

(1) Walter A. Wood, Boston, Mass., XXX tempering oil; as cheap in initial expense as any; good lasting qualities.

(2) Frankfort tempering oil, Strong, Carlisle & Hammond Co., Cleveland, Ohio.

(3) Fish oil, cottonseed or linseed oil may also be used; in many cases these are mixed with high fire and flash test mineralized oils.

Tests and Analysis

The analysis and test results of oils when new (not used) as compared with those of oils which have been used such a

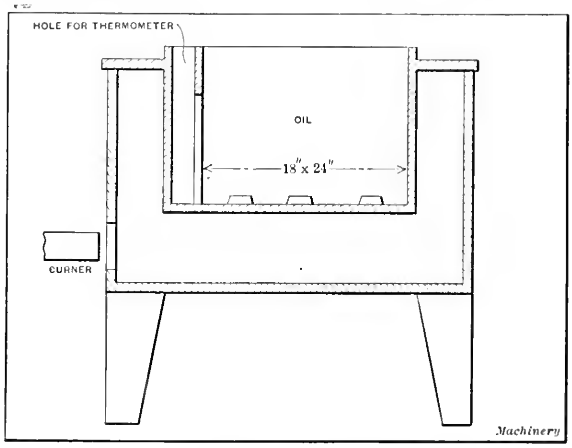

Fig. 9. Ordinary Type of Tempering Furnace

length of time as to render them practically valueless will be found interesting.

	W. A. Wood Tempering Oil		Lard and paraffine oil mixed (half and half) used for quenching	
	New	Old (thick)	New	Old (thick)
Flash point	550	475	400	380
Fire test	625	550	475	450
Mineral oil, per cent	94	30	25	10
Saponifiable oil, per cent	6	70	75	90
Specific gravity	0.920	0.950	0.912	0.925

Houghton tempering oil: flash point, 595 degrees; fire test, 685 degrees; specific gravity, 0.900.

Frankfort tempering oil: fire test, 670 degrees.

Frankfort quenching oil: fire test, 500 degrees.

Paraffine oil (Underhay): fire test, 450; specific gravity, 0.912.

Lard oil (Bleecker): fire test, - - ; specific gravity, 0.920.

The great difference in tests and analysis between new and used oils should be noted; oils used constantly at high heats will gradually lose the "mineral" part of the oil, the more so the higher the heat used. A tempering bath can therefore be prolonged in life by adding to it now and then new mineral oil. To lengthen the life of the bath high heats should be avoided as much as possible.

Receptacles and Furnaces used in Quenching and Tempering

The main point to be considered in a quenching bath is, as mentioned, to keep it at a uniform temperature so that suc-

* There are tempering oils on the market claimed to have a flash test of 750 degrees, but it is doubtful if they ever have been found to stand this test. Heavy black cylinder oil has been found to stand a flash test of 725 degrees.

cessive pieces quenched will be subjected to the same heat. The next consideration is to keep the bath agitated, so that it will not be of different temperatures in different places; if thoroughly agitated and kept in motion, as is the case with the bath shown in Fig. 3, it is not even necessary to keep the pieces in motion in the bath, as steam will not be likely to form around the pieces quenched. Experience has proved that if a piece is held still in a thoroughly agitated bath, it will come out much straighter than if it has been moved around in an unagitated bath. This is an important consideration, especially when hardening long pieces. It is, besides, no easy matter to keep heavy and long pieces in motion unless it be done by mechanical means.

In Fig. 3 is shown a water or brine tank for quenching baths. Water is forced by a pump or other means through the supply pipe into the intermediate space between the outer and inner tank. From the intermediate space it is forced into the inner tank through holes as indicated. The water returns to the storage tank by overflowing from the inner tank into the outer one and then through the overflow pipe as indicated. In Fig. 4 is shown another water or brine tank of a more common type. In this case the water or brine is pumped from the storage tank and continuously returned to it. If the storage tank contains a large volume of water, there is no need of a special means for cooling. Otherwise, arrangements must be made for cooling the water after it has passed through the tank. The bath is agitated by the force with which the water is pumped into it. The holes at A are drilled on an angle, so as to throw the water toward the center of the tank. In Fig. 5 is shown an oil quenching tank in which water is circulated in an outer surrounding tank for keeping the oil bath cool. Air is forced into the oil bath to keep it agitated.

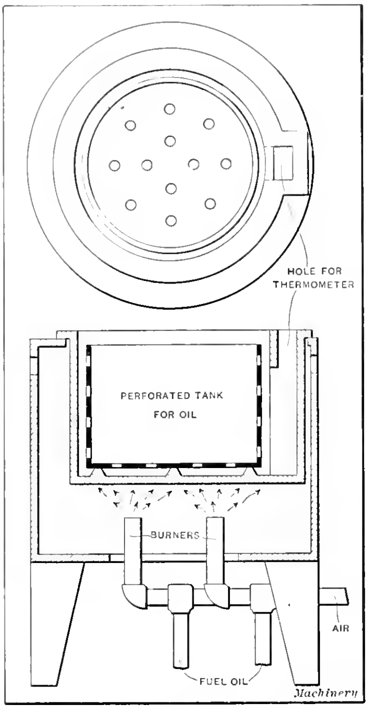

Fig. 10. Special Tempering Furnace with Perforated Oil Tank

Fig. 6 shows a water and oil tank combined. The oil is kept cool by a coil passing through it in which water is circulated, which later passes into the water tank. The water and oil bath in this case is not agitated.

Fig. 7 shows the ordinary type of quenching tank cooled by water forced through a coil of pipe. This can be used for either oil, water or brine. Fig. 8 shows a similar type of quenching tank, but with two coils of pipe. Water flows through one of these and steam through the other. By this means it is possible to keep the bath at a constant temperature.

Tempering Furnaces

In tempering furnaces the only really important consideration is to insure that the furnace is so built as to heat the bath uniformly throughout. It is doubtful if there can be found a tempering furnace on the market that will fill this requirement entirely, although many give good results in general. It is never safe, however, to let any tools being tempered rest against the bottom or sides of the tank, as no matter how scientifically the furnace may be built these parts are, in most cases, hotter than the fluid itself. It is, of course, just as important not to let the thermometer rest against any of these parts in order to insure correct readings. After the pieces tempered are taken out of the oil bath, they should immediately be dipped in a tank of caustic soda (not registering over 8 or 9), and after that in a tank of hot water. This will remove all oil which might adhere to the tools.

Fig. 9 shows an ordinary type of tempering furnace. In this the flame does not strike the walls of the tank directly. The tools to be tempered are laid in a basket which is immersed in the oil. In Fig. 10 is shown a tempering furnace in which means are provided for preventing the tools to be tempered from coming in contact with the walls or bottom of the furnace proper. The basket holding the tools is immersed in the inner perforated oil tank. This same arrangement can, of course, be applied to the furnace shown in Fig. 9.

* * *

ARE IRON AND STEEL CHIPS COMBUSTIBLE?

"Pig iron under water" has been described as a typically safe insurance risk, and to most persons iron or steel in any shape is equally free from liability to catch fire and burn up. Nevertheless, a recent experience of the Rushmore Dynamo Works in Plainfield, N. J., with a big pile of steel chips which actually caught fire from a blazing rubbish heap near by shows that finely divided iron or steel may sometimes oxidize faster than it can get rid of its heat, and hence may exhibit all the phenomena of combustion. The story is vouched for by Mr. S. W. Rushmore in the following words:

"Out in our yard we have a big heap of steel chips from the automatic turret and screw machines, which we sell from time to time in lots of several car loads. Steel being generally considered a non-combustible, this heap is quite close to the box lumber pile. Saturday afternoon, August 2, the pile stood eight feet high and contained several car loads, when the yard gang piled up alongside of it a lot of old barrels and rubbish and set fire to the latter. Of course, the steel pile got warm. On going my rounds, to see that everything was in shape before going home, I discovered smoke and flame issuing from the supposedly fireproof heap, which at several points at the bottom glowed white hot. The heat rapidly increased until it threatened to fire the lumber, so the watchman got out the hose and played a one-inch stream on the pile. The flame went down and I supposed the fire would soon go out, so I went home. Three hours later the night watchman 'phoned me that in spite of the hose the fire was getting worse, so I called the fire department, which found a lively little volcano at work. They worked on that pile of chips for just an hour with two powerful streams, and after many explosions of steam and gas, and after the whole yard had been flooded, declared the fire out and went home. At 10 o'clock Sunday morning the day watchman 'phoned me in a hurry that the fire had started again, and sure enough I found that darned pile a seething mass, making a weird and threatening hissing sound, but with little smoke and only thin yellowish flames. The department was again called, and after a couple of hours the pile was cooled down and dug into until apparently dead.

"The chips are put through a centrifugal separator, and the small amount of oil remaining had nothing to do with the fire. It was a plain case of burning iron. The metal was so finely divided, and presented so much surface to the oxygen in proportion to the radiating surface of the pile, that, once started by the heat from the rubbish pile, the combustion proceeded exactly as in a pile of coal, only apparently at a more rapid rate. I had never seen an iron fire before, and had never considered iron chips a fire risk, but anyone having seen that fire would never think of storing a large quantity inside any building. I was surprised to find that the metal had not melted. Where the fire had been hottest the chips were a dark blue. The pile sank about a third in height, and a lot of metal must have been oxidized to create so much heat. Next time I shall almost expect to see the concrete walls blaze up."

* * *

We talk lightly of high vacua, or even of a perfect vacuum, says the *Scientific American*. It is instructive to calculate the number of molecules contained in a cubic millimeter of gas at the lowest pressure on record. W. Gaede has recently succeeded in exhausting a vessel to a pressure of two ten-millionths of a millimeter of mercury (four one-thousand-millionths of a pound per square inch). At this pressure one cubic millimeter of gas would still contain about eight-and-a-half million molecules.

AN ITALIAN MILLING MACHINE

A MACHINE IN WHICH BOTH SPEED AND FEED CHANGES ARE DERIVED FROM THE SAME GEAR BOX

BY JOSEPH HORNER*

An unusual design of milling machine, manufactured by Officine Dubosc, Societa Anonima, machine tool builders of Turin, Italy, is shown in Fig. 1. The most interesting feature

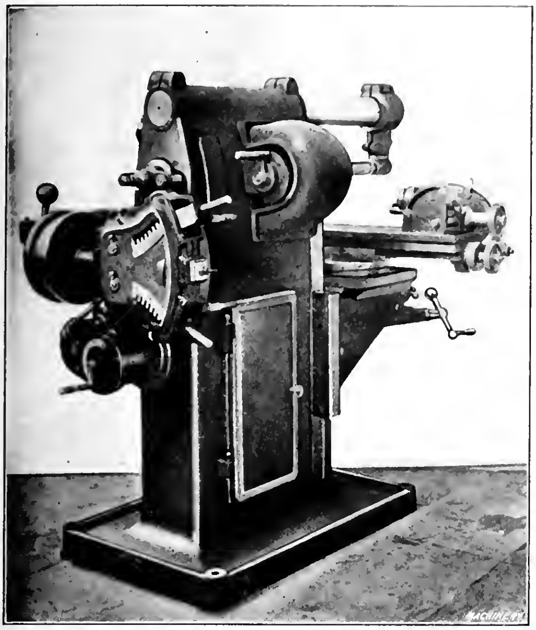

Fig. 1. Italian Milling Machine with Combined Speed- and Feed-changing Mechanism

of this machine is the mechanism by means of which the speed and feed changes are obtained. The power is derived from a single belt pulley which transmits motion through a cluster of bevel gears enclosed in a box at the rear of the column. The main spindle is driven through a sliding gear meshing with one side of the central cone of gears, and the

with a brass bushing. The belt pulley is engaged or disengaged by means of these friction disks which are located on each side, as shown. The disks are operated by a lever attached to part B, the lever being weighted with a knobbed handle, as shown in Fig. 1. When the machine is not in use, the friction disks are kept out of contact with the pulley by a coiled spring located in recesses formed at the inner ends of the disk hubs. Part B has a threaded extension which screws into a bushing in bearing bracket C. When the ball-handle attached to B is turned to the right, the adjustable screw E and part B move axially and cause disk D to grip the driving pulley. The amount of this axial movement is slight, being just enough to make and break frictional contact with the pulley.

The pulley shaft G is mounted in three bearings and is equipped with a ball end-thrust bearing, having provision for adjustment by means of lock-nuts. On the right end of this shaft, through which power is transmitted to the spindle and feeding mechanism, a cone of seven bevel gears is keyed permanently. The sliding gears H and F, which are feather-keyed on the diagonal shafts seen above and below, can be engaged with any one of the cone of gears on shaft G. The speed changes are obtained by shifting lever N and gear H, and the feed changes by lever O and gear F. These levers have two movements; that is, they swing vertically about pivots at the inner ends, to bring the sliding gears into mesh with large or small gears of the cone, and the handles and sliding gears also have an axial movement. As will be seen, the gears are carried in bosses at the ends of the handles, in which they are secured by circular nuts. The axial movement is provided for by splines extending along the pivoted shafts.

In the diagram Fig. 4, the locations of the centers of the pitch cones for different positions of the movable gears are shown by the small circles. The apices of the pitch cones of any movable and fixed gear that may be in mesh intersect on the center line of the central cone of gears. The speed- and feed-change levers are properly located and locked in each position by a series of notches with which suitable locking pins engage. Adjacent to each notch the speeds and

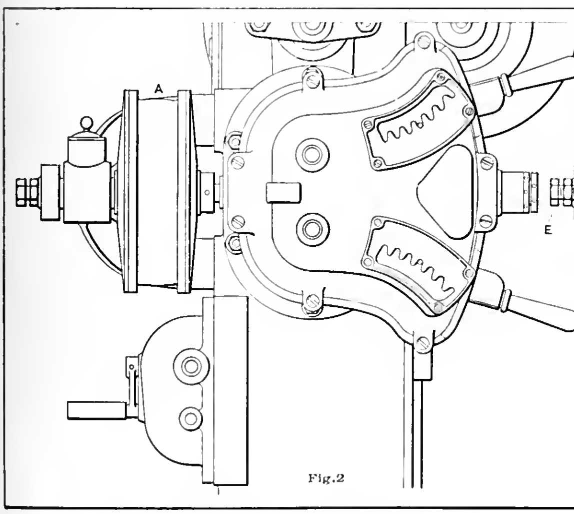

Fig. 2. Rear View of Speed and Feed Box

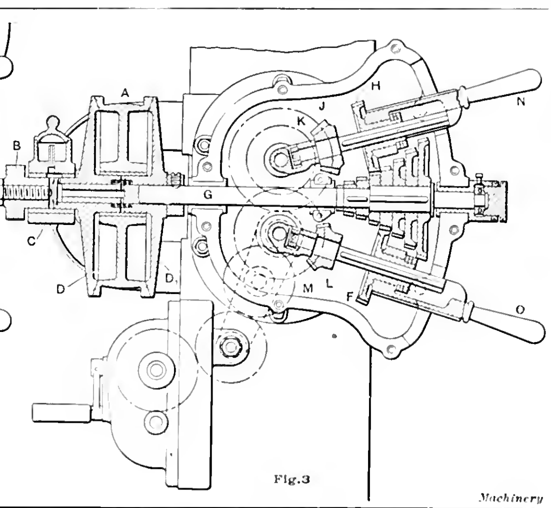

Fig. 3. Sectional View of Speed and Feed Box

feed mechanism is driven through a sliding gear on the opposite side of the central cone.

Fig. 2 is a rear elevation showing the outside of the gear box, and Fig. 3 is a sectional view showing the nest of cone gears and their relation to the driving pulley. This pulley A is driven at 320 revolutions per minute. Normally, it runs loosely on the hubs of friction disks D and D_1 and is provided

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feeds which correspond to that particular position are stamped.

The speed and feed motions are transmitted through the sliding bevel gears H and F upward and downward, respectively. Motion to the spindle is transmitted through fixed pinion J, which engages with gear K (see Figs. 3 and 5). Gear K, in turn, is keyed to a horizontal shaft N, Fig. 5, having at its opposite end a gear O. The latter is constantly

in mesh with gear *P*, which, with gear *S*, runs loosely on the main spindle *Q* of the headstock. On this spindle a larger gear *R* is keyed. By means of these gears, and the spring pins *B*, the spindle can be driven either direct or through the back-gearing. This change is effected by operating a forked lever engaging with collar *T* and actuated by the

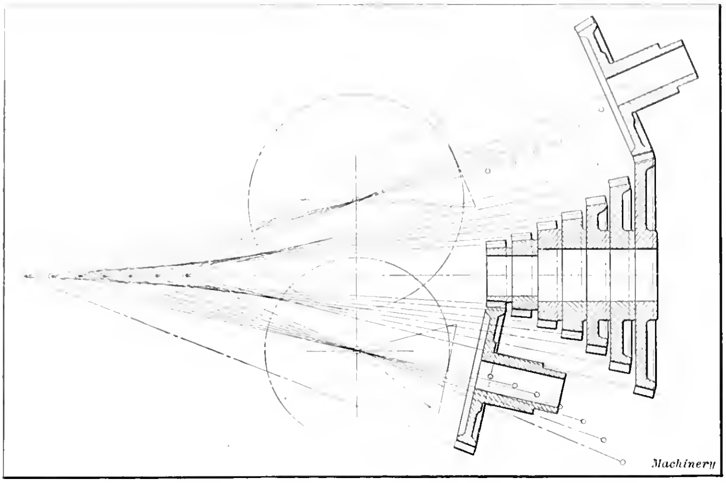


Fig. 4. Diagram showing Relative Positions of Fixed and Sliding Gears

handle seen at the rear of the housing, in Fig. 1. When the spindle is driven direct, gears *P* and *R* are locked together by pins *B*, at which time the back-gears are disengaged. The movement of the lever for shifting collar *T* also controls the position of the back-gears, so that when the spindle is to be driven direct the back-gears are automatically disengaged.

The speed-changing mechanism gives the following revolutions of the cutter spindle per minute:

With the back-gears in mesh....	14	17	22	27	34	42	54
When driving direct.............	63	84	108	132	164	203	260

The feed motion is derived from fixed pinion *L* which meshes with gear *M* (Figs. 3 and 5). The latter is keyed to shaft *W*, which, through gears *X*, transmits motion to feed box *Y* at the rear of the machine. At this point two changes of feed can be obtained by shifting the handle seen attached to the box in Fig. 1. The feeding movement is transmitted to the front of the machine through a telescopic shaft in the usual manner. Gear *Z*, through a shaft and gear meshing with gear *A*, drives the cross-feed shaft which engages nut *C*. This nut has an adjustable section for taking up the back-lash due to wear of the threads. The shaft driven by gear *Z* carries the miter gear *D* which meshes with another miter gear on the vertical shaft (not shown) from which pinion *E* is driven. The latter, in turn, transmits motion to miter gear *F*, which actuates the longitudinal feed-screw; the latter is provided with the usual reverse clutch. The vertical adjustments of the knee are effected by a ball-handle having a shaft set diagonally and connecting with the telescopic screw through a pinion meshing with bevel gear *J*. The main spindle bearings are fitted with split boxes which are fitted in bored conical seats. Axial adjustment is provided for taking up wear.

REDUCING SHOP COSTS

The efficiency expert or systematizer who tries to accomplish a reduction of manufacturing costs by reducing wages is attacking the problem at the wrong end, and he generally comes to speedy grief. The storekeeper who tries to get more trade by reducing prices is in the same class. The storekeeper is likely to go into bankruptcy soon after having demoralized his trade and prices. Both the efficiency expert and the storekeeper fail to realize that the secret of success is service. The systematizer's real business is to train the employes to produce more with the same effort and thus to earn more for themselves and the concern employing them. To cause them to earn less for themselves will almost inevitably result in earning less for their employers. The storekeeper who cuts prices voluntarily reduces his own wages, which means that he must eventually render poorer service. What he should do is to study how he can serve the public better. If he can render better service and thus attract larger trade at standard prices, he may then be able to reduce prices because he is producing more per employe, and all are earning more. Service should be the motto—not merely reduction of costs. More service means lower costs, and this applies to goods and wages alike.

* * *

CYANIDE FOR CLEANING HARDENED STEEL

A method of treating taps and other tools in hardening which leaves them free from scale and with a silvery surface is to use a layer of potassium cyanide on top of a lead heating bath. A tap or other tool immersed in the lead receives a coating of cyanide which cleans off all scale or rather prevents its formation. When dipped in the hardening bath the cyanide dissolves instantly, leaving the work in condition for rapid polishing. Of course an exhaust hood must be provided over the pot to draw off the deadly cyanide fumes

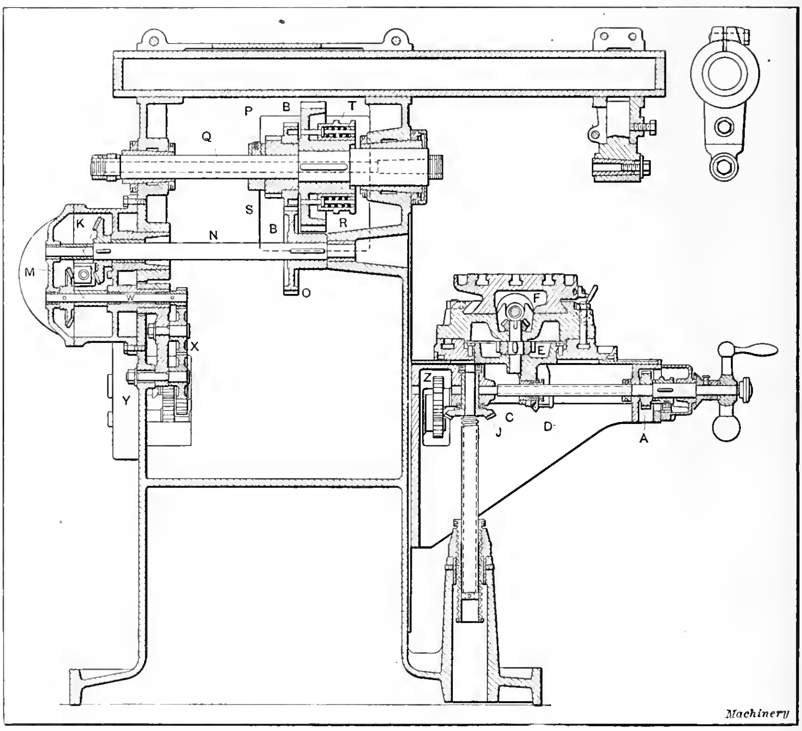


Fig. 5. Sectional View of Italian Milling Machine

RESISTANCE OF STEELS TO WEAR IN RELATION TO HARDNESS AND STRENGTH*

The increasing speeds and heavy duty of machinery and motive power, with resultant shortening of the length of service of parts through rapid wear, makes the study of wear resisting qualities of metals, especially steel, one of increasing importance. In the railway field, the increasing wear of tires and rails due to increased loads and speeds is a serious matter. Not only is it desirable to have high resistance to wear, but it is necessary to have other qualifications, such as strength and toughness, to insure against failure or breakage. The tests described in this article were undertaken with the object of studying the relations, if any, between the wear resistance of various steels and the various physical properties of elastic limit, tensile strength, and hardness. Owing to several protracted interruptions, only a relatively small proportion of these tests have so far been completed.

TABLE I. CHEMICAL COMPOSITION OF STEELS TESTED

Mark	Wear Mg. per 1,000,000 Rev.	Treatment, Degrees C	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Chromium, Per Cent	Nickel, Per Cent	Vanadium, Per Cent	Remarks
P	3813.2	none	0 25	0.60	....	....	....	...	
P-1	2436.4	825—600	0.25	0.60	....	....	....	....	
O	1462.0	none	0.45	0.48	....	....	....	....	
O-1	1334.8	825—600	0.45	0.48	....	....	....	....	
8	1120.5	none	0.66	0.70	0.27	....	....	....	Tire
M-1	1104.1	825—600	0.28	0.61	0.28	....	3.10	....	
12	1079.6	825—600	0.75	0.68	0.25	....	....	....	Tire
E-1	1043.1	825—600	0.43	1.30	....	....	....	....	
U-1	958.0	825—650	0.58	0.65	0.20	1.26	...	0.20	Tire
C-1	829.8	825—600	0.38	0.30	....	1.16	2.08	....	
K-1	436.8	900—600	0.46	0.90	0.11	1.03	....	0.14	
F-1	371.9	825—650	0.48	1.15	....	....	....	0.22	
22	368.8	900—625	0.62	0 62	0.27	0.95	....	0.24	Tire
Y-1	367.8	900—600	0.28	0.50	0.12	0.96	....	0.22	
J-1	261.0	900—600	0.46	0.86	0.06	1.02	....	0.22	
D-1	230.1	825—600	0.42	0.22	....	1.27	2.14	0.26	

Machinery

Note—Under the heading Treatment, 825—600 degrees C, for example, indicates that the specimen was oil-quenched from 825 degrees and drawn back at 600 degrees C.

There are three classes of wear: (1) Abrasion—such as grinding, crushing and excavating machinery is subjected to. (2) Lubricated sliding or rolling friction, such as that experienced by machine parts, axles and shafting. (3) Dry rolling friction of the kind existing between wheels and rails. The first class, wear by abrasion, is in many ways less important than the other two. It has, however, been utilized frequently as a means of comparing the wearing qualities of metals for all three classes. The machines used for this purpose are some form of grinding machines and the specimens are ground or abraded under a constant pressure for a certain length of time. The amount of metal removed under these conditions determines the relative wearing value. The most extensive investigations along this line were made by F. Robin and published in the 1910 proceedings of the British Iron and Steel Institute.

Investigations of wear by lubricated friction have been in the past largely confined to bearing metals rather than steel. This undoubtedly has been due to the fact that steel is usually worked against soft bearing metals or bronzes which wear much faster. The investigation of the wear resistance of steel and iron under lubricated friction, however, is growing more important with the increasing severity of the requirements of service. Probably the most satisfactory machine for testing wear under lubricated sliding friction is the Derihon machine consisting of a hard steel disk revolving in oil, against the edge of which is pressed the test specimen. E. Nusbaumer, engineer of the Derihon Steel Works, describes this machine and some tests made with it in the proceedings of the fifth congress of the International Association for Testing Materials, 1909.

The third class, wear by dry rolling friction, is the most important; especially when we consider the vast tonnage of steel in service in the form of rails, wheels and tires. A machine for investigating wear under dry rolling friction was described by E. H. Saniter in 1908 British Iron and Steel Institute and consists essentially of a revolving test specimen which drives by friction the inner ring of a ball bearing, the outer ring of which is stationary and loaded. At the sixth congress of the International Association for Testing Materials, Mr. Saniter presented a report on hardness testing and resistance to mechanical wear and gave a summary of the results obtained by Robin, Nusbaumer and himself of the investigation of each of the three classes of wear. The general conclusions of Mr. Saniter were "that while metal with a high Brinell number may be expected to give better wear, there are so many exceptions that the use of a hardness test for the purpose of indicating wearing properties is unreliable as far as the methods of wear testing reviewed are concerned."

The investigations of the author have been confined so far to the third class of wear *i. e.*, dry rolling friction. The machine used is a modification of Dr. Stanton's fatigue-testing machine described by him in a paper before the British Iron and Steel Institute, 1908. Details of the machine are shown in the illustration. It consists essentially of three casehardened rollers 3½ inches in diameter. The two lower rollers are driven by gears, while the third or upper roller is driven by friction. The upper roller is carried in the lever by which the load is applied to the test specimen. A load of 1000 pounds on the specimen is possible with this machine. The rollers each have a groove in the middle, ¼ inch wide, to take the corresponding band on the test specimen and keep it from lateral motion. If the rollers all revolved at a uniform speed the amount of wear on the test specimen would be very slight, practically nil, as there would be no slippage of the test specimen. In order to accelerate the wear and approximate as nearly as possible the actual wearing conditions of wheels and rails, the two lower

TABLE II. RELATION BETWEEN HARDNESS, TENSILE PROPERTIES AND WEAR

Mark	Wear, Mg. per 1,000,000 Rev.	Hardness		Elastic Limit, Pounds per Square Inch	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent in 2 Inches	Reduction of Area, Per Cent	Treatment, Degrees C
		Brinell	Scleroscope					
P	3813.2	134	23	47,000	68,000	33.0	57.3	none
P-1	2436.4	170	27	58,000	80,000	28.5	67.0	825—600
O	1462.0	156	26	43,000	79,000	28.5	47.5	none
O-1	1334.8	207	30	71,000	96,000	23.0	57.3	825 600
8	1120.5	196	34	63,000	121,000	14.0	19.0	none
M-1	1104.1	207	30	87,000	106,000	25.0	67.5	825 600
12	1079.6	228	38	97,560	144,930	15.0	23.0	825 600
E-1	1043.1	223	35	91,000	105,000	23.5	58.6	825 600
U-1	958.0	248	43	98,000	120 000	19.0	52.8	825 650
C-1	829.8	286	47	127,000	134,000	20.0	57.3	825 600
K-1	436.8	340	54	156,000	163,000	15.0	45.0	900—600
F-1	371.9	262	42	115,000	127,500	18.5	54.7	825—600
22	368.8	302	43	128,000	147,000	16.5	42.0	900 625
Y-1	367.8	293	50	137,000	148,000	16.5	46.0	900—600
J-1	261.0	340	54	162,000	167,500	14.5	49.0	900 600
D-1	230.1	340	52	156,000	161,150	16.0	53.3	825—600

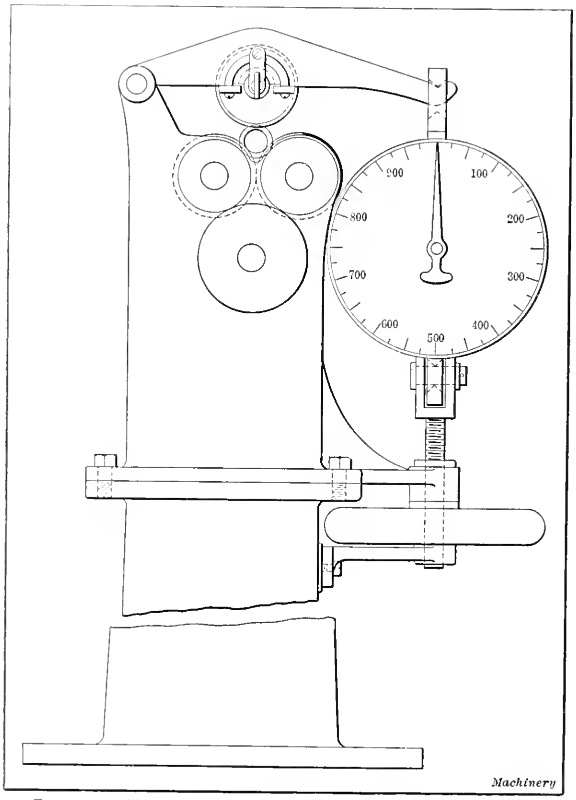
Machinery

*Abstract of a paper read by George L. Norris before the sixteenth annual meeting of the American Society for Testing Materials.

rollers are driven at different speeds to produce slippage of the specimen. This is accomplished by having three less teeth in one of the driving gears.

The test specimens are 2 inches long by 7/8 inch in diameter; and the guide band is 1/8 inch larger in diameter and a scant 1/4 inch wide. They weigh about 160 grams and can be accurately weighed on a chemical balance to 1/10 milligram. The diameter of the specimens which this machine will accommodate can vary from 5/8 inch to 1½ inch as may be required. The driving speed of the machine is 1000 revolutions per minute, and the speed of the test specimen is about 5000 revolutions per minute. The usual run before weighing is 100,000 revolutions of one of the driving rollers, corresponding to practically 500,000 revolutions of the test piece. In the following tests the applied load was 224 pounds, or 100 kilograms. Excepting in the cases noted in Table I, the specimens were all turned from rolled bars 1⅛ inch in diameter. While the tests show a general decrease in the amount of wear, as the hardness and strength increase, the progression is very irregular, and there are several instances where softer steels show less wear than the harder ones, as, for example, 12 and E-1; C-1 and F-1.

It is evident that the composition of the steel influences the resistance to wear to a very considerable degree. Robin,



Type of Machine used for testing Resistance to Dry Rolling Friction

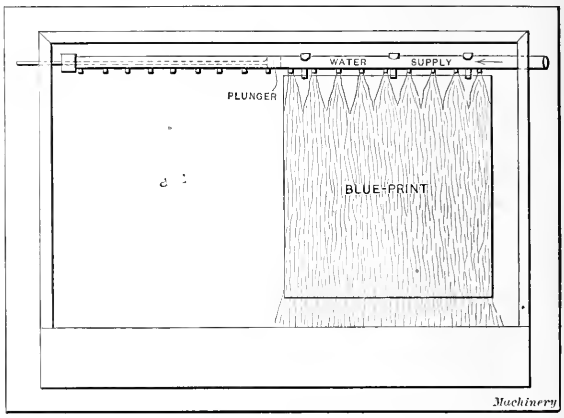
in his investigations, found that nickel, chromium and vanadium each increased the resistance of the steel to wear. The tests made by Nusbaumer showed remarkable resistance to wear in low carbon steel with manganese about 1.5 per cent. Saniter, on the contrary, did not find increased resistance to wear in the case of the few alloy steels he reported, excepting for a high manganese steel of the Hadfield type. His chrome-vanadium anad nickel-chrome steels gave greater wear with greater hardness than simple carbon steels of about 0.70 per cent carbon and 0.60 per cent manganese.

The tests made by the writer confirm the conclusions of both Robin and Nüsbaumer, and also those of actual experience that manganese, nickel, chromium and vanadium have a marked effect on the wearing quality of steels. Manganese apparently has a greater effect than either nickel or chromium. Vanadium, however, evidently has a much greater effect than either of these three elements, as it only requires a very small percentage to produce a marked increase in resistance to wear. This is very apparent in steels E-1 and F-1, and C-1 and D-1, each of which pairs is practically alike, excepting for vanadium. As stated in the beginning of this article, these tests are only a small proportion of those planned, and it is the intention to cover not only a considerable range in composition and heat-treatment, but also to study the effect of rollers of different composition and hardness on the rate of wear of the various steels.

* * *

A BLUEPRINT WASHER

A little kink in washing blueprints that is in use in the drafting-room of the George P. Clark Co., Windsor Locks, Conn., seems worthy of description. The principal feature of this washing arrangement is that it takes care of small prints as well as large ones without waste of water. Above the washing sink there is an upright board, slightly inclined, along the top of which runs the water supply pipe, as shown in the accompanying illustration. The blueprint is hung over the top of this pipe by means of clips and the water emerges from small openings closely spaced in the bottom of the pipe. Within the supply pipe there is a plunger which may be moved to any desired position by means of a rod which extends through the blind end of the pipe. This plunger serves to cut off the water supply at any desired point, and limits the stream to passing through the openings at the right of the



A Blueprint Washer

plunger, bringing the full force of the water upon the print and nowhere else. Thus, when a small print is being washed, it is hung at the right-hand side of the washing tank and the plunger moved, so as to limit the progress of the water to the section of the tank occupied by the blueprint. This prevents waste of water and confines that in use to the space occupied by the blueprint, resulting in quicker and better washing.

C. L. L.

* * *

The press agent of the New York, New Haven & Hartford Railroad has great faith in the new steel passenger cars. In describing the Merchants' Limited Express train, "the most gorgeous train in America," he says: "These new trains are practically indestructible. Made of steel, they could go through a stone wall without being scratched. Reinforced underneath with two immense steel girders running the length of the car and attached at the end to a solid cast-steel U-frame, forming the vestibule, no impact, however great, could telescope them. A rear end collision might tilt them up on end a bit, but that would be all. So far as resisting powers go they are built like battleships."

* * *

Speed at the expense of quality is easy, because it is sliding down hill.

ELECTRIC FURNACE HEAT-TREATMENT OF STEEL*

ARRANGEMENT OF THE ELECTRIC FURNACE—EFFECT OF DIFFERENT ELEMENTS ABSORBED BY HEATED STEEL

BY E. F. LAKE†

The use of electric furnaces for hardening and tempering steel, has passed through the experimental stage and there are several types now on the market that have been made commercial successes. It is now about three years since the electric furnace was placed on the market that uses a molten salt bath in which to heat the steel to any of the hardening temperatures used for carbon, alloyed or high-speed steels. This electric salt-bath furnace is also used for any drawing temperature above the flash points of oil, while an oil bath type is used to heat steel to drawing temperatures below this flash point. In the salt-bath furnaces, the electric current is sent directly through the salt by placing electrodes inside of the bath on opposite sides, while in the oil bath furnaces the oil tank is heated from the outside.

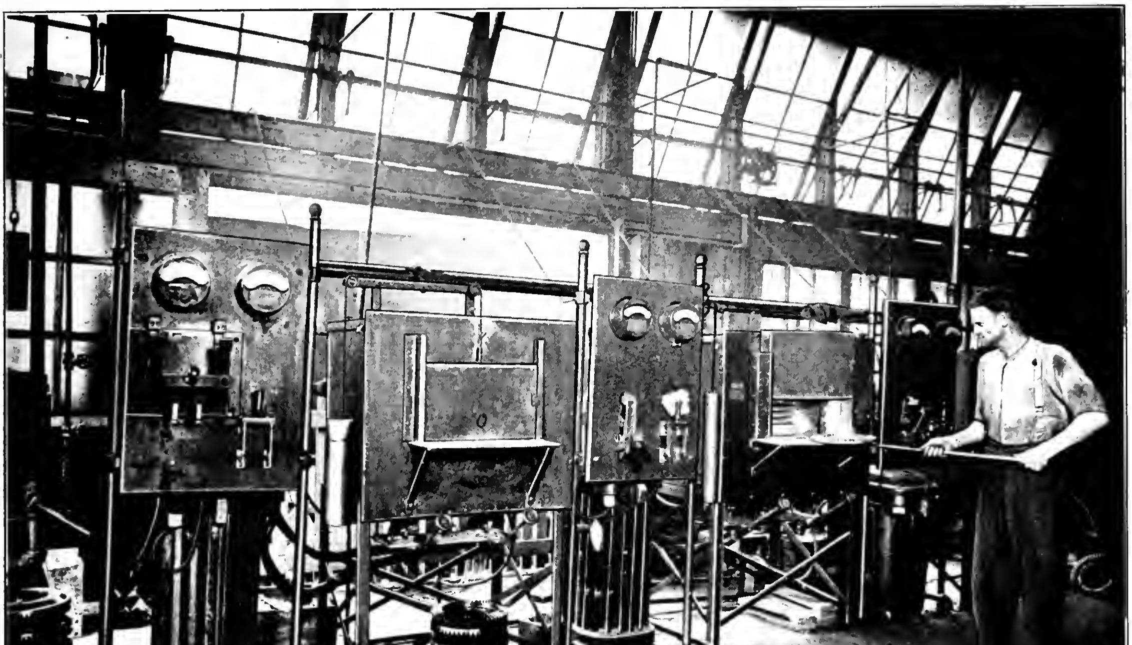


Fig. 1. Battery of Hoskins Electric Hardening Furnaces

Since the introduction of the salt-bath furnace, the oven type of electric furnace has been perfected and installed by several manufacturers for commercial work. Small furnaces of this type have long been in use for laboratory and experimental work, but the principle used for heating, namely, sending the current through coiled resistance wires inside of the heating chamber, is too expensive for the larger furnaces used for commercial work, and the high temperatures required for high-speed steel cannot be reached without burning out the resistance wires. They are very successful, however, for small furnaces that are used at temperatures below 1800 degrees F.

One of the largest installations of this kind is the battery of electric hardening furnaces that are in daily use at the Timken-Detroit Axle Co's. plant, as shown in Fig. 1. These were manufactured and installed by the Hoskins Mfg. Co. of Detroit, Mich. Each separate unit consists of a furnace, switchboard and transformer, which stands back of the switchboard. On the board is placed the line switch for turning on and off the current; a circuit breaker, adjusted to open the circuit automatically in case of an excessive flow of current; an ammeter to show the amount of current being used; and a pyrometer to indicate the temperature inside of the furnace. No rheostat is required, as the furnace can be adjusted to regulate the amount of current that is necessary to produce any given degree of temperature.

Heating Gears in Electric Furnace

The bulk of the work heated in these furnaces consists of the gears that enter into the construction of rear axles used on automobiles. In Fig. 2 is shown the method employed to heat the driving gears to the hardening temperature. It was difficult to harden these large ring gears uniformly at accurate predetermined temperatures, without warpage, before the electric furnaces were installed, but now most of the difficulties have been overcome and good results are obtained. The gears are first preheated to about 1200 degrees F. in another kind of furnace, the corner of which is shown to the right in the halftone. Four gears are then placed on the thick iron disk *A* and heated to the correct temperature for quenching to harden. The disk *A* is slowly revolved automatically, by mechanical means, to insure obtaining a uniform temperature around the entire circumference of the gears. To re-heat four carbon-steel gears, 11¼ inches in diameter, from the 1200 degrees of the preheating furnace, to the 1500 degrees required to harden the gears, takes about twenty minutes. Prolonged heating does not harm the gears as the furnace is maintained at the correct hardening temperature and they will not be overheated, while the atmo-

* For additional information on electric furnaces see the following articles previously published in MACHINERY: "Improvements in Electric Furnaces," July, 1912; "Heat-Treatment of Steel by the Electric Furnace," June, 1912; "Electric Hardening Furnaces," December, 1908; "Hardening Steel by Electricity," February, 1907.

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sphere is reducing and thus prevents the formation of any scale. If not left in long enough, however, they will not attain the temperature of the furnace and therefore the quenching will not give them the desired hardness.

Adjustment and Arrangement of the Electric Furnace

To keep the furnace at the desired temperature, handwheels *B* are turned either to the right or left. This either raises or lowers the electrodes and squeezes together or allows gaps between the carbon plates that form the sides of the interior walls of the furnace. The carbon plates on one side can be seen at *C*. Squeezing the carbon plates together, causes more current to flow and hence more heat to be generated, while allowing them to separate, reduces the flow of current and also the heat inside the furnace. By watching the ammeter, any desired temperature can be produced when one knows what ammeter reading corresponds to this temperature. The operation can be more plainly seen by referring to Fig. 3, which is a sectional view through the center of the furnace. *J* is the heating chamber and *I* the outer shell, which is filled with firebrick. The screws *G* are operated by handwheels *B* to raise and lower electrodes *F*. The latter, in turn, press against graphite blocks *E*, to squeeze together or allow gaps to occur between the carbon plates *C* that form two sides of the interior of the furnace. *D* is the carbon top plate, or roof, and *H* the cement bottom of the heating chamber. The current enters and leaves the furnace at *K*.

Action of Carbon in Heated Steel

It is a well known fact that steels absorb various elements which they come in contact with, when the conditions are conducive. As is well known, this is the principle of the carbonizing process. Many impurities which injure some of the good qualities possessed by the metal, are absorbed under certain conditions, and several elements that better some qualities are absorbed under other conditions. Some of these conditions are known and can be controlled, while many others are unknown or partially known.

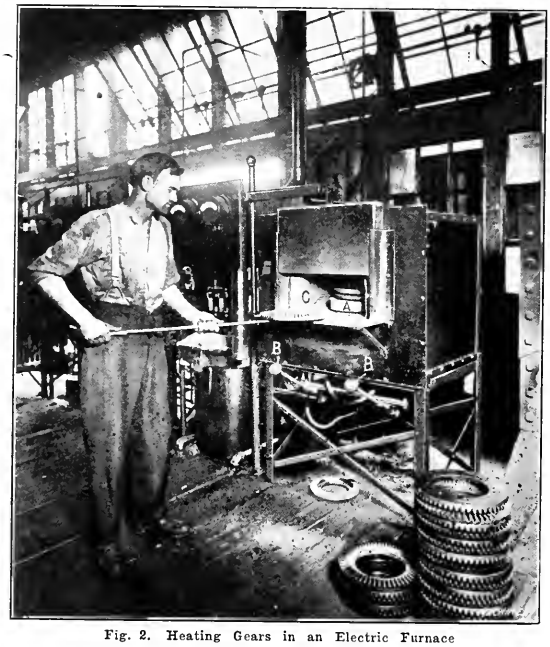


Fig. 2. Heating Gears in an Electric Furnace

Some beneficial elements, of which chromium is an example, can be injected into steel. Carbon flows through steel in a somewhat similar manner to the flow of electricity, although very much slower. If a piece of high-carbon steel and a piece of low-carbon steel are bound closely together and allowed to stand a long enough time, they will both have the same percentage of carbon. This would take many years at atmospheric temperatures, but if the steel is heated, each degree of temperature increase accelerates the flow of the carbon. When the molten stage is reached, minutes will produce, in the equalization of the carbon content, what it might take centuries to produce at atmospheric temperatures.

The principle here involved is that carbon flows to the body or element which has the greatest attraction for carbon. In carbonizing steel, a carbonaceous gas is produced, but the steel has a greater attraction for the carbon than the atmosphere in the carbonizing retort and hence it enters into a combination with the steel. Likewise, with two pieces of steel, the one low in carbon has a greater attraction than the piece high in carbon and draws this element away until the attractive force in each piece has been equalized. In manufacturing steel, the carbon is put into the molten metal and as the iron has a greater affinity for carbon than any of the elements in the slag, it combines with the iron and stays in the steel thus produced; hence, the correct percentage is found in the finished product.

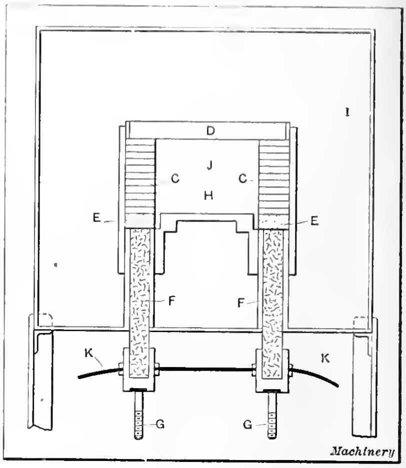


Fig. 3. Diagram showing Arrangement of Electric Furnace

In some furnaces, we often find decarbonized spots in steel that has been heated for hardening. A condition has here been produced whereby some element has entered the heating chamber that has a greater attraction than iron for the carbon; hence enough carbon flowed out of the steel to satisfy this attraction for the time this condition prevailed. Time and temperature seem to be the two factors that control the rate of flow of the carbon. Salt and lead-bath furnaces may produce these decarbonized spots. Sometimes a pitting of the surface occurs, which means that some element is present that has a great attraction for iron and has eaten it away.

In the electric furnaces previously referred to, no such elements seem to be present, as pitted and decarbonized surfaces are not found in the steels heat-treated in them. This applies to the carbon steels, which are heated to hardening temperatures as low as 1300 degrees F., and also to the high-speed steels that require a temperature as high as 2200 or 2300 degrees. Nearly all of the temperatures between these points are utilized, as the correct hardening temperature for some of the carbon steels is as high as 1500 degrees, while the alloyed steels require from 1500 to 1700 degrees and some high-speed steels need a temperature as low as 1750 degrees. The elimination of pitting and decarbonizing is doubtless due to the fact that the oxygen in the air is not required to perfect combustion and none of the products of combustion are present to attack the metal. As the steel leaves the furnace, no scale can be seen and scale always comes from an excess of oxygen. Even when the heated steel is held in the air, the formation of scale starts very slowly; neither is there any of the deposit that is sometimes produced by the products of combustion.

Effect of Oxygen on Iron and Steel

Under certain conditions oxygen has a great affinity for iron and penetrates steel much more rapidly in a moist atmosphere, or one that has been heated. If steel is left in a damp place, it is only a question of time when it will be reduced to an iron oxide in a powdered form, the degree of dampness being the factor that governs the speed of this reduction. This is due to the fact that oxygen forms only one-fifth of the air, whereas it forms eight-ninths of water, by weight.

Thus, if steel is immersed in water it decomposes much more rapidly than when left in the air. Salt water reduces the time of this decomposition as the salt aids the oxygen in forming its combination with iron. Without the aid of moisture, any increase in the temperature of steel increases the ability of oxygen to unite with the iron. When the boiling point is reached, the metal is saturated with oxygen and other gases, but the bulk of these are expelled when the steel solidifies. Enough is often left, however, to considerably weaken its various physical properties.

In furnaces that depend on combustion, or flames, for obtaining the necessary heat, a scale is liable to form on steel at the temperatures required for hardening, unless all of the oxygen is utilized to form the combustion and passes out of the vent as carbon dioxide (CO_2). This scale injures the piece being hardened, as it reduces its size and makes the surface uneven. This formation of scale proves that oxygen combines with steel at temperatures way below the melting point; hence the valves of such furnaces must be carefully adjusted so as not to deliver an excessive supply of air.

In addition to the formation of scale, oxygen injures steel in other ways. When the steel is heated to the higher temperatures, oxygen may enter the open pores to form microscopic bubbles and thus reduce the cohesive force that binds the molecules of the mass together. It may take the form of occluded gas in combination with other gases, or it may form a ferrous oxide with the iron. In any of these forms, oxygen reduces the strength, wearing qualities and resistance to fatigue or torsion stresses. Steels containing oxides also rust more quickly than those that are practically free from them. It is not so much the oxygen itself that is injurious, as it is the oxides that it forms with other elements. The percentage of oxygen has heretofore been considered to be too small to be taken into account, but it is now known that 0.05 per cent of oxygen is equal to 0.22 per cent of ferrous oxides and this is sufficient to materially reduce the physical properties. As oxygen is a gas, it was long difficult to analyze steels for this element, but with the new methods that have been devised, it has been found to be present in steel in larger quantities than was supposed, and efforts are now being made to reduce this impurity in all steels. That the pores of steel are opened by heat and allow the gases to enter or leave, has been proved by a number of experiments where both cast and rolled steel have been heated in a vacuum. Under this condition, the gases began to leave the steel at temperatures between 300 and 600 degrees F. The volume reached a maximum at temperatures between 900 and 1000 degrees, and then reduced to a minimum volume at about 1300 degrees. Another maximum point was reached at about 1450 degrees; then again reduced and again increased at higher temperatures. The greatest evolution of gas seemed to take place at the transformation point of the metal. That gases travel into the steel under atmospheric pressure, instead of out when in the vacuum, is shown by the fact that oxygen combines with iron and raises blisters or scale and also that nitrogen penetrates steel that has been raised to temperatures around 2200 degrees.

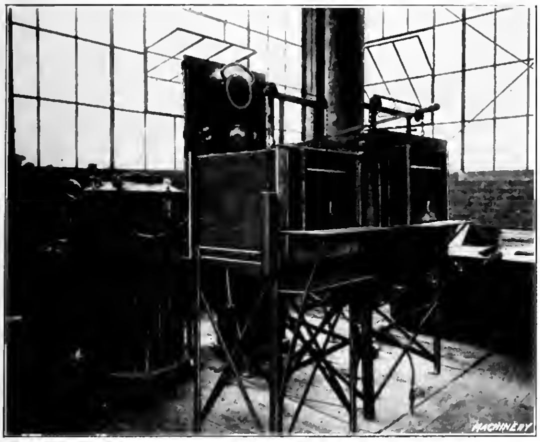


Fig. 4. Low- and High-temperature Electric Furnaces used in Pairs

Effect of Nitrogen on Steel

Nitrogen is just beginning to be recognized as an injurious element in steel. It now occupies practically the same position that sulphur and phosphorus did but a short time ago, when the chemist first proved that they were very injurious elements to the physical properties and means should be devised to keep them as low as possible. Then the practical steel makers scoffed at the chemists for saying that such small percentages of any element could weaken the steel and if it did their ancestors would have made it known. One does not have to be very old to remember the time when such talk was prevalent in the steel mills. It has been proved, however, that nitrogen is as liable to cause brittleness and "cold shortness" as does phosphorus and is as injurious.

The better grades of steel contain 0.005 to 0.025 per cent of nitrogen, while the cheaper grades contain between 0.010 and 0.065 per cent. Each increase in the percentage causes the elongation to diminish rapidly and the ductility to reduce. At first, only a slight decrease occurs in the toughness, but the decrease becomes more rapid as the percentage of nitrogen increases. When the carbon content of steel is high, 0.035 per cent of nitrogen will cause the elongation and contraction to become practically nil, while in medium carbon steel it may take a nitrogen content of 0.050 per cent to accomplish this, and 0.065 per cent in low-carbon steels. Steels made in the resistance type of electric furnace contain only traces of nitrogen, but those made in the presence of basic slag in the arc type may contain an injurious amount.

As four-fifths of the air is composed of nitrogen, by volume, consuming the oxygen with a flame would leave much of the nitrogen free to enter the pores of steel that is heated to the hardening temperatures in ordinary oven furnaces; especially when the steel is heated to the 2200, or more, degrees F. required for hardening some brands of high-speed steel. Decarbonization is doubtless due to the nitrogen that may be occluded in steel combining with the carbon to form methane, which escapes when the metal is heated. Hydrogen being the lightest of the gases, if any of this is present in the steel, it will escape when the metal is heated. This will cause the proportion of nitrogen to carbon to increase and thus enhance the tendency toward decarbonization. As the resistance type of electric furnaces do not consume any of the oxygen in the air, none of the nitrogen is set free. Thus a condition that allows the nitrogen to penetrate the steel is not created, even though it be heated and the pores open. As steel pieces do not warp as much in this type of electric furnaces, as in coal-, oil-, or gas-fired furnaces, it may be because the metal is more dense owing to its not absorbing any gases. The absorption of nitrogen, followed by the formation of iron nitrides, keeps molecules of their own kind further apart by preventing the iron molecules and iron-carbide molecules from coalescing. This causes a greater contraction of the metal, and, consequently, a lower temperature, before the like molecules are brought sufficiently near together for the molecular attractive force to effect a change; hence there is a greater tendency for the piece to warp.

The combustion type of furnace, especially when using coal as fuel, gives off many elements as products of combustion which may be injurious to steel. Among these may be mentioned such hydrocarbons as anthracine, naphthalene, toluene, benzine, methane, ethane, etc., while acetylene, benzole and sulphur are other products. With a large amount of hydrocarbons present in a furnace, it is almost impossible to prevent carbonization in the steels as the gases that are commonly present, other than nitrogen, have no other effect on steels. Thus, some parts of the piece being hardened would be carbonized more than others and cause a variation in the hardness. To prevent this, the muffle type of furnace should be used. The instruction given with all high-grade steels is to heat in a muffle furnace so the products of combustion, or the flame, cannot attack the metal. The construction of the electric furnace, however, is such that it forms its own

muffle and the expense of renewing muffles is done away with. In the neutral atmosphere inside the electric or muffle furnace, the oxygen holds the nitrogen and the nitrogen holds the oxygen. Neither are active and they do not attack the steel. This is plainly seen, as far as the oxygen is concerned, by watching the steel that is being heated. No matter how long it is subjected to the temperature of the furnace, no scale forms on the steel while in this neutral atmosphere. Oxygen always attacks the exposed surfaces first and causes blisters or scale to form on them; therefore, its action is visible. When no scale forms, the elements in the air must be inactive. When the hot steel is exposed to the air, other forces cause the oxygen to become active, and scale forms rapidly until the steel has cooled to comparatively low temperatures.

In Fig. 4 is shown two electric furnaces that are in use in the Sprang & Chalfant Co.'s plant in Pittsburg, Pa. The furnace to the left is heated by resistance wires and is of the type that is commonly used for laboratory work. It is here used for hardening all steels that do not require a hardening temperature of more than 1800 degrees F., and for preheating high-speed steels which require a greater temperature for hardening. As the wires would burn out if the temperature were raised to about 2000 degrees, its practical working temperature should be kept below this; thus, 1800 degrees is a good maximum to establish. After preheating in this furnace, which is the cheapest in fuel consumption, high-speed steels are heated to the hardening temperature in the furnace on the right-hand side. This furnace is capable of withstanding a temperature of 2400 degrees continuously. It is the same type as shown in Figs. 1, 2 and 3.

Current Consumption and Operating Cost

The carbon resistance furnace to the right, with a heating chamber 12 inches wide, 18 inches deep and 8 inches high, can be brought up to the higher temperatures required for high-speed steel, with 30 kilowatts, in one hour and fifteen minutes, and then be maintained at this temperature with about one-half of this current. With an average amount of steel to heat, it can be operated during a ten-hour day with about 145 kilowatts. The wire resistance furnace on the left-hand side, with a heating chamber 12 inches wide, 26 inches long and 8 inches high, can be raised to its working temperatures for carbon steels in one hour and 30 minutes, with 15 kilowatts and then be held at this temperature with less than one-half of this current. The heat insulation is so effective that furnaces have been closed after turning off the current, and at the end of twelve hours the temperature had only dropped to between 700 and 800 degrees. Smaller furnaces with a heating chamber 7 inches wide, 12 inches deep and 5 inches high, only use one-half as much current.

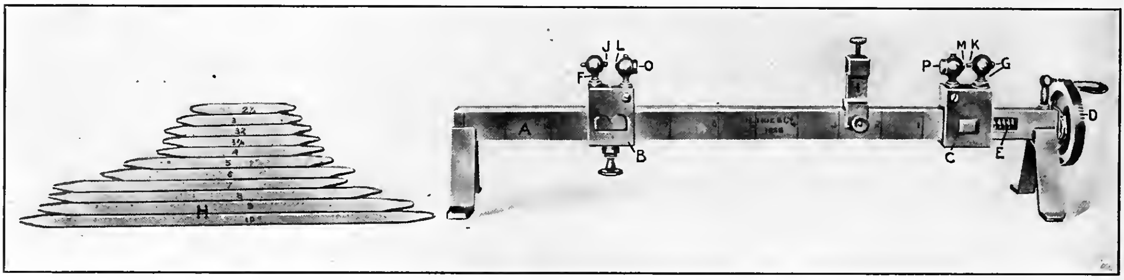
The current cost for an electric furnace is undoubtedly higher than the fuel cost for a gas-, oil- or coal-fired furnace of the same size, but when all other things have been taken into consideration, this current cost is minimized and the electric furnace can be made to compete commercially with other kinds. This is especially true when quality is a factor in the work heat-treated. The ease with which the temperature can be controlled and accurately maintained; the absence of scale or pitting; the decrease in warpage; the cleanliness of the work due to the absence of deposits of any kind; the overcoming of decarbonized spots; the lowering of the penetration of gases or other injurious elements, such as sulphur; and the uniformity in the hardness or temper of the steel, are all things which should be figured against the cost of fuel. In addition to this, the electric furnace can be so heat-insulated that the hand can be held on the outer shell or case without burning. This lowers the temperature of the hardening room and makes the working conditions so much better that operators are enabled to turn out more work. One company cites a case where they heat-treated three tons of cold-rolled steel per week, in the shape of razor blades, in six electrically heated furnaces with two operators; whereas, before their installation, it required fifteen men and sixty-five machines, that used gas and blast, for the hardening operations on the same tonnage. While this might be a case where the work was particularly adapted to electric furnaces, many others can doubtless be found, where a saving could be effected when all of the factors are figured into the cost.

[Since the foregoing article was written, a report has been received from the Timken-Detroit Axle Co. to the effect that the four furnaces mentioned have been in operation three months, and that each hour of the ten-hour work day averages 75 pounds of steel gears heated to the hardening temperature in each furnace. The average current consumption is 13 K. W. per hour for each furnace, costing 1¼ cent per K. W. The average cost per pound of steel hardened is a trifle more than 0.2 cent.—E. F. L.]

* * *

AN OLD BEAM MICROMETER CALIPER

The measuring machine shown in the accompanying illustration was found by the writer in the shops of R. Hoe & Co., New York City, manufacturers of printing presses. This interesting measuring device which is virtually a bench beam micrometer caliper was made by F. Corwin in 1858, who at the time was employed as a first-class toolmaker. The caliper is considered to be one of the first of its type ever developed. The beam *A* is laid off in twelve one-inch divisions, and the graduation lines and figures on the beam were all hand engraved. The adjustable jaw *B* is set on the line by the aid of a magnifying glass, while the other jaw *C* which is screw adjusted is set at division 1, the dial *D* being set at zero. The screw *E* is a square thread of ten pitch, and the dial *D* has 100 divisions, thus providing for readings of 0.001 inch.



An Old Measuring Device originated in the Shops of R. Hoe & Co. Fifty-five Years ago

When first made the caliper jaws were set on the inch mark by the aid of a magnifying glass, and fractional readings between the inch divisions were read off on the dial *D*. An addition was made to the machine so that it could be used for outside as well as inside measurements. This was accomplished by putting additional studs *F* and *G* in the jaws *B* and *C*. Hardened steel pins were inserted in these studs and acted as contact points between which the standard length gages shown at *H* were placed. These standards having square bodies were held in a support *I* clamped to the beam. To set the machine at a required dimension a standard length gage of the required length was placed between the measuring points and the dial set at zero. Then both outside and inside measurements could be taken, as the continued points of the measuring surfaces *L* and *M* (which have since been cut off) were in exact alignment with the points *J* and *K*. The machine was further remodeled by dispensing with the standards and using the additional measuring surfaces *O* and *P* in connection with the graduations on the dial. The jaws were set by standard plug gages and then by means of the graduations on the dial, readings exceeding the setting by one inch could be obtained. D. T. H.

ARBORS FOR SECOND-OPERATION WORK

VARIOUS TYPES USED FOR TURNING, BORING AND GRINDING, WITH EXAMPLES ILLUSTRATING APPLICATION

BY ALBERT A DOWD*

Cylindrical work which cannot be completely machined in one setting and which requires concentricity of the various surfaces obviously makes necessary some method of holding

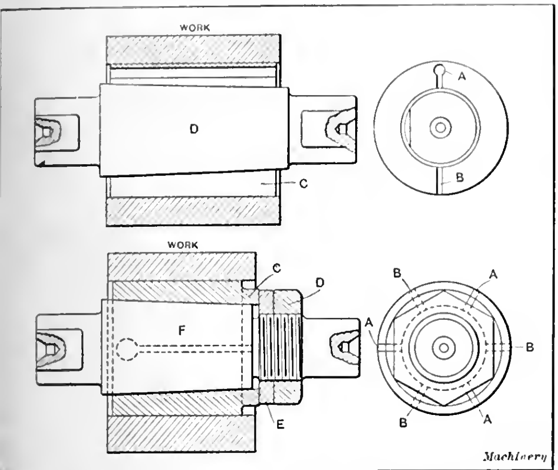


Fig. 1. Two Types of Expansion Arbors with Split Sleeves

it for the second operation which utilizes a previously machined surface for securing the proper location. When this surface is external, the use of soft jaws, a step-chuck or collet jaws is feasible, but when an internal surface is the locating

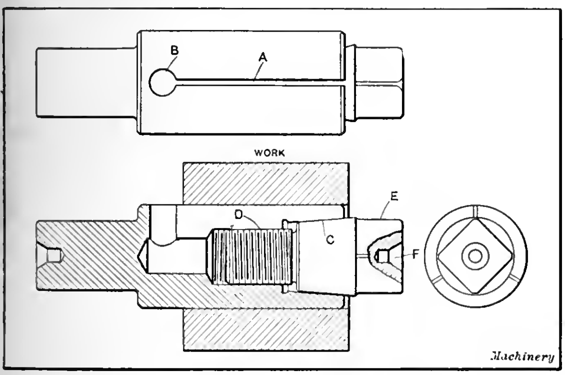


Fig. 2. Arbor expanded by Internal Taper Plug

point the most efficient method is conceded to be some form of arbor. This arbor may be either a plain stud made to fit the hole in question, or it may be so designed as to be susceptible of a certain amount of expansion and contraction in order to take care of slight variations in the finished hole. The degree of accuracy required in the finished product determines the form of arbor which should be used. If a variation of 0.002 to 0.003 inch in concentricity is permissible, a plain arbor with some method of driving the work will answer the purpose very well. When very accurate work is required, however, greater care must be used in the design, and the expanding type of arbor is commonly used.

Important Points in Design of Arbors

The fundamental features which tend to make an arbor thoroughly efficient are as follows: Expansion must be uniform along the entire periphery; release must be quick and easy; ample driving facilities must be provided; clamping the work must be effected without chance of distortion.

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As an additional refinement, provision may be made for truing up the arbor so that it will run accurately with the center line of the spindle.

Lathe Arbors

Let us first consider the arbors designed for use in the engine lathe, adapted to be held between centers and driven by means of a dog on one end. The arbor shown in the upper part of Fig. 1 is the simplest of all those which have a split sleeve or bushing capable of expansion or contraction. The mandrel *D* is slightly tapered and is flattened on each end to receive the dog for driving. The sleeve *C* is correspondingly tapered and is drilled entirely through at *A*, after which it is saw-cut at *B* to allow for expansion. This arbor is the poorest of all the expanding types in that the expansion is not uniform, being in two directions only, and it cannot be depended upon to give results which are absolutely accurate.

A much better arbor is shown in the lower part of the same illustration. It will be noted that the mandrel *F*, in addition to being tapered, is threaded on one end to receive the hexagon nut *D*. This does away with the necessity of

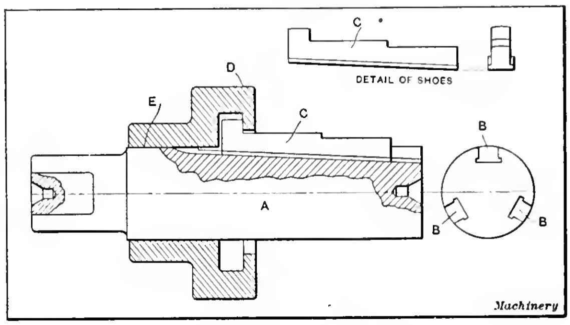


Fig. 3. Expanding Arbor of Sliding-shoe Type

using the arbor press to expand the sleeve. The collar *E* is interposed between the nut and the split bushing. This bushing *C* is saw-cut at *A* from one end and at *B* from the other, thus allowing a uniform expansion along its entire periphery. In this connection, it is well to note that the ends of the saw-cuts should be left tied together until after the sleeve has been hardened and ground; they can then be cut apart readily with a thin emery wheel. An arbor of this kind is mechanically correct and, if carefully made, should give results which leave nothing to be desired as far as accuracy is concerned.

Fig. 2 shows an arbor of a very different type, which might be called a solid expanding arbor. Three holes *B* are drilled 120 degrees apart and the saw-cuts *A* are milled as shown.

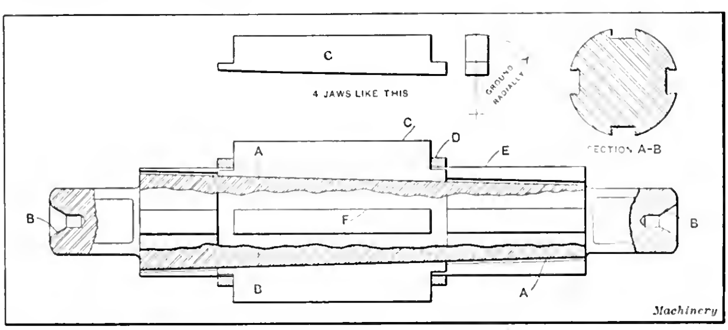


Fig. 4. Expanding Arbor with Sliding Shoes retained in Slotted Sleeve

The special screw *E* is tapered at *C* and threaded at *D* in the body of the arbor. The end of this screw is squared and contains the center *F*. When made as shown there is nothing

in this arbor to commend it. In the first place, the expansion takes place at one end only and is not at all uniform, and, in the second place, the center F in the end of the screw cannot be depended upon to remain true for any length of time, even assuming that it may have been made reasonably true to start with, which, in itself, is a difficult machining proposition.

The arbor shown in Fig. 3 was at one time manufactured commercially by G. E. Le Count, South Norwalk, Conn., but the writer is unable to state whether it is on the market at the present time or not. It consists of the body A in which are milled the tapered slots B. The shoes C (also shown in detail in the upper part of the illustration) have a narrow rib running along each side and this rib engages with the grooves in the sides of the slots B, thus preventing the shoes from falling out. The collar D controls the action of the shoes and is ground to a sliding fit on the cylindrical portion E of the arbor. It may be noted that the shoes have two shoulders, thus increasing the range of the arbor. By providing shoes of various diameters the range can be increased considerably.

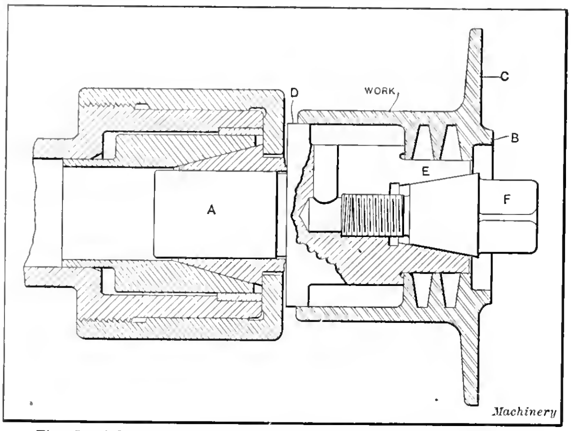


Fig. 5. Arbor held in Collet and expanded by Internal Taper Plug

W. H. Nicholson & Co., Wilkesbarre, Pa., manufacture the expanding arbor shown in Fig. 4 in various sizes and to suit various conditions. The body A is made of tool steel, hardened and ground to a cylindrical form. The centers are exceptionally large and are carefully rounded and lead-lapped after hardening. There are four slots in the body (shown in the section A–B), and these slots are relieved at each corner to prevent any interference by dirt. After hardening, the slots are also ground to insure truth. The jaws C (also shown in detail) are made of special steel and carefully ground to the same taper as the slots. After assembling, they are also ground radially on their own arbor. The sleeve D acts as a retainer for the jaws and is a running fit on the cylindrical portion E of the arbor. Four slots are cut through the sleeve and the jaws are held in position by them. These arbors are too well known to need further comment, as they are in general use throughout the country.

Turret Lathe Arbors

We will now go a step further and take up the type of arbors adapted for use in the horizontal turret lathe. It is well to bear in mind that arbors of this sort should be so designed that the work may be easily and quickly put on and taken off without the assistance of anything more than a wrench or spanner. Every precaution must also be used in clamping and driving the work, so that no chance for distortion is possible.

The arbor shown in Fig. 5 is somewhat similar in construction to that in Fig. 2, except that it is adapted to be held in collet jaws instead of on centers, as in the former instance. This arbor gave satisfactory results on the work for which it was used, the surfaces B and C being faced within the required limits of accuracy. The work was a push fit on the cylindrical portion D, the expansion taking place at E, controlled by the tapered screw F. In this case, the nature of the work permitted a slight margin of error and

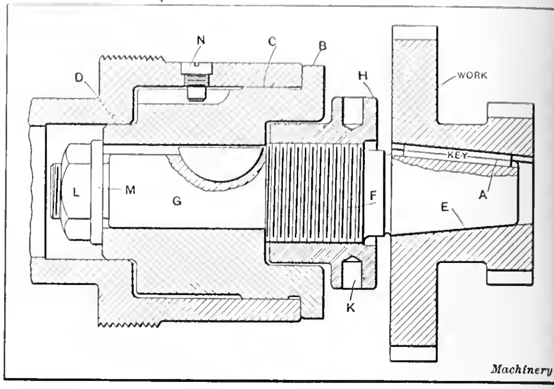


Fig. 6. Taper Arbor mounted in Spindle and equipped with Nut for removing Work

the expansion was only necessary to prevent chatter and act as a driver. The shank A is held in the collet jaws.

The arbor shown in Fig. 6 was made for the transmission gear which is shown in position. After the taper hole had been "chucked" in the work (which was done in a previous setting), the keyway A was cut for assistance in driving. The arbor body B is of cast iron, ground to fit the spindle at C and D. The stem G is of steel, hardened and ground to fit the body, into which it is keyed to resist the torsion of the cut. It is held in position and drawn back by the nut and collar L and M. The forward end is ground to the correct taper E, and the key is inserted at A. The portion F is threaded with a six-pitch Acme thread, right-hand, and the nut H is used to remove the piece after the work is finished, a piece of drill rod being used in the spanner hole K to turn the nut. The screw N prevents the body from turning in the spindle. This arbor has given very satisfactory results.

A somewhat extraordinary condition is shown in Fig. 7, which illustrates a steel automobile hub and arbor. In this case, the bearing seats at A and B were required to be absolutely concentric. In order to assist in machining, the portion C was bored to size in the first setting, although no finish was required at this point. The body of the arbor D is of tool steel, hardened and ground at all important points. The small end is slotted in three places as shown at F and

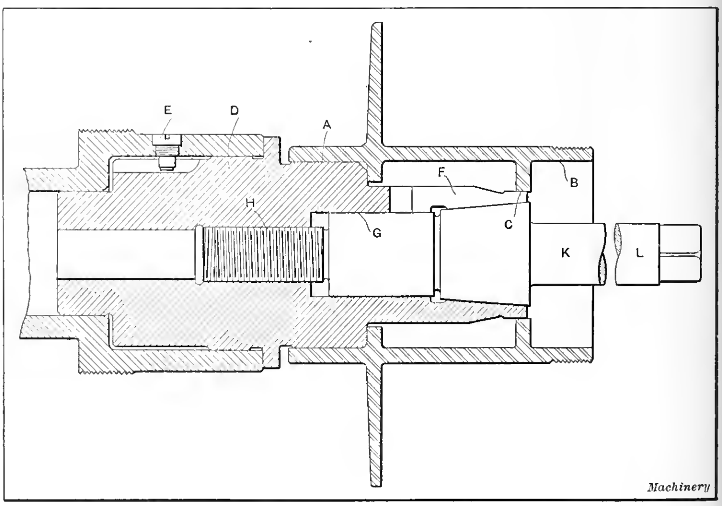


Fig. 7. Arbor with Split Expanding End and Pilot for steadying Tools

is spring tempered at this end. The operating rod K has a very free thread at H and is ground to a snug running fit in the cylindrical portion G to insure a true running pilot L, regardless of the condition of the threaded part. All the tools used on surface B of the work were piloted by the stem L, thus securing absolute truth and concentricity of the ends A and B.

There are several important points to be noted in the construction of this arbor. First, the method of obtaining a true running stem L by means of the long cylindrical bearing at G; second, the use of the stem as a pilot for tools, thereby obtaining concentricity in the two ends of the work A and B; third, the positive location of one end at A, while using an expansion principle at the other end to insure rigidity and freedom from chatter. This arbor was very satisfactory, the two ends being within the extremely narrow limits of concentricity required.

An entirely different type is illustrated in Fig. 8. This is used for two different sizes of bronze bearing retainers, the use of adapters making this feasible. In the construction of this arbor, the body A is screwed directly onto the spindle nose, bringing up snugly against the end of the spindle at B. The body itself is of steel and is tapped out at C to receive the operating screw E. As in Fig. 7, the thread is a free fit, while the cylindrical portion D is ground to a snug running fit to insure concentricity. The bushing F is saw-cut in six places, three cuts from one end running nearly through, and the other three in like manner, in order to allow uniform expansion of the bushing. Both the bushing and the operating screw are tapered correspondingly at G. The adapter H slips onto the body of the arbor and is located from shoulder M and secured in place by three screws N. A pin driver L in the adapter relieves the bushing of excessive strain. The larger retainer O (shown in detail) is also handled on this same arbor by using the adapter K. The results obtained with this arbor were perfectly satisfactory.

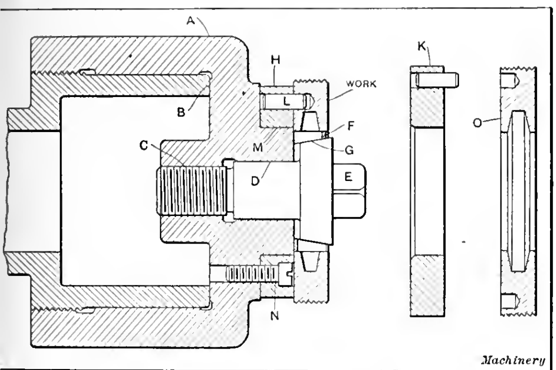


Fig. 8. Arbor having Taper Plug which expands Split Bushing

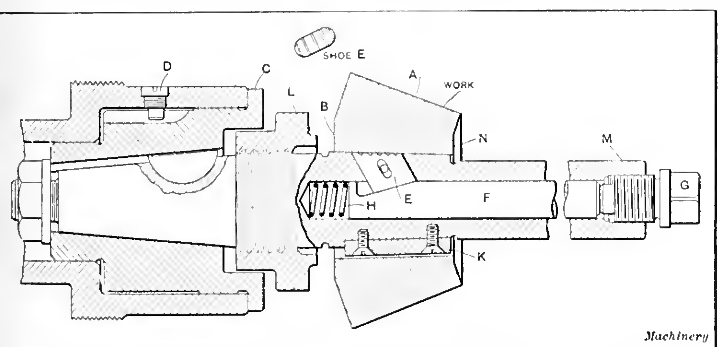


Fig. 10. Arbor having Adjustable Shoe E which bears against Taper Bore of Pinion Blank

In Fig. 9 the principles of expansion and contraction are both used in handling steel rifle part A. The permissible limits of error on this work were very close, so that extremely careful workmanship was necessary. This operation was the final one on the piece, after it had been machined all over, leaving 0.015 inch at C for truing to insure absolute concentricity between surfaces B and C.

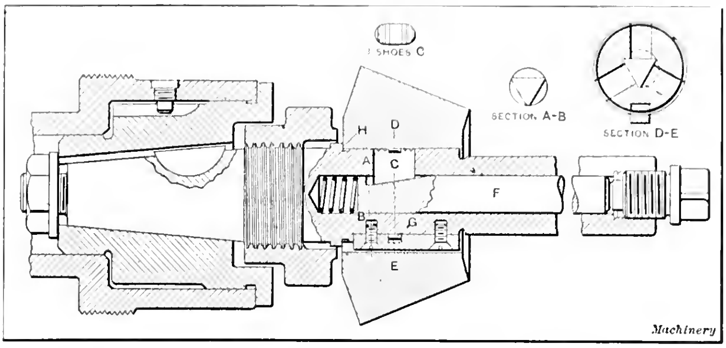


Fig. 11. Arbor for Pinion Blanks, equipped with Three Expanding Shoes

The machine to which this fixture was applied was equipped with collet mechanism, part of which was used in the operation. The body of the fixture E is of cast iron and is screwed onto the spindle nose, being secured against turning by the teat-screw F. The sides of the fixture were left open to enable the operator to reach in and grasp the work, in order to guide it onto the locating bushing B. The operating rod G was milled at an angle on the forward end H, in order to force the pin K outward and thus insure rigidity at this point. The collet operating sleeve M is secured to the rod by pin N, so that the collet closing mechanism can be used to operate the rod. At the forward end of the fixture, the split bushing O is used to center the work which is gripped on the finished cylindrical surface D. The bushing is knurled at Q and is contracted by the action of the hollow set-screw P. All important surfaces were ground to an accurate fit and parts subject to wear were hardened. No trouble was experienced with this fixture and the work was machined within the limits of accuracy required.

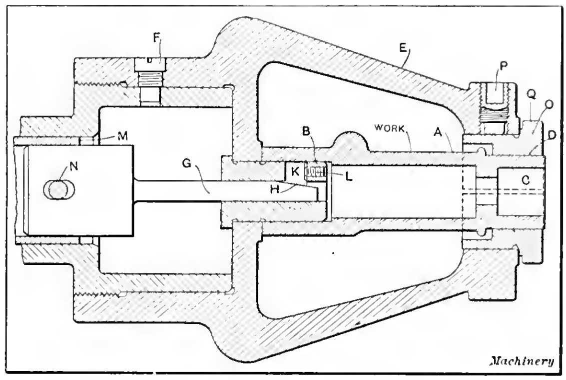


Fig. 9. A Fixture which holds Work by Expansion and Contraction

The steel pinion blank shown at A in Fig. 10 has been previously faced at B and the taper hole carefully bored, leaving the remainder of the work to be accomplished at the setting shown. The body C, in this instance, is of cast iron and is held in position by the teat-screw D. The arbor is of tool steel, carefully hardened and ground. The shoe E is shaped as shown in the detail above. The operating rod F is forced inward by screw G, and its release is effected by spring H which bears against its inner end. It should be noted that the action of shoe E is both outward and backward; therefore it has a tendency to force the work back

onto the tapered portion. Obviously key K acts as a driver. In order to avoid any chance of springing the arbor out of true a small, special wrench is used for turning screw G, so that too much pressure cannot be applied. The nut L is threaded on the arbor with a coarse-pitch Acme thread and is of hexagon shape at the forward end. This nut is used to start the work off the arbor when the piece is finished. The stem of arbor M enters a bushing in the turret and acts as a support while the beveled surface of the work is being turned. This stem is also used as a pilot for the face mills which form the end of the pinion at N. This arbor while used for producing work of the best quality was somewhat fragile and required careful handling.

The pinion blank shown in Fig. 11 has a straight hole instead of a taper one, and the arbor for holding it, while somewhat similar in construction to that shown in Fig. 10, differs as regards a number of points. There are three shoes C, 120 degrees apart, controlled, as to their outward movement, by the operating rod F. These shoes are retained in their positions by the thin circular spring G. The shoulder H on the arbor acts as a positive longitudinal stop for the work. The various sectional views give a good idea of the construction. This arbor is also of tool steel and all important surfaces are hardened and ground. It gave very satisfactory results, but the rather delicate construction necessitated careful handling.

Arbors for Vertical Boring Mill and Vertical Turret Lathe Work

We now come to a class of work of larger size, which can be more conveniently handled in the vertical boring mill or the vertical turret lathe. Arbors for comparatively large work frequently develop into combination locating and holding devices, so that they are more nearly related to locating fixtures in the truest sense of the word. It is well to remember that in all fixtures of large size some efficient means

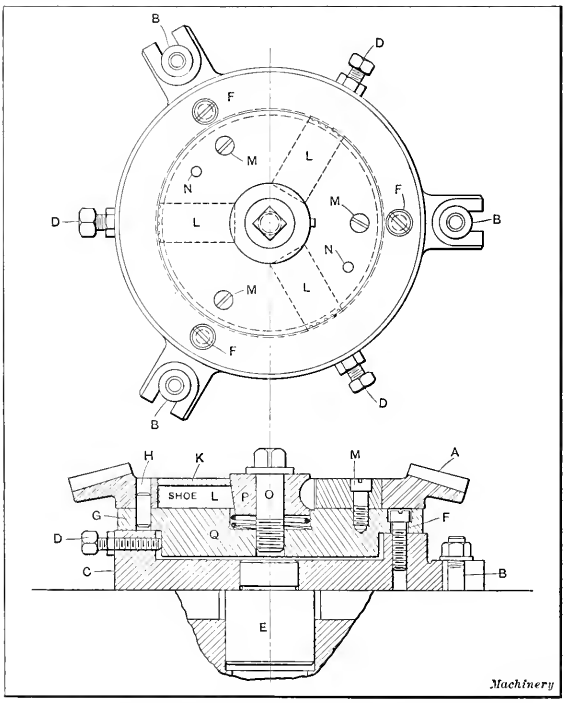


Fig. 12. Vertical Boring Mill Fixture for holding Bevel Gear—The Three Shoes L are forced outward by Plug in Center

of driving the work must be provided, for the thrust of the tool, incident to the cutting action, is much greater on work of large diameter; furthermore, the amount of stock to be removed is usually considerably more than on smaller work. The fixtures themselves should also be of exceptional strength and rigidly secured to the table to prevent movement or breakage.

The large automobile bevel driving gear shown in Fig. 12 is of alloy steel, and it has been previously bored and faced on the rear side; the screw holes were also drilled in a jig before placing the gear on the fixture shown. This fixture was rather expensive, being made entirely of steel (except the base, which is of cast iron), and all working parts were hardened and ground or lapped to a perfect fit. The base is located in the center of the table by means of the locating stud E, and is securely fastened down by the three T-bolts B which enter T-slots in the table. The adjustable part G is held onto the base by the three screws F. It will

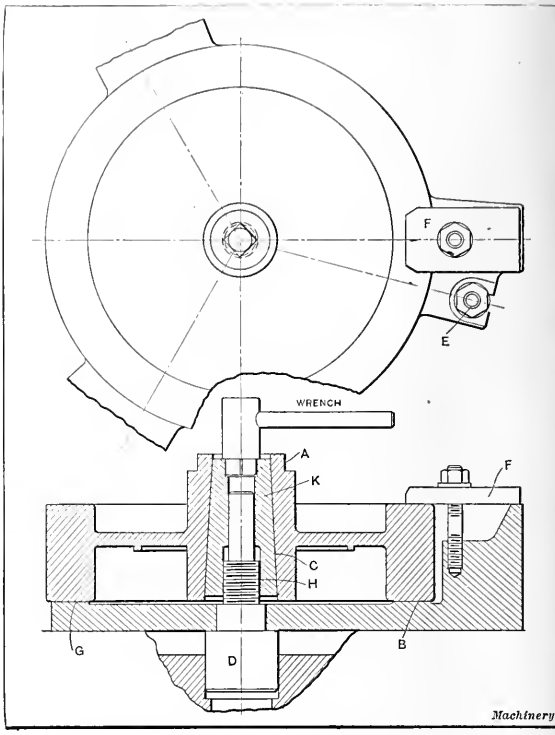


Fig. 13. Flywheel Centering Plug having Vertical Adjustment to compensate for Slight Variation between Bore and Rim Face

be noted that the screw holes have a certain amount of clearance over the body of the screw to permit adjustments to be made. The screws and check-nuts at D are for the purpose of conveniently adjusting the fixture. A pin-driver H engages one of the jig-drilled holes in the work. The upper plate K is square slotted at three points L to receive the shoes L. The screws M and the dowels N hold this plate in its proper position. The collar-head screw O forces down the plunger P on which three angular flat spots are milled. These angular surfaces control the action of the shoes L and force them out, uniformly, against the work, thus centering it. The spring Q simply aids in releasing the shoes.

This fixture is an exceptionally good one, for in its construction every care is taken to insure a true-running arbor and one which can readily be indicated for truth and brought into perfect concentricity by means of the adjusting screws. Its action was satisfactory in every respect.

Fig. 13 shows an automobile flywheel which has a finished taper hole and has been turned, bored and faced in a previous setting. It was essential that the surface A should be concentric with the taper hole. As it was practically impossible to machine the face of the flywheel B and the taper hole C so that they would always come in exactly the same relation to each other, it was necessary to make the taper plug adjustable in a vertical plane. The base of this fixture is of cast iron and is located centrally by means of plug D which accurately fits into the hole in the table. The base is clamped in position by three T-bolts E (see plan view) engaging the table T-slots. Three clamps F are used to clamp the work down on the annular rim G of the fixture. The plug D not only locates the fixture base, but extends above the latter and is threaded at H, while above

this portion it is cylindrical and is carefully ground to a running fit in the taper bushing K. The threaded portion mentioned is a very free fit, so as to permit the cylindrical part to do all the centralizing. In using the fixture, the bushing K is screwed down and the flywheel placed in position, after which, by the aid of the wrench, the bushing is raised until it bears in the taper hole. After this, the clamps F are swung around and tightened. This is a simple fixture, rather inexpensive, and one which was thoroughly dependable.

Fig. 14 shows a cast-iron double-bevel gear used on harvesting machinery, the gear rings A and B having cast teeth. These were not machined, thus leaving a rough surface by which to clamp the work, as some support was needed in order to properly machine the annular ring C. The cylindrical hole D and the end E were machined at a previous setting.

The cast-iron base of the fixture is centered by the stud F which fits the center hole in the table. This stud extends up through the fixture and is tapered at its upper end to receive the spit bushing G. This bushing is saw-cut in six places—three from each end—and is shouldered at its upper end so that the vertical movement can be controlled by the operating screw H. The collar K was pinned in place after the bushing was slipped over the screw. It will be noted that the vertical movement of the bushing is entirely mechanical, no springs being used to effect its release, as in previous instances. The positive locating point of the fixture is at E, but as it was necessary to have some support at B the four spring pins L were used; these bear against the rough surface of the casting and are prevented from being pushed down by the screws shown. The flat spot against

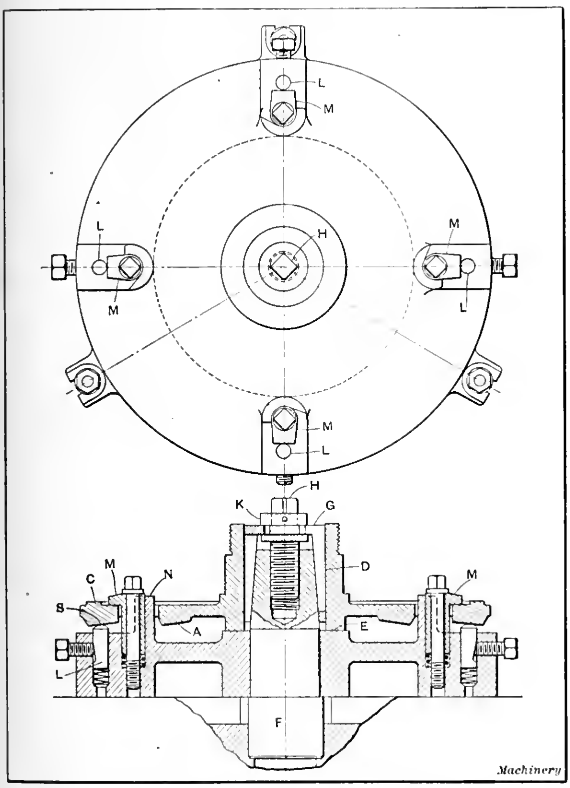


Fig. 14. Vertical Boring Mill Fixture for Special Design of Bevel Gear

which the screws bear is milled back at an angle of ten degrees. The rim of the gear has four cored holes and hook-bolts were necessary for holding and driving. These are shown at M in the illustration. In this connection, it is well to note that these hook-bolts are well backed up by a portion of the fixture N, for a hook-bolt which is not backed up in some way is worse than useless. This fixture was capable of rapid manipulation and the results obtained by its use were within the necessary limits of accuracy.

An Expanding Arbor for the Vertical Milling Machine

In one of the large automobile factories, considerable trouble was experienced in the manufacture of eccentric piston rings by the breaking of the rings as they were being cut off on an automatic machine. A new method was therefore devised by which the "ring pots" were bored and turned eccentric and then taken to a vertical milling machine where they were placed on the arbor shown in Fig. 15. The fixture of which the arbor forms a part is located in

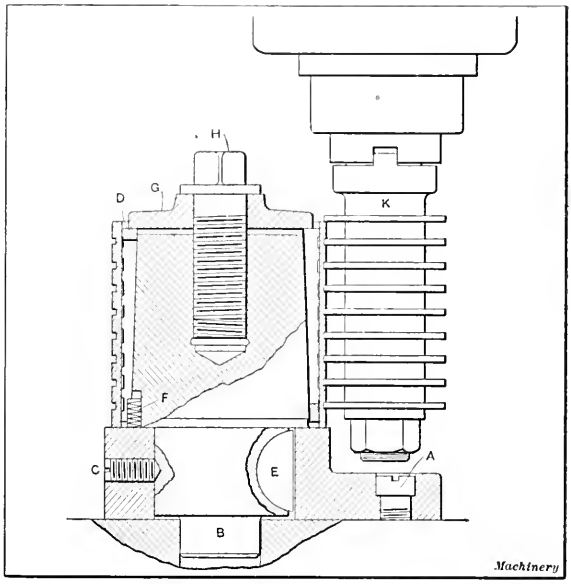


Fig. 15. Expanding Arbor for holding Casting while Gang-sawing Packing Rings

the center of a circular milling table by the stud B, and is secured to the table by means of the three screws A in the T-slots. The stud is tapered at its upper end to receive the split bushing D, and is secured by the pointed screw C and prevented from turning by the key E. The bushing was saw-cut in six places to permit expansion, and was also counterbored in three places at its lower end to make a pocket for the coil springs F. These springs tend to make the releasing of the split bushing easy after the work has been done. The collar G bears on the upper portion of the split bushing D and is operated by the screw H which is threaded into the body of the arbor.

A special arbor K in the spindle of the vertical milling machine was arranged with a gang of saw cutters properly spaced for the correct width of ring. As the table is revolved by power feed, the gang of cutters produce a set of nine clean and unbroken rings. It may be noted that the split bushing is relieved on its periphery at the points where the cutters pass through the work, in order to avoid dulling the cutting edges on the hardened surface. This fixture was made up very carefully and proved very satisfactory. To the best of the writer's knowledge, it is still in use although made over six years ago.

A Grinding Arbor for Piston Rings

The right-hand view, Fig. 16, shows an eccentric piston ring for a gas engine which has been bored, turned eccentric, ground parallel on the sides and split apart at the point A. The arbor shown to the left in the same illustration was used for grinding the periphery to make it perfectly cylindrical after it had been split and closed up at A. The body of the arbor B is of tool steel with generous centers in each end. These centers were lead-lapped after hardening and before grinding the cylindrical portion. The faces C and D are also carefully ground. The locating collar E is of tool steel, hardened and ground to a very close running fit on the arbor and at the point H where the rings fit. The portion F is knurled to give a good gripping surface for the hand when pulling back the sleeve. The spring detent G serves to hold the sleeve in position when it is pulled back

out of the way for grinding. The hole K is an air hole and is very essential, for as the parts are all very closely fitted the suction is so great that it is almost impossible to pull back the sleeve unless this relief hole is drilled. A longitudinal groove along the arbor would answer the same purpose, but is more likely to catch dirt and thus cause trouble. The nut N is of tool steel, has a coarse pitch thread and is made hexagon at the small end. The faces which bear against the rings are ground parallel with the thread. When in use, the nut is slipped back out of the way and the two rings M are sprung into place inside the locating collar, after which the nut N is brought up against the rings and tightened. The locating collar is then pushed back out of the way, until the detent snaps into place, and the work is then ready for the grinding operation on the periphery. Arbors of this type are in daily use in nearly all of the automobile factories in this country.

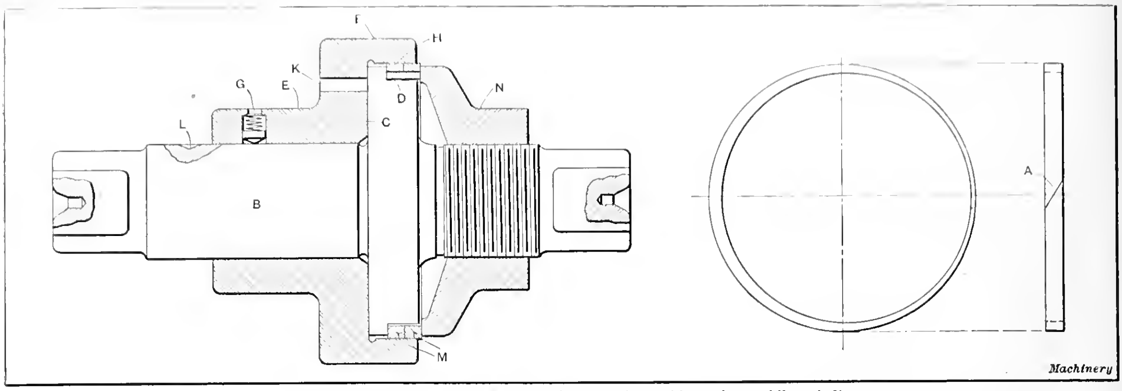


Fig. 16. Arbor for compressing and holding Split Packing Rings while grinding

The various types of arbors and fixtures illustrated and described in this article cover representative work of nearly all kinds, and may be modified to suit almost all possible conditions whether they affect the work part, the machine, or both.

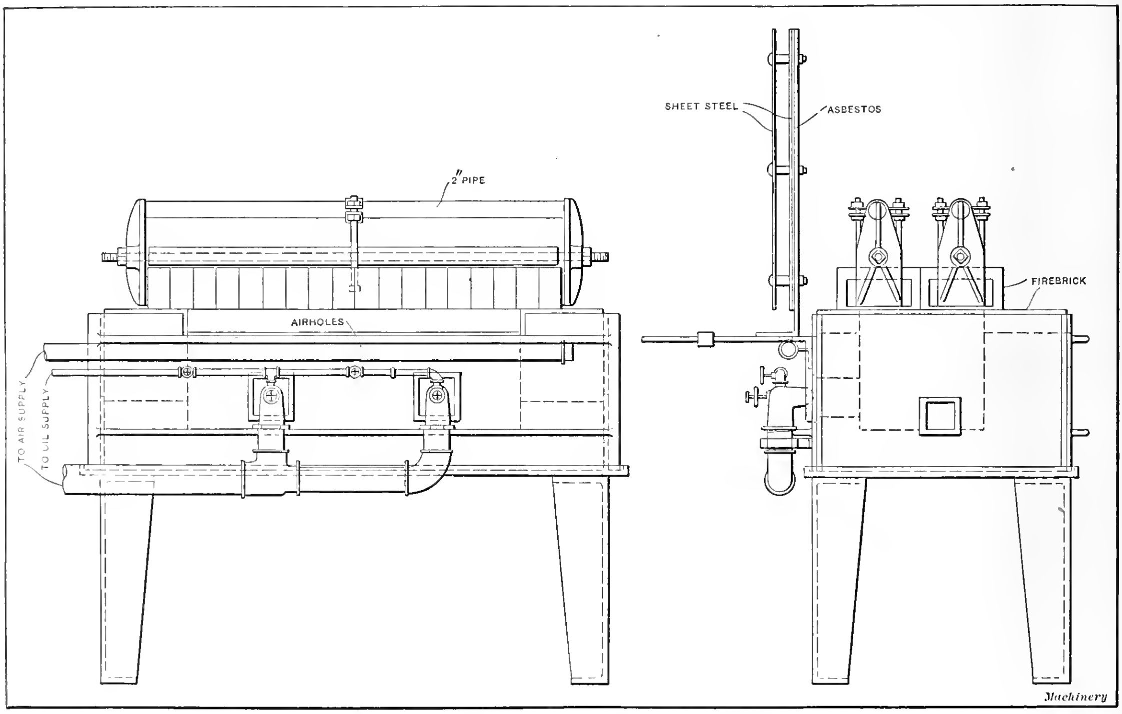
* * *

It is better to have a customer kick at the price than at the quality.

OIL FORGE FOR MACHINE BLACKSMITHING

BY M. W. W.

The oil forge illustrated herewith was built and tried out in a large shop which produces many varieties of forgings, and it was found to be so well suited for this class of work that two more similar forges were made. The distinctive feature of this forge lies in the bridge construction which is made of two rows of firebricks held together by the clamping mechanism shown in the illustration. It will be seen that this clamping mechanism consists of two clamp members which bear against the end bricks of the bridge construction. These clamps are carried by pieces of 2-inch pipe and are tightened by a bolt provided with a nut at each end. When these nuts are tightened, the firebricks are firmly held without requiring the use of fireclay or cement of any kind. It will be seen from the illustration that two rows of bricks are secured in this way to form the bridge of the forge, the bridge itself being held in place by gravity. With this form of construction, it is a very easy matter to renew the bridge work when the bricks have become so badly burned that replacement is necessary. The convenience of this construction will be evident to all who have maintained furnaces.



Bridge Construction for Oil Forge which is easily Renewable

SOLVING THE FUEL PROBLEM FOR THE MOTOR TRUCK

CHARACTERISTICS OF KEROSENE AS A FUEL FOR INTERNAL COMBUSTION ENGINES

BY HAROLD WHITING SLAUSON*

No sooner has the gasoline motor been well-nigh perfected, than the automobile designers and drivers find themselves face to face with another problem. Methods of carburetion, lubrication, and ignition have all been successfully developed, and the driver now looks for little trouble from these sources; but the success of the designers in eliminating these troubles has, in a sense, defeated its own purpose, for when the low price, reliability, and compactness of the gasoline engine began to solve so many power-producing problems, the demand for what had once been the "useless by-product" of the refineries increased to such an extent that gasoline is now a valuable fuel. A fifty per cent increase in price in a few months is not so important in itself, but when it is taken as an indication of further increases the problem assumes a serious aspect—serious for the motor truck owner, at least, if not for the driver of a pleasure car.

The reason for the slow acceptance of substitutes for gasoline is psychological as well as chemical and mechanical. The owner of a pleasure car is not as disturbed over the few cents increase in the cost of gasoline as might be expected; he argues that gasoline is a tested fuel that has given satisfaction, and he understands its characteristics perfectly. A small or even a large amount, spilled when filling the tank, causes no damage or annoyance, for the evaporation is rapid and no residue is left to collect dust. The heavier oils, such as kerosene, however, are slow to disappear by evaporation. The owner of a motor truck, however, has invested in the machine because he is convinced it will represent a dollars-and-cents saving over his former delivery or hauling system, and any device which will contribute toward economical operation will be given due consideration; furthermore, the fuel consumption of a motor truck is much higher than that of a pleasure car. A gallon of gasoline that will drive the latter twelve or fifteen miles will serve only for one-third or one-fourth that distance in a two- or three-ton business vehicle.

Kerosene as a Fuel for Internal Combustion Engines

In the search for new fuels that has been in progress since it has been evident that the supply of gasoline could not hold

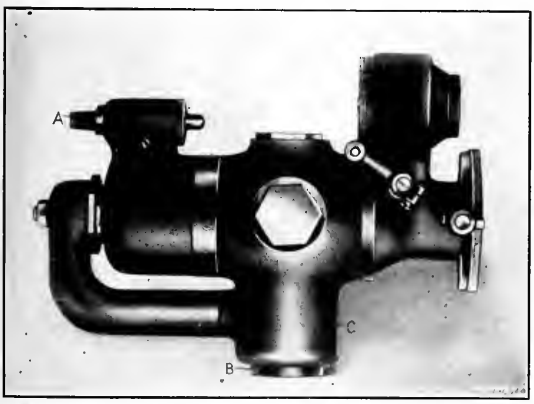


Fig. 1. Kerosene Carbureter in which the Primary Air is admitted Cold and the Exhaust Heat is used only around the Float Chamber

out, kerosene has stood foremost. This is logically due to several reasons, the chief of which is probably the fact that no change whatsoever need be made in the design of the gasoline engine in order to adopt it to the use of kerosene. In addition, kerosene is but one group lower than gasoline in the great hydrocarbon family of which petroleum is the parent, and the motor car driver therefore feels that he is not dealing with an absolutely new and unknown fuel; but of course, kerosene would not be regarded as a satisfactory solution of the fuel problem were it not present in large quantities in all grades of petroleum. The most valuable petroleum is the Pennsylvania crude, but even in this, gasoline is not present to a greater extent than three or four per cent, and in the poorer qualities, it is so scarce that no effort is made to distill it. Kerosene, on the other hand, is present

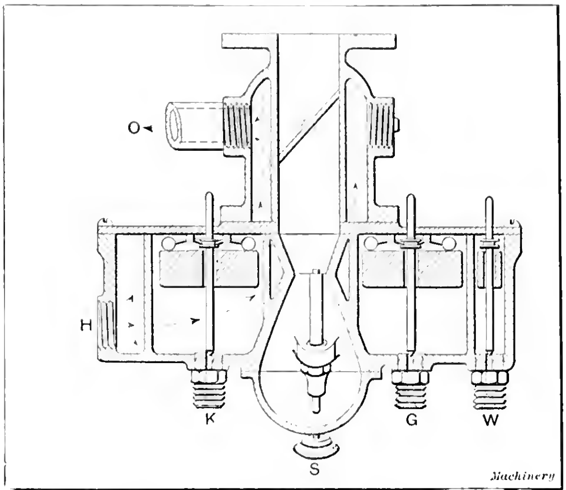


Fig. 2. Kerosene Carbureter having Part of Intake Pipe and Throttle Chamber jacketed for heating, as well as the Float Chamber

in varying quantities in practically every quality of petroleum and in some grades comprises as much as thirty or forty per cent of the total. Hence the supply of kerosene would seem to answer the fuel requirements of the internal combustion engines for years to come—or at least until the engines manufactured and in use today are worn out and the condition of the alcohol market has been so changed that the production of alcohol-burning motors becomes profitable.

When we say that the specific gravity of present-day gasoline on the Baume scale is approximately 62 and that of kerosene 45 or 48, we do not express the only difference that exists between the two liquids. Kerosene has a higher specific gravity and is therefore heavier and less volatile than gasoline, but it is by no means a poor substitute. The carbon content is different, and therefore kerosene in a gaseous state is as dissimilar from gasoline as when in a liquid form. Both before and after evaporation, the two fuels must be treated differently. The fact that kerosene is not volatile at ordinary atmospheric temperatures was the first problem to be met by the designers. It must be borne in mind that it is the *vapor* of the fuel, and not small globules, that must be mixed with the proper quantity of air and ignited in the cylinder of the internal combustion engine. A spray is not a vapor; the former may be mixed with the air but the liquid will separate and condense as soon as it strikes the cylinder walls. Engines of the Diesel type inject either kerosene or crude oil into the cylinder in the form of a spray, but previous to ignition, the compression is increased to 500 pounds per square inch, or more, which generates sufficient heat to gasify the fuel particles immediately and ignite them. The compression of the gasoline motor, however, does not exceed 70 or 80 pounds per square inch, and this is insufficient to enable the engine, when cold, to vaporize the non-volatile particles that may be introduced into it in the form of the finely divided spray. A gasoline engine will become hot in a very few minutes of operation, and this appealed to the designers as a convenient source of heat for increasing the temperature of the liquid kerosene to the evaporating point; therefore, three-fourths of all the kerosene carbureters used at the present time employ a bowl or float chamber to contain a small quantity of the liquid, and this is surrounded by a jacket that communicates with the exhaust pipe of the

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motor. A carbureter of this type is shown in Fig. 1. The fuel inlet is at *A* and the exhaust heat is admitted at *B*. The motor is started on a small amount of gasoline, and when the exhaust pipe has become sufficiently hot to vaporize the kerosene in the bowl, a two-way valve is turned which conducts the heavier fuel to the carbureter. The same carbureter is used for both the gasoline and the kerosene, although with some designs the gasoline is burned directly around the bowl containing the kerosene, to obtain the necessary heat.

Simple as such carbureters may appear, there are a number of problems that must be solved before the use of kerosene can give as good results as are obtained from gasoline. The fineness into which the kerosene jet should be divided, the amount of heat to which the fuel should be subjected, and the treatment of the mixture in order that the same "flexibility" as that delivered by a gasoline engine can be obtained from one using kerosene, are all subjects of vital interest to the designer and user. It has been found that the finer the spray into which the kerosene jet is divided, the more complete the combustion in the engine cylinder; atomization or pulverization probably more correctly describes the process to which the fuel should be subjected. The proper pulverization of the fuel, together with the application of heat, breaks it up into so fine a mist that actual gasification is not necessary, provided the intake manifold is made of such a shape and dimensions that the velocity of the mixture is kept high, to prevent condensation on the cool walls of the pipe. The temperature to which the fuel is raised before atomization is generally from 200 to 300 degrees, although in some carbureters the kerosene is subjected to a temperature of 600 degrees.

One of the drawbacks to the more general use of kerosene in automobiles has been its reputation for forming heavy deposits of carbon in the cylinder. When this condition exists, however, it is an indication of improper pulverization, condensation, or of faulty design or adjustment of the heat-

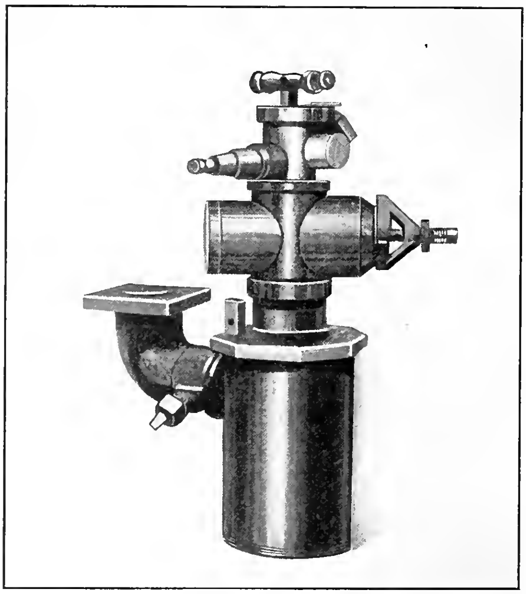

Fig. 3. Unique Type of Carbureter in which Spark Plug maintains a Continuous Flame in Path of Atomized Kerosene

and air-regulating apparatus. The best lubricating oils should be used when kerosene is employed as a fuel, but the formation of carbon in the cylinders or the presence of black smoke at the exhaust indicates that imperfect combustion is taking place.

Carbureter in which Variable Quantity of Water is added to Kerosene Mixture

An elaboration of the general type of kerosene carbureter previously referred to has been in successful use on many of the large traction engines used in the western section of this country. In this carbureter, cold air is supplied to the fuel immediately after pulverization, for it was found that this arrangement gave the greatest power and the best economy. It was also discovered that if the air admitted to this particular type of carbureter were heated, loss of power would result, attended by pre-ignition and other signs of an imperfect mixture. The unique feature of this carbureter, however, lies in an arrangement whereby a variable quantity of water is supplied to the mixture of kerosene spray and air before it is admitted to the cylinder. The water valve is connected with the crankshaft of the motor so that the supply of moisture to the mixture is increased as the throttle is opened and the spark advanced; when the motor is running

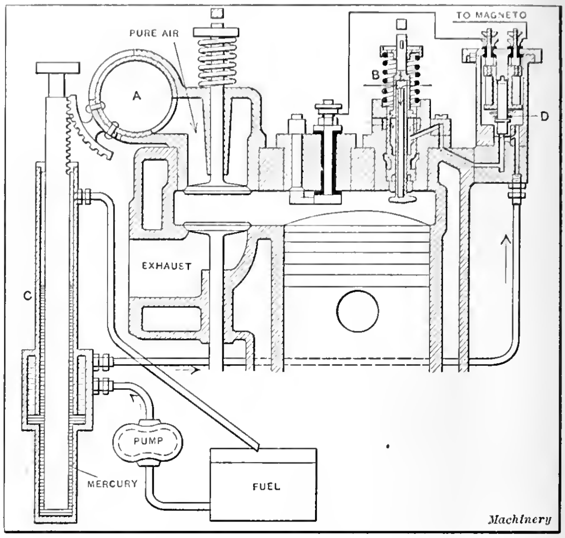

Fig. 4. Kerosene Carbureting Device which requires no Heat. It is equipped with electrically operated Valve for controlling Supply of Fuel

idle or is pulling very light loads no water is supplied to the fuel. The purpose of the water is to keep the temperature of the explosion within the limits from which the best results can be obtained, and also to assist in a more perfect combustion of the charge. At the same time that the water absorbs a portion of the excessive heat of combustion oxygen is liberated and the mixture is rendered more completely combustible. One of the troubles sometimes experienced with the use of kerosene in a gasoline motor is the inability of the engine to "pick up" with a load; full load can be maintained when it is once reached, but after throttling the motor—as on a hill, for example—the engine seems unable to respond when power is again desired. This lack of flexibility has been overcome by the introduction of the water spray that automatically accommodates its volume to the power demanded of the motor. It must be remembered, however, that the carbureter in question is designed especially for large, heavy-duty engines, and it should therefore be understood that the omission of the water spray from a kerosene carbureter designed for the average automobile in nowise indicates lack of flexibility in the power plant; in fact, many of the most successful carbureters in use on pleasure cars and trucks have no provision for the introduction of water into the air passage above the atomizing chamber.

The Wilcox-Bennett Carbureter Co., Minneapolis, Minn., makes a kerosene carbureter of the type described in the foregoing paragraph.

Heat for the Vaporization of Kerosene

While the heat for assisting in the vaporization of the kerosene is usually obtained from the exhaust manifold of the engine, the circulating water can sometimes be used for this purpose by jacketing the carbureter and connecting it with the water system of the engine. As the water in the jackets holds its heat for a greater length of time than does the exhaust manifold, it is evident that the motor could be started directly on kerosene—even after an appreciable interval had elapsed since its previous running—if the stored-

up heat in the water jackets were utilized. However, the operation of starting on gasoline, and then switching to kerosene, is neither difficult nor time-consuming and it is the surer method; but in order to obviate the necessity of even this slight trouble, some kerosene carbureters are supplied with an electrical coil placed within the vaporizing chamber. This coil is operated for a few moments by the current obtained from the lighting, starting, or ignition storage battery. But a short time is required to bring the finely divided spray from the atomizing nozzle to the vaporizing temperature, so that the current can soon be turned off, heat for further vaporization being obtained in the usual manner from the exhaust manifold of the engine.

Although the practice of heating the kerosene, either before or after pulverization, is almost universal, theories differ as to the advisability of warming the air with which this kerosene mist is first mixed. In one of the most successful types of carbureters the air is admitted cold after the kerosene has become thoroughly atomized by the mechanical action of the jet and the application of heat to the bowl. It is evident that the admission of the cold air will reduce the temperature of the resulting mixture to the point where condensation will be prevented when the charge comes in contact with the cool metal of the intake manifold. As previously mentioned, the intake manifold should be small enough so that the velocity of the mixture will be high and thus prevent condensation. By the use of cold air in medium-sized engines, however, this difficulty is overcome without the necessity of making any change whatsoever in the intake manifold of the engine. Another method of obtaining the same results, and one which is employed in one of the well-known kerosene carbureters designed especially for marine use, consists in jacketing not only the fuel bowl but the choke tube and throttle as well, so that the mixture is maintained at a high temperature throughout a good part of its journey to the hot cylinder. A carbureter of this type is shown in Fig. 2. The intake for the exhaust is at *H*, the outlet at *O*, the kerosene intake connection at *K*, the gasoline intake connection at *G*, the water intake connection at *W*, and the fuel spray nozzle at *S*. This type is manufactured by the Hampton Kerosene Carbureter Co., Inc., 1876 Broadway, New York City.

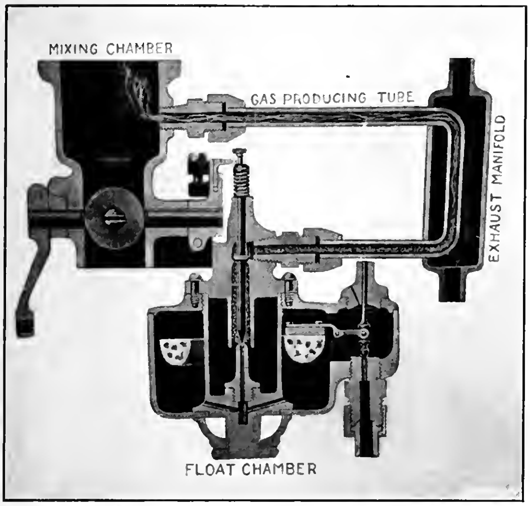

Fig. 5. Cross-section of Carbureter in which Exhaust Heat is not applied until Fuel has been well pulverized. Dotted and Wavy Lines indicate Transformation from Mist to Vapor after Application of Heat

Kerosene carbureter designers have long since discovered that the amount of heat supplied to the fuel before admission to the cylinder must be regulated to a nicety. It has already been pointed out that with insufficient heat, the kerosene is not properly vaporized. The application of too much heat, on the other hand, will result in what is known as the "cracking" process, in which the kerosene will be split up into its component parts, an ill-smelling exhaust will be ejected, and large quantities of carbon will be deposited on the piston and cylinder heads.

In one of the newest carbureters on the market (see Fig. 3) the mixture is given exactly the right composition in rather a novel way. The heat for assisting the vaporization of the fuel is obtained from the atomized kerosene itself, as soon as the motor is started, and no previous heating is required. The kerosene is atomized when cold in the usual manner; that is, by drawing it, by means of the suction of the motor, through a series of small orifices, which serves to break it up into globules, after which a strong current of air is passed over it for the purpose of further diffusion of the mist. If this mixture is discharged directly onto some cool surface, however, such as the hand, it will be observed that the kerosene will immediately condense and roll off in the form of drops. The atomizer and air inlet are at the top of the carbureter. Immediately below these is a small compartment into which projects the "business end" of a spark plug operated by a coil and set of dry batteries separate from those that may be used for the ignition system of the motor. As soon as the motor is turned over, the spark at the end of this plug is started. As this projects directly into the path of the recently atomized kerosene and air, a portion is ignited. This compartment is of such a size that only about two per cent of the kerosene spray is ignited, but this seems to be sufficient to "burn the excess carbon" out of the mixture and to transform it into an ideal combustible charge for the cylinders. This resulting mixture, if discharged into the air, appears in the form of a white cloud of vapor that does not easily condense, and seems to be as stable a gas as any yet used for internal combustion engines. This carbureter is manufactured by Alex. T. Porter Oil Utilities Co., 171 Broadway, New York City.

While the idea of burning a portion of the mixture directly in the path of the combustible charge may seem like a dangerous system, the flame is effectively prevented from spreading by the use of a wire gauze that holds the fire within the proper bounds in the same manner that the fine wire screen of the miner's lamp admits air to the burner but prevents any of the surrounding inflammable gases from becoming ignited. The location of this wire screen governs the proportion of the mixture that will be ignited by the spark plug, and the proper adjustment is important. A mica window is placed in one side of the spark plug chamber, so that the condition of the flame may be noted. The spark plug is used as long as the motor is in operation, but the inventor of the device is now working on a system which will require the use of the plug only at starting.

Kerosene Carbureting Device requiring no Heat

In view of the foregoing methods of carbureting kerosene, it is surprising to learn that a system has been devised in France which entirely does away with the application of heat, either to the raw kerosene or to the atomized mixture. In fact, a motor equipped with this device can be started when cold directly with kerosene as easily as though high-test gasoline were the only fuel used. The attachment can hardly be called a carbureter, in the ordinary sense of the word, inasmuch as it depends for its operation on several electrical and mechanical parts as well as physical properties, and requires a slight change in the design of the engine in order to make its installation satisfactory.

The first point in which this remarkable device differs from the ordinary carbureter lies in the fact that pure air only is admitted through the inlet valve. The amount of air so admitted is controlled by a slotted, hollow cylinder *A* (see Fig. 4), the orifice in which can be made to register with the opening in the inlet valve through an automatic control connected with the throttle or the gasoline pressure regulator. The raw kerosene is led from the pressure-regulating tank—into which it is forced by a rotary pump—into the atomizer *B* which is screwed into the cylinder head. This atomizer consists of an inverted automatic poppet valve, the head of which projects into the cylinder nearly over the head of the piston. The stem of this valve is hollow, and surrounding it is an auxiliary air space connected with the outer atmosphere. As the liquid kerosene under pressure rushes into the atomizer, it is broken up into fine particles and

united with the proper quantity of air admitted through the auxiliary opening and through the hollow stem. To be sure, this is not a *bona-fide* vapor (it is merely a fine spray), but it is admitted directly into the combustion space of the cylinder, mixed with the proper quantity of air entering through the inlet valve and immediately compressed; there has been no opportunity for condensation, for the atomization practically has taken place within the cylinder itself.

The pressure on the fuel is regulated by means of a variable column of mercury *C* extending into the space into which the kerosene is pumped. This pressure can be controlled by the same levers that throttle the supply of air admitted to the cylinder, but this would not be sufficient regulation to provide for the demands of the motor at all speeds, if the supply depended entirely upon this pressure and the suction of the piston in the cylinder. To obtain the proper regulation, there has been devised what is probably the most ingenious carburetion attachment to be found in use. Before the raw kerosene is admitted to the atomizing chamber, it is forced through a needle valve at *D*, the stem of which constitutes the armature of a solenoid. This solenoid is a coil of wire that is excited by the current derived from a low-tension magneto. The stem of the needle valve (assuming, of course, that it is made of a magnetic metal) serves as the plunger or armature of the solenoid and is drawn into the interior of the hollow coil whenever the current passes through the wire. When the coil is not excited, the needle valve is held in place on its seat by means of a spring that effectually prevents the passage of fuel to the atomizer when the motor is not running. By means of an electric circuit-breaker which may be geared to the crankshaft of the motor, the number of current excitations or "pulsations" imparted to the coil may vary with the speed of the engine, and a supply of fuel proportionate to the demands of the engine will thus be obtained. This kerosene carbureting device has passed the experimental stage and is now used on many French cars.

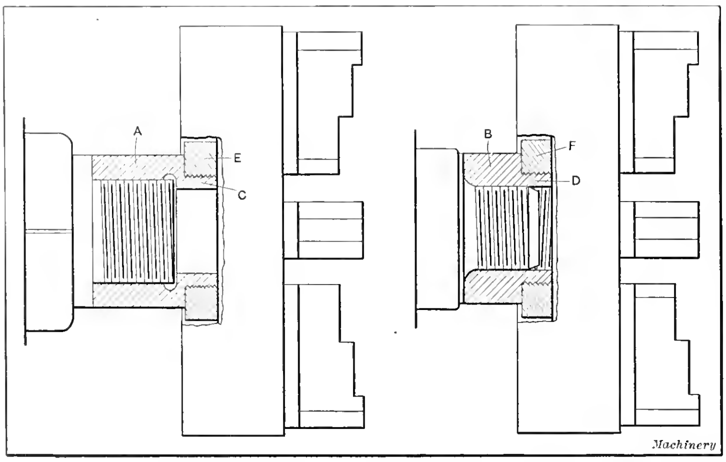

Fig. 1. Two Styles of Lathe Spindle with Standard Chuck mounted on them

To the ordinary motorist, familiar with the comparative simplicity and efficiency of the gasoline carbureter, these various devices for obtaining power from kerosene may seem somewhat complicated, but to the business man who will look deeper and see in them the real solution of the problem created by the constantly increasing cost of gasoline, they give evidence of the stability of the internal combustion engine and of its ability to adapt itself to whatever fuel may be used. These carbureters are in use today in all parts of the country, and if the owner of the pleasure car still prefers to pay the excessive price for gasoline, when a satisfactory substitute at half the cost is available, it may be but small consolation for him to know that the arrival of the time is inevitable when he will be forced to make the change. But whether the change will come soon or late, it is a satisfaction to the truck owner to know that one of the most important problems of his delivery and hauling system is being solved, and that the future of motor transportation is brighter than ever, even before that one universal fuel, gasoline, took its sudden upward leap in price.

* * *

INTERCHANGEABLE LATHE CHUCKS

BY GEORGE L. COLBURN*

Where threaded engine lathe spindles vary in pitch and diameter, it is evident that a chuck screw plate will not fit more than one of the spindles. This difficulty may be overcome by using intermediate screw bushings. Referring to Fig. 1, the bushings provided for this purpose are shown at *A* and *B*. The threaded ends *C* and *D* of these bushings are made of the standard pitch and diameter to fit the screw plates *E* and *F* of the chucks. Threads are cut on the inside of the opposite ends of the bushings to fit the different lathe spindles on which they are to be used. It will be evident that this is the means of enabling a standard chuck to be used on lathe spindles of various diameters and thread pitches, the only additional equipment necessary being bushings having the proper inside thread.

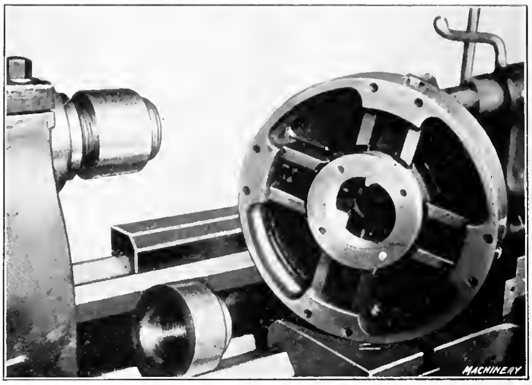

Fig. 2. Adapter Bushing partially screwed onto Spindle of Reed Lathe

Figs. 2 and 3 illustrate the screw plates fastened to the chucks by means of four screws. In Fig. 2 a screw bushing is partly screwed onto the spindle of a Reed engine lathe; a second screw bushing is shown resting on the bed of the lathe. In Fig. 3 is illustrated a screw bushing which is partly screwed onto the spindle of a Hendey engine lathe.

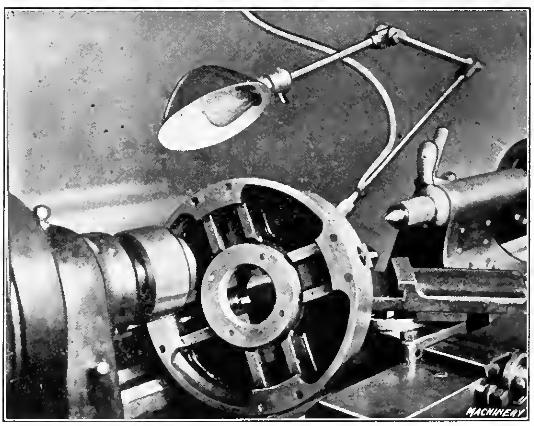

Fig. 3. Adapter Bushing partially screwed onto Spindle of Hendey Engine Lathe

* Address: Boston Gear Works, Norfolk Downs, Mass.

KEROSENE FOR STEEL HEATING FURNACES

ARRANGEMENT OF A WELL EQUIPPED HEAT-TREATING DEPARTMENT—COMPARATIVE VALUES OF FUEL OIL AND KEROSENE

BY HARRY C. SPILLMAN

During the last few months the price of fuel oil has steadily advanced and the oil refineries, in a number of states, have notified industrial plants that they will be unable to supply fuel oil after a certain date. At the present time it is almost impossible to enter into a contract with the refineries for a year's supply of this oil. This condition has caused many manufacturing plants to analyze the situation and try to find a substitute for fuel oil without installing new equipment in the heat-treating department.

The Continental Motor Mfg. Co., Detroit, Mich., has made numerous experiments with different kinds of oils and burners in order to be ready to meet the situation in case there is a shortage of fuel oil. Kerosene has proved most satisfactory after many experiments, and the data in this article show the results which have been obtained.

The furnaces show a very even temperature in all parts of the heating chamber, and a laboratory pyrometer fails to show over 10 degrees variation in any part of the heating chambers. Each furnace is equipped with both an indicating and a recording pyrometer (see Fig. 2) so that the operator can tell at a glance the temperature of each chamber. To facilitate the handling of material, the hearths of all furnaces, packing tables, trucks, quenching tanks and other equipment are made the same height from the floor. The door openings are made the full width of the heating chamber and are counterweighted.

The quenching tanks are of special design and are located in the center and opposite the furnaces so that they are readily accessible. Water, brine and oil are used for quenching, and by means of cooling tanks and circulating pumps the quenching mediums are kept at a constant temperature. The pumps deliver the liquid in the bottom of the tanks by means of perforated pipes which are protected by a wooden grating. This wooden grating also acts as a cushion for any parts which happen to fall in the tanks. The entire surface of the liquids is removed at a uniform rate by means of numerous outlets located near the top of the tank and connected with a common overflow pipe. The rate of flow can be governed by means of a valve fitted to the inlet pipe near the floor. The oil quenching tanks have a cover which can be closed very quickly in case the oil ignites. The quenching mediums are circulated through coils and are cooled by means of cooling water which is varied to suit conditions. The circulating pumps are direct motor-driven centrifugal pumps, located in the basement (see Fig. 3). The liquid is fed by gravity to these pumps, which does away with the troublesome feature of priming.

Fig. 1. Row of Furnaces and Quenching Tanks—Heat-treating Department of Continental Motor Mfg. Co.

The heat-treating room is of the most modern design and contains many unique features which are of interest. This department is housed in a fireproof building of structural steel and metal sash, and is entirely isolated from the other buildings. The steel sash has large ventilating sections and a monitor roof affords additional light and ventilation. All auxiliary apparatus, such as oil and circulating pumps, air compressor and storage and cooling tanks, is located in the basement, so that the entire first floor is given up to the furnaces and quenching tanks. A view of the first floor is shown in Fig. 1 which illustrates the general arrangement of the furnaces. These furnaces were made by the American Shop Equipment Co., and consist of four double-chamber casehardening furnaces of semi-muffle type, with heating spaces 54 by 27 inches and 18 inches high. The combustion chambers are 27 inches wide by 7½ inches high. The two burners in front of each chamber are supplied with oil at 18 pounds pressure and air at 1½ pound pressure. The three heat-treating furnaces are of the same make and size. The casehardening furnaces are built up from the floor and are of heavy construction in order to withstand the service required of them.

The oil is fed to the burners by direct-connected, motor-driven rotary pumps, in duplicate. The oil is pumped from a 12,000-gallon tank located outside the building, and the surplus oil is returned to the storage tank by means of a relief valve and overflow. This system allows a constant

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pressure of oil at the burners at all times and the fuel oil is entirely drained back to the storage tank when the heat-treating room is not in operation. The elevation and plan, Fig. 5, show the storage tank and arrangement of the furnaces (oil and brine cooling coils, quenching tanks, etc.).

A General Electric turbo air compressor (Fig. 4) furnishes the necessary air for the burners at $1\frac{1}{2}$ pound pressure. The air lines were carefully laid out in order to reduce the friction to a minimum. The advantage of this type of air compressor is the constant pressure of air, regardless of the volume.

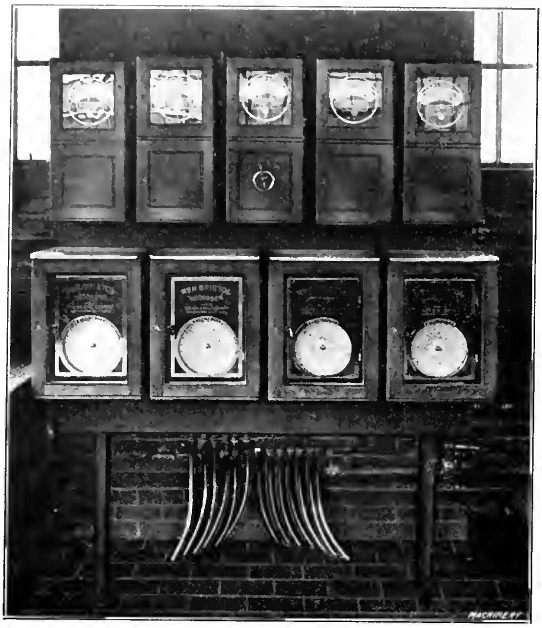

Fig. 2. Indicating and Recording Pyrometers of Plant shown in Fig 1

Tests were repeated for ten successive days on both kerosene and fuel oil. Both oils burned uniformly and needed very little attention after the proper regulation. One of the chambers of a double furnace was used for these tests, and in order to accurately measure the oil a tank of 60 gallons capacity was independently connected with one of the rotary pumps. The proper connections were made to maintain a constant pressure of oil, together with the necessary return piping for the overflow to the tank. A temperature record was obtained by means of smoke charts made on Bristol recording pyrometers. Both the indicating and recording pyrometers were carefully calibrated. The tests were made under actual working conditions and the same kind and quantity of material was heat-treated each day. The material placed in the chamber consisted of fifteen cam-shafts each weighing 21 pounds. Each cam-shaft was packed in a $3\frac{1}{2}$-inch steel pipe with the carbonizing material. The total weight of each tube, with shaft and container, was 55 pounds. All the tubes were placed on a form made of narrow strips of bar steel. This form held the steel pipes in position and made the total weight in each chamber 950 pounds.

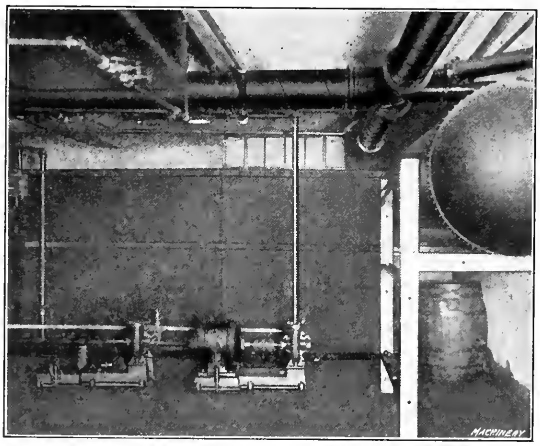

Fig. 3. Circulating Oil Pump in Basement of Plant shown in Fig. 1

This department is only operated ten hours each day. The material is taken out at 5 P. M. and the furnaces are allowed to cool over night. In the morning the furnace pyrometers register about 700 degrees F. At 6.30 A. M. the burners are lighted and the material is placed in the furnaces which are continued in operation until about 5 P. M. The furnaces reach 1700 degrees about 9 A. M., and they show a uniform heat throughout the working chamber about one hour later. The tests were made under these conditions. The furnaces would have shown higher efficiency if they were run continuously twenty-four hours every day.

The points noted in making these tests were: Time required for the furnace to reach 1700 degrees; time to obtain a uniform heat in the furnace; evenness of burning and regulation; and amount of oil consumed. The results of the tests follow:

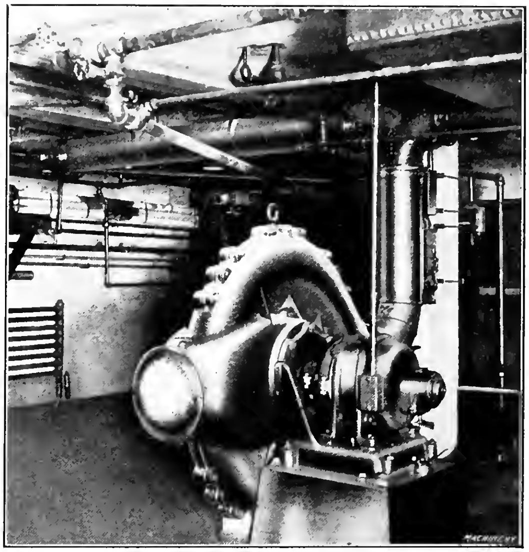

Fig. 4. Turbo Air Compressor for supplying Air to Burners

	Fuel Oil	Kerosene
Time tests started	6.30 A. M.	6.30 A. M.
Time required for chamber to reach 1700 degrees F	9.00 A. M. (2 hr. 30 min.)	8.45 A. M. (2 hr. 15 min.)
Time for chamber to reach uniform heat	10.15 A. M. (3 hr. 45 min.)	9.45 A. M. (3 hr. 15 min.)
Time test stopped	4.45 P. M.	4.15 P. M.
Fuel consumption required for chamber to reach 1700 degrees F	26.5 gal.	23 gal.
Additional gallons to reach uniform heats	3.5 gal.	3 gal.
Number gallons for operating furnace $6\frac{1}{2}$ hours after chamber reaches uniform heat	18 gal.	13 gal.
Number gallons per chamber, per hour after uniform heat is reached	2.77 gal.	2 gal.
Number gallons to heat-treat one pound of metal after uniform heat is reached	0.057 gal.	0.041 gal.
Specific gravity of fuel	41 deg. Baume	50 deg. Baume
B. T. U. per pound of fuel	19890	19917
Temperature of fuel	65 deg. F.	65 deg. F.

The comparative cost of fuel based on these tests shows that kerosene is from 23 to 25 per cent higher than fuel oil, but the tests also show that there is a saving of thirty minutes in order for the furnace to reach a uniform heat, and a saving of nearly 20 per cent in fuel, by using kerosene. Each burner has a $\frac{1}{2}$-inch oil line and a $1\frac{1}{2}$-inch air line and two burners are connected to each chamber. Power tests show that each burner requires 470 watts, which is equivalent to 0.63 horsepower.

* * *

Gradually the world is coming to the realization that even in the ordinary business affairs of life a man must consider the other fellow, and that he best serves himself who best serves his fellow-men.—*J. W. Pogue.*

THE TEST THAT COUNTS

BY WILLIAM A. WEBB*

It seems that steel makers have inexhaustible resources for bringing out new brands of high-speed steel which they claim to be better than the other fellow's. Although we continue to test out their samples, we sometimes find it difficult to tell just which one of the numerous brands is the best for our particular purpose. If we believe what the traveling salesmen tell us, however, the steel made by their respective companies is the best—but the method of testing has something to do with it.

I have listened to a great many interesting stories about how certain brands of steel have proved their wonderful superiority when tested on the glassy face of a worn car wheel, on a piece of chilled cast iron or on some other unusually hard metal that had been laid aside because the tools could not turn it. This method of testing might prove that high-speed steel is better than carbon steel, but when it comes to a show-down between different brands of high-speed steel, I believe this method would be wholly unsatisfactory, because the hardness of such metals is seldom uniform. The tool that gets the hardest part might stand up until it was just about to reach the softer metal and then give up, thus preparing the way for the next tool to make a good showing, although it might be of an inferior grade of steel. Then again, they tell about tests being made when the speed was shoved way up beyond all reasonable limits, and how one tool went two inches and another was unable to even start on the work. We have been guilty of such misdemeanors ourselves but after going through with a lot of such unsatisfactory testing, we came to the conclusion that the only way to get a fair comparison was to try the different steels out on regular work, where the stock was uniform, and let each tool show what it could do under everyday working conditions. This is the test that counts and gives the company the information it wants before buying steel in large quantities.

We have made it a practice of late years to take a selected number of sample tools, say half a dozen or whatever number it is desired to test, and grind them all to the same clearance and rake angles, and as near alike in every way as possible. These tools are put to work, one at a time, on regular stock where there is enough of it to allow each tool to make several trials. The speeds and feeds are arranged within reasonable limits and all the tools are set at exactly the same height in relation to the lathe centers (that is if a lathe is being used, which has been the case in most of our tests). A record is kept of how far each tool goes, and after they have all had six or eight trials apiece, we add up the totals and see how they compare. It appears to me that each tool should be given several trials before condemning or approving it, because in some cases it will make its best run the first time it is used after coming from the forge room, but more often the steel improves after the first or second grinding. Then again, a tool will make a freak run that looks incredible, but it will not do it every time, and after the test has been repeated several times the good tools will surely rise to the top. A test by this method can be repeated as often as desired without much extra expense to the company, as regular work is being turned out all the time. We never make expensive formed tools or milling cutters for other machines except from steel that has first been tested in the lathe and proved to be entirely satisfactory.

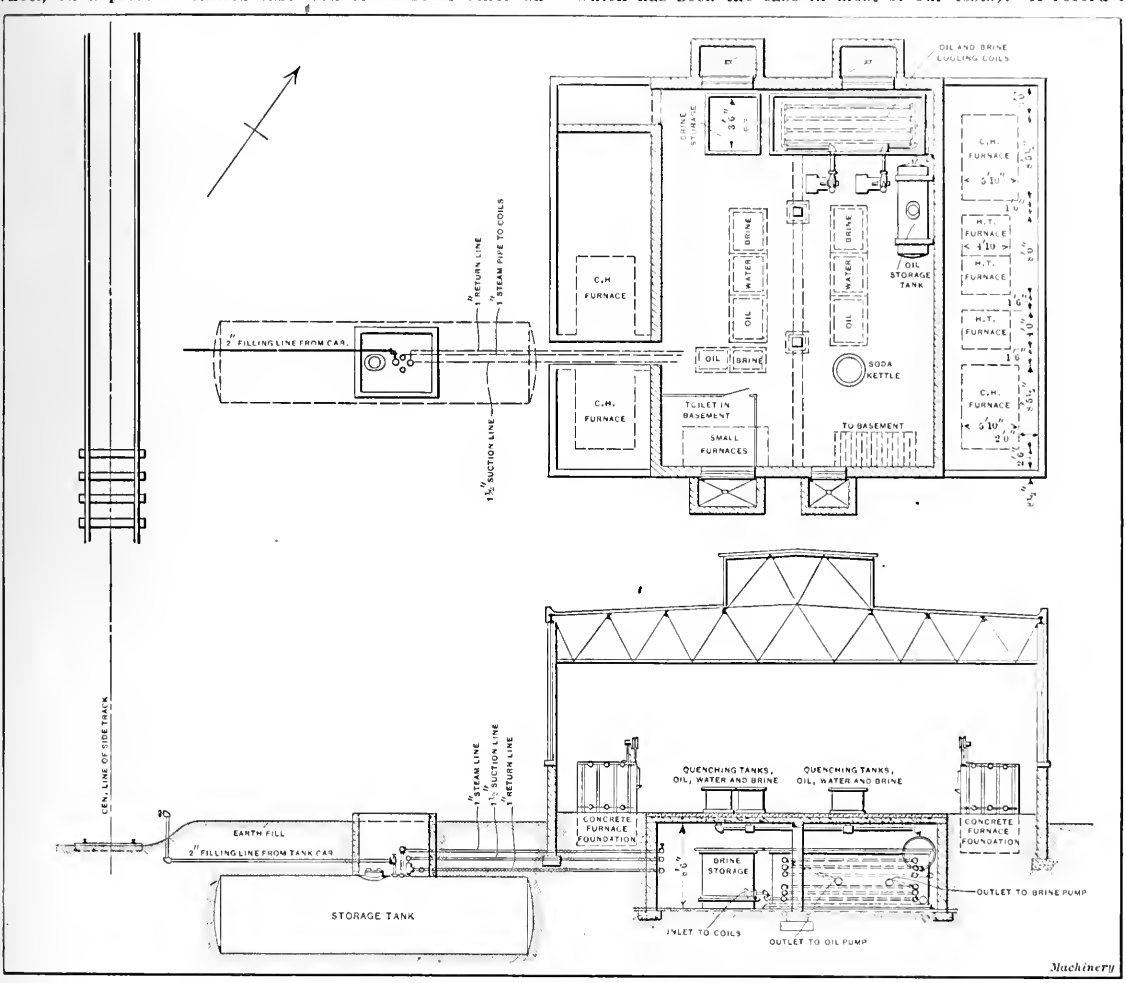

Fig. 5. Elevation and Plan of Heat-treating Department

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DISK AND SQUARE METHOD OF DETERMINING ANGULAR SETTINGS

BY GUY H GARDNER*

The method shown in Fig. 1 for determining angles for setting up work on a milling machine or planer possesses several advantages: No expensive tools are required, the method

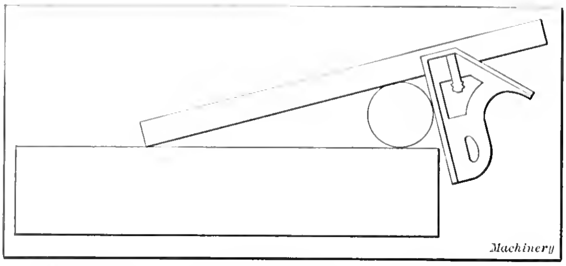

Fig. 1. Method of determining Angles by Use of a Disk and Square

can be quickly used, and the results obtained are quite accurate enough for any but the most exacting requirements. It will be seen from Fig. 1 that an ordinary combination square is used in connection with a disk, the head of the

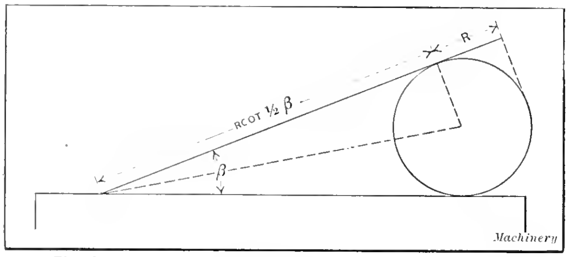

Fig. 2. Diagram illustrating Method of deriving Formula for setting of Square

square being set at different points on the blade according to the angle that is desired. Theoretically, a one-inch disk could be used for all angles from about 6 degrees up to a right angle, but in practice it is more convenient and accurate to employ larger disks for the larger angles. The table here given is calculated for three disks, 1, 2 and 4 inches in diameter.

When standard disks are not available, satisfactory substitutes can be made of machine steel, casehardened and ground. Satisfactory results can generally be obtained from disks which are left soft, although it is desirable to harden them when possible. It is a good plan to stamp on each disk, the diameter, the angles for which it is used and the points at which the head of the square is placed to obtain each angle.

The only inaccuracy resulting from this method is due to setting the square at the nearest "scale fraction" instead of at the exact point determined by calculation. This error is very small—less than two minutes in seventy-five of the angles in the table, and in five angles a trifle over three minutes—the error being negligible in practically all cases. When other than standard disks are used, the setting required for any desired angle can easily be found by multiplying one-half the diameter of the disk by the cotangent of one-half the desired angle, and adding to this product one-half the diameter of the disk. This rule is given in algebraic form by the following formula:

$R \cot \frac{1}{2}\beta + R =$ required setting.

The derivation of this formula will be readily understood by referring to Fig. 2. If, for example, it is desired to set the work at an angle of 31 degrees 10 minutes, the setting to be made with a 3-inch disk, we have:

$R = 1.5$ inches

Cot 15 degrees, 35 minutes = 3.5856

R cot 15 degrees, 35 minutes = 5.3784

Then the required setting is $5.3784 + 1.5 = 6.8784$. The nearest scale fraction is $6\frac{7}{8}$ inches; using this setting, the angle obtained is 31 degrees, 11 minutes and 8 seconds, the error of 1 minute and 8 seconds being negligible for most classes of work.

For angles less than 6 degrees, smaller disks or size plugs may be used, but the method illustrated in Fig. 3 will generally be found more convenient.

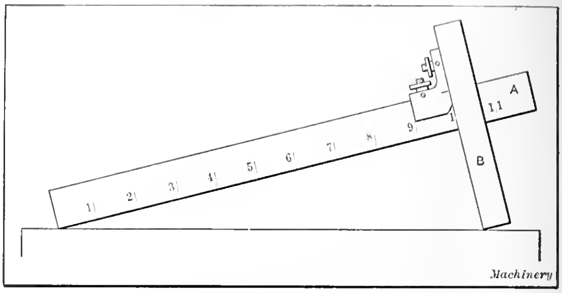

Fig. 3. Use of Small Scale in Place of Disk for determining Angles of less than Six Degrees

It will be seen that a small scale B is held on the blade of the combination square, set so that its edge coincides with the 10-inch mark and extends below A a distance equal to ten times the tangent of the required angle. The scale B is graduated to 0.01 inch to facilitate making accurate settings. If greater accuracy is required, the scale B may be graduated to fortieths of an inch and a vernier placed on the attachment which carries the scale. With such an arrangement this device may properly be classified as a precision tool.

* * *

The electric welding process is employed to some extent in the manufacture of taps. Orders for extra long shanks are filled by making the threaded part the same as for regular taps and then welding to it a shank of open-hearth steel. The practice is both economical and rapid. Orders for special taps can be quickly and cheaply filled. Welding shanks to regular taps saves turning down the long shanks.

TABLE OF SETTINGS FOR ANGLES FROM SIX TO FIFTY DEGREES

Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction	Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction	Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction	Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction
6	1	10.0406	$10\frac{3}{64}$	$17\frac{1}{2}$	...	7.4971	$7\frac{1}{2}$	29	...	4.8666	$4\frac{55}{64}$	$40\frac{1}{2}$	...	7.4212	$7\frac{27}{64}$
$6\frac{1}{2}$	....	9.3053	$9\frac{5}{16}$	18	...	7.3137	$7\frac{5}{16}$	$29\frac{1}{2}$	...	4.7983	$4\frac{51}{64}$	41	...	7.3492	$7\frac{11}{32}$
7	....	8.6749	$8\frac{43}{64}$	$18\frac{1}{2}$	...	7.1402	$7\frac{9}{64}$	30	...	4.7320	$4\frac{47}{64}$	$41\frac{1}{2}$	...	7.2789	$7\frac{9}{32}$
$7\frac{1}{2}$	....	8.1285	$8\frac{1}{8}$	19	...	6.9757	$6\frac{31}{32}$	$30\frac{1}{2}$	4	9.3359	$9\frac{11}{32}$	42	...	7.2102	$7\frac{13}{64}$
8	....	7.6504	$7\frac{21}{32}$	$19\frac{1}{2}$	...	6.8196	$6\frac{13}{16}$	31	...	9.2118	$9\frac{7}{32}$	$42\frac{1}{2}$	...	7.1430	$7\frac{9}{64}$
$8\frac{1}{2}$	....	7.2283	$7\frac{15}{64}$	20	...	6.6712	$6\frac{43}{64}$	$31\frac{1}{2}$	...	9.0915	$9\frac{3}{32}$	43	...	7.0773	$7\frac{5}{64}$
9	....	6.8531	$6\frac{55}{64}$	$20\frac{1}{2}$	...	6.5300	$6\frac{17}{32}$	32	...	8.9748	$8\frac{31}{32}$	$43\frac{1}{2}$	...	7.0130	$7\frac{1}{64}$
$9\frac{1}{2}$	....	6 5173	$6\frac{33}{64}$	21	...	6.3955	$6\frac{25}{64}$	$32\frac{1}{2}$	...	8.8617	$8\frac{55}{64}$	44	...	6.9502	$6\frac{61}{64}$
10	....	6.2151	$6\frac{7}{32}$	$21\frac{1}{2}$	...	6.2672	$6\frac{17}{64}$	33	...	8.7519	$8\frac{3}{4}$	$44\frac{1}{2}$	...	6.8887	$6\frac{57}{64}$
$10\frac{1}{2}$	....	5.9415	$5\frac{15}{16}$	22	...	6.1446	$6\frac{9}{64}$	$33\frac{1}{2}$	...	8.6453	$8\frac{41}{64}$	45	...	6.8284	$6\frac{53}{64}$
11	....	5.6927	$5\frac{11}{16}$	$22\frac{1}{2}$	...	6.0273	$6\frac{1}{32}$	34	...	8.5417	$8\frac{35}{64}$	$45\frac{1}{2}$	...	6.7695	$6\frac{49}{64}$
$11\frac{1}{2}$	....	5.4655	$5\frac{15}{32}$	23	...	5.9151	$5\frac{59}{64}$	$34\frac{1}{2}$	...	8.4410	$8\frac{7}{16}$	46	...	6.7119	$6\frac{23}{32}$
12	....	5.2572	$5\frac{1}{4}$	$23\frac{1}{2}$	...	5.8077	$5\frac{13}{16}$	35	...	8.3432	$8\frac{11}{32}$	$46\frac{1}{2}$	...	6.6551	$6\frac{21}{32}$
$12\frac{1}{2}$	....	5.0655	$5\frac{1}{16}$	24	...	5.7046	$5\frac{45}{64}$	$35\frac{1}{2}$	...	8.2480	$8\frac{1}{4}$	47	...	6.5997	$6\frac{19}{32}$
13	....	4.8885	$4\frac{57}{64}$	$24\frac{1}{2}$	...	5.6057	$5\frac{39}{64}$	36	...	8.1554	$8\frac{5}{32}$	$47\frac{1}{2}$	...	6.5453	$6\frac{35}{64}$
$13\frac{1}{2}$	...	4.7245	$4\frac{23}{32}$	25	...	5.5107	$5\frac{33}{64}$	$36\frac{1}{2}$	...	8.0652	$8\frac{1}{16}$	48	...	6.4920	$6\frac{31}{64}$
14	....	4.5722	$4\frac{37}{64}$	$25\frac{1}{2}$	...	5.4194	$5\frac{27}{64}$	37	...	7 9774	$7\frac{63}{64}$	$48\frac{1}{2}$	...	6.4398	$6\frac{7}{16}$
$14\frac{1}{2}$	....	3.4303	$4\frac{7}{16}$	26	...	5.3315	$5\frac{21}{64}$	$37\frac{1}{2}$	...	7.8918	$7\frac{57}{64}$	49	...	6.3886	$6\frac{25}{64}$
15	2	8.5957	$8\frac{19}{32}$	$26\frac{1}{2}$	...	5.2469	$5\frac{1}{4}$	38	...	7.8083	$7\frac{13}{16}$	$49\frac{1}{2}$	...	6.3383	$6\frac{11}{32}$
$15\frac{1}{2}$	....	8.3478	$8\frac{11}{32}$	27	...	5.1653	$5\frac{11}{64}$	$38\frac{1}{2}$	...	7.7271	$7\frac{47}{64}$	50	...	6.2890	$6\frac{9}{32}$
16	....	8.1153	$8\frac{7}{64}$	$27\frac{1}{2}$	...	5.0867	$5\frac{3}{32}$	39	...	7.6478	$7\frac{41}{64}$	...	...	....	.....
$16\frac{1}{2}$	....	7.8969	$7\frac{57}{64}$	28	...	5.0108	$5\frac{1}{64}$	$39\frac{1}{2}$	...	7.5704	$7\frac{9}{16}$	....	...	....	.....
17	....	7.6911	$7\frac{11}{16}$	$28\frac{1}{2}$	...	4.9375	$4\frac{15}{16}$	40	...	7.4950	$7\frac{1}{2}$	...	...	....	.....

Machinery

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SETTING UP AND OPERATING AUTOMATIC SCREW MACHINES—2*

APPLICATION TO THE "ACME" MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

In the previous installment of this article, which appeared in the May number of MACHINERY, a general idea was given of the method employed in setting up and operating the "Acme" multiple-spindle automatic screw machine, together with the "assumed" method used in calculating the product per hour. In this connection, it was mentioned that while the "assumed" method of determining the product per hour was quickly obtained it had the disadvantage of not being clearly understood by those who were not familiar with the construction and operation of this type of multiple-spindle automatic screw machine. Before going more fully into this subject, it might be advisable to give all the data necessary for laying out a new job on this machine. Following this, the formulas used for making the calculations will be given, and a practical example illustrating the various points taken up in the article will be presented in order to make this subject more clearly understood.

Working Relations of Side-working Tool-slides to Work-spindles

In laying out a job on the "Acme" multiple-spindle automatic screw machine, it is necessary to know the working relations of the tools on the side-working tool-slides to the end-working tools, in order to provide for tool clearance, etc. This information is especially necessary when special tools have to be designed to use in these various positions. In Table I are given the principal dimensions of the side- and top-working tool-slides and their relations to the work-spindles when in the extreme forward and backward positions, the latter dimensions being given as maximum and minimum in the table. It will also be noted that on the Nos. 515, 52, 55 and 56 machines two positions are given for the side-working tool-slides. The reason for this is that the cam levers and brackets on these sizes of machines are provided with two pivot holes, thus making it possible to increase the travel of the slides without changing the cams operating them. The capacities or diameters of stock which can be formed and cut off with the levers fulcrumed in the two positions were given in Table I of the January installment of the series "Acme Multiple Spindle Automatic Screw Machine."

Working Relations of End-working Tool-spindles to Work-spindles and Side-working Tool-slides

In connection with Table II is presented a diagram illustrating the relations of the end-working tools, side-working tool-slides and work-spindles, and in the table the principal dimensions noted on the illustration are tabulated. These data are necessary in order to determine the length of the shanks and bodies of the end-working tools and also their diameters. The extreme positions of the end-working tool-slide in relation to the face of the nose pieces enclosing the chucks are given by dimensions H and I, which are the minimum and maximum distances. The dimension C on the side-working slides is the distance from the inner edge of the tool slot to the face of the nose piece on the spindles when the center of the slide is directly over the center of the cam lever operating it. Of course this slide can be adjusted longitudinally on the machine, as was described in a previous article, in order to bring the cut-off and forming tools in the correct relation to each other and the work.

In laying out a job it is always advisable, whether standard or special tools are to be used, to determine whether there is sufficient clearance between the face of the tools and the ends of the work when the tool-slide is in its extreme backward position. This is necessary, of course, in order for

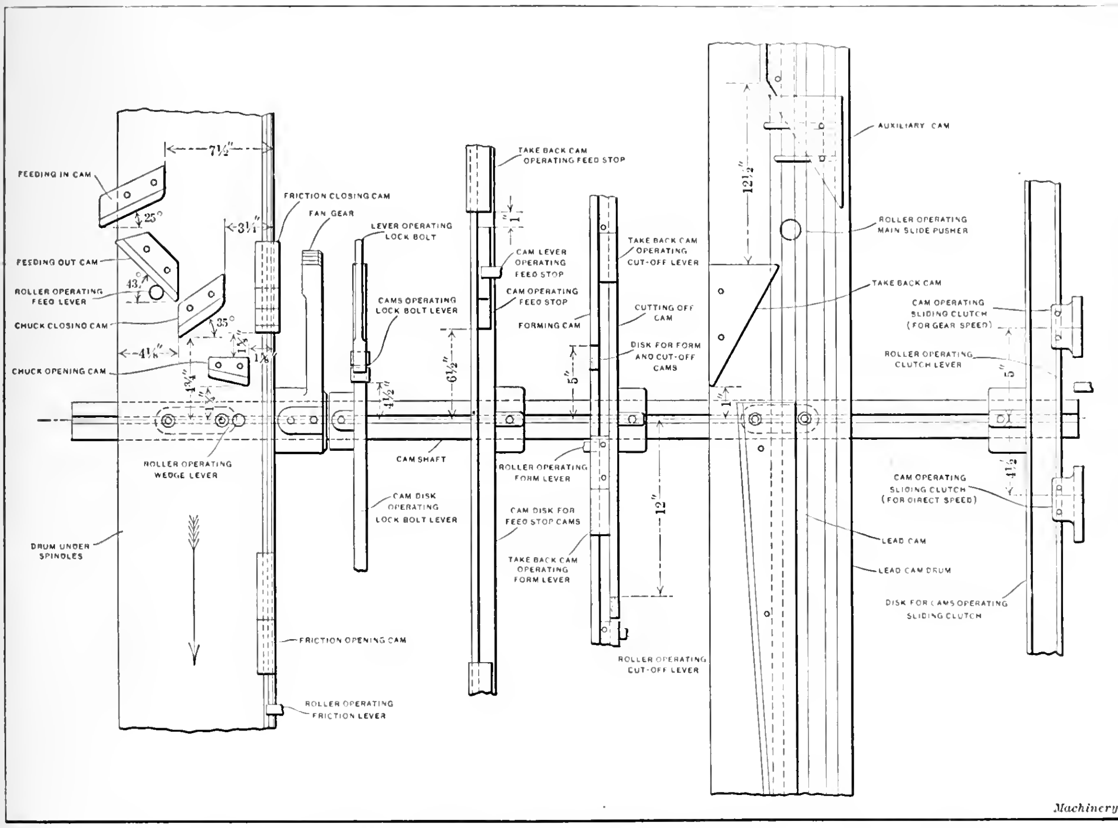

Fig. 9. Developed Plan View of Main Cam-shaft on Nos. 54 and 55 Machines showing Position of Cams and Operating Mechanism when Machine is indexing

* "Setting up and Operating Automatic Screw Machines—1" appeared in the May, 1913, number of MACHINERY.
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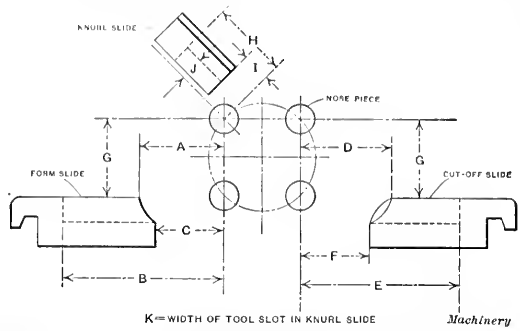
the cylinder to index. When designing special tools an endeavor should always be made to have the tool shank the full length of the hole in the tool-spindle. In order to decrease the liability to chatter and spring, it is preferable to have a tool with as long a body as possible, as this increases the rigidity of the tool considerably.

Another point to bear in mind is that the tools should be designed to correspond with the positions that they occupy on the work; that is to say, the box-tool which performs the second cut on a piece should extend out further than the first box-tool a distance equal to the advance made on the work by the first tool, and hence must be considerably longer. In laying out the job, therefore, it is essential that this particular point be borne in mind so that all tools in the main tool-slide will clear the work. This is particularly important, as on this machine the tools work from the end on different bars at the same time, and as these bars all project the same distance from the face of the chuck it is

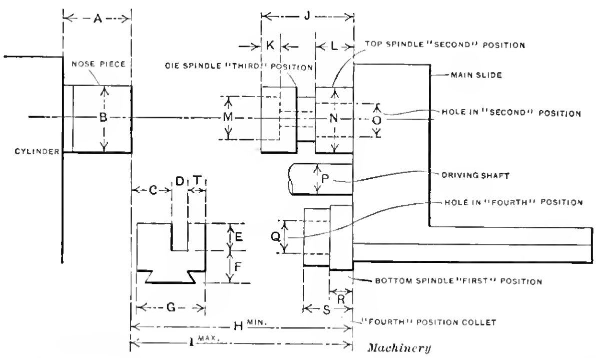
TABLE I. PRINCIPAL DIMENSIONS GIVING RELATIONS OF FORMING SLIDES TO WORK-SPINDLES



Number of Machine	Dimensions of Form Slide in Inches												Dimensions of Cut-off Slide in Inches												Cut-off and Form Slide	Principal Dimensions of Knurl Slide in Inches					
	Top Pivot Hole in Cam Lever and Bracket						Bottom Pivot Hole in Cam Lever and Bracket						Top Pivot Hole in Cam Lever and Bracket						Bottom Pivot Hole in Cam Lever and Bracket												
	A		B		C		A		B		C		D		E		F		D		E		F			H		I		J	K
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	G	Max.	Min.	Max.	Min.		
51	3 1/16	2 1/8	6 9/16	5 5/8	2 1/16	1 1/16	..	..	..	..	..	..	..	..	5 7/8	5 1/8	1 3/4	1 1/16	..	..	..	..	..	..	2 3/16	5 1/4	4 5/8	2 1/2	1 13/16	5/8	7/8
515	3 1/8	2 1/4	6 7/8	6	2	1 5/16	3 13/16	2 1/2	7 5/8	6	2 11/16	1 1/16	3 1/8	2 1/2	6 3/4	6 1/8	1 13/16	1 3/16	3 3/4	2 1/2	7 5/16	6 1/16	2 7/16	1 3/16	2 13/16	6 3/8	5 1/8	3 5/8	2 1/16	3/4	15/32
52	3 1/16	2 1/4	6 13/16	6	1 13/16	1 3/16	3 3/4	2 1/4	7 7/16	6	2 1/2	1 3/16	2 15/16	2 3/8	6 7/16	5 15/16	1 5/8	1 1/16	3 3/8	2 3/8	6 7/8	5 15/16	2 1/16	1 1/16	3 3/16	6 5/16	5 1/2	3 5/8	2 3/4	13/16	15/32
53	4	3 1/4	9 1/8	8 3/8	2 13/16	2 1/16	..	..	..	..	..	..	3 3/4	2 15/16	9 1/8	8 3/8	2 7/8	2	..	..	..	..	..	..	4 5/16	7 9/16	6 5/16	4	2 11/16	3/4	23/32
54	4 1/4	3 7/16	10	9 3/16	2 3/4	1 13/16	..	..	..	..	..	..	4 1/16	2 15/16	10 3/8	9 3/16	3	1 7/8	..	..	..	..	..	..	5 3/8	7 15/16	6 7/8	4 5/16	3 5/16	7/8	23/32
55	4 3/8	3 1/2	10	9 1/8	2 9/16	1 11/16	4 9/16	3 1/2	10 3/16	9 1/8	2 13/16	1 11/16	4	2 15/16	10 1/4	9 3/16	2 15/16	1 7/8	4 1/4	2 15/16	10 1/2	9 3/16	3 3/16	1 7/8	5 3/8	8 1/16	6 7/8	4 1/2	3 1/4	1	23/32
56	4 5/16	3 1/2	10 11/16	9 13/16	2 13/16	1 3/4	4 15/16	3 1/2	11 1/4	9 13/16	3 1/4	1 3/4	4 9/16	3 5/8	10 15/16	9 15/16	2 11/16	1 3/4	5 7/16	3 5/8	11 3/4	9 15/16	3 1/2	1 3/4	6 7/8	9 1/16	7 3/8	5 1/8	3 1/2	3/4	1 1/32

Machinery

TABLE II. PRINCIPAL DIMENSIONS AND RELATIONS OF END-WORKING TOOLS TO WORK-SPINDLES AND FORMING SLIDES



Number of Machine	Principal Dimensions in Inches																									
	Nose Piece		Form Slide						Cut-off Slide						Main or Tool Slide											
	A	B	C	D	E	F	G	T	C	D	E	F	G	T	H	I	J	K	L	M	N	O	P	Q	R	S
51	1 17/32	1 1/2	1 1/4	19/32	1 1/32	27/32	3	1 1/16	3/4	19/32	1 5/32	23/32	3	1 25/64	3 13/32	7 31/32	2 9/32	1	13/16	1	1 13/16	3/4	1 1/4	1/2	13/16	1 5/8
515	2	2 1/4	15/16	23/32	1 1/16	1 1/16	3	1 1/16	1/16	19/32	1 3/16	15/16	3	1 17/64	3 5/8	8 5/8	2 1/4	1	15/16	1	1 15/16	7/8	1 1/4	7/8	7/8	2 1/4
52	2	2 15/32	1 3/8	23/32	1 1/16	1 1/16	3	1 1/64	9/16	19/32	1 3/16	15/16	3	1 17/64	3 3/4	9 5/8	2 1/4	1	15/16	1	1 15/16	7/8	1 1/4	7/8	7/8	2 1/4
53	2 5/8	2 31/32	1 3/16	27/32	1 1/2	1 1/4	4 5/8	1 17/64	5/16	27/32	1 1/2	1 1/4	4 5/8	2 21/64	7 1/8	13 1/16	3 7/16	1 1/2	1 5/8	1 1/2	2 15/16	1 1/8	1 3/4	1 1/8	1 1/8	3 11/16
54	2 13/16	3 9/16	2 9/16	27/32	1 3/8	1 3/4	4 3/4	1 13/64	Flush	27/32	1 1/2	1 5/8	4 3/4	2 15/32	7 7/16	13 13/16	4 3/8	1 1/2	1 5/8	2 3/16	3 9/16	1 3/4	1 3/4	1 3/4	1 1/8	3 11/16
55	3 15/32	4 7/16	2 1/16	27/32	1 3/8	1 3/4	4 3/4	1 13/64	15/16	27/32	1 1/2	1 5/8	4 3/4	2 15/32	7 1/32	13 9/32	4 3/8	1 1/2	1 5/8	2 3/16	3 9/16	1 3/4	1 3/4	1 3/4	1 1/8	3 11/16
56	4 3/8	5 1/8	2 1/4	1 3/32	1 3/4	1 15/16	5 1/4	1 25/64	1/4	1 3/32	1 13/16	1 7/8	5 1/4	2 49/64	10	18 13/16	5 5/8	2 1/2	2 1/8	3	4 5/16	2 5/16	1 3/4	2 5/16	1 5/8	4 3/16

evident that all tools must be so designed as to clear the work while the cylinder is being rotated. That is to say, the main tool-slide must be pulled back far enough to enable the longest tool to clear the work.

Calculating Speed of Work-spindles

The speed of the work-spindles obtainable by direct drive and through the back-gearing was given in the January, 1913, number of MACHINERY, but as it might be possible in some cases to secure more satisfactory speeds with gears having a different number of teeth than those given in the table, it may be advisable to carry through the calculations used in obtaining the proper gears to use for the required speeds. As was explained in a former article, the work-spindles are rotated from the main drive shaft through gearing. The gears on the main shaft drive the spindles through a friction gear that can be disconnected from the spindle when it is necessary to stop its rotation for performing operations such as threading, cross-drilling, milling, etc. As there are only two gears involved in this calculation, the method of obtaining the speeds of the spindle is simple and can be obtained from the following formula:

$$R = \frac{r \times N}{n}$$

in which:

R = R. P. M. of work-spindles;
r = R. P. M. of top or main drive shaft;
N = number of teeth in gear on top or main drive shaft;
n = number of teeth in friction gear.

For example, on the No. 54 machine $R = \frac{35 \times 480}{45} = 373$

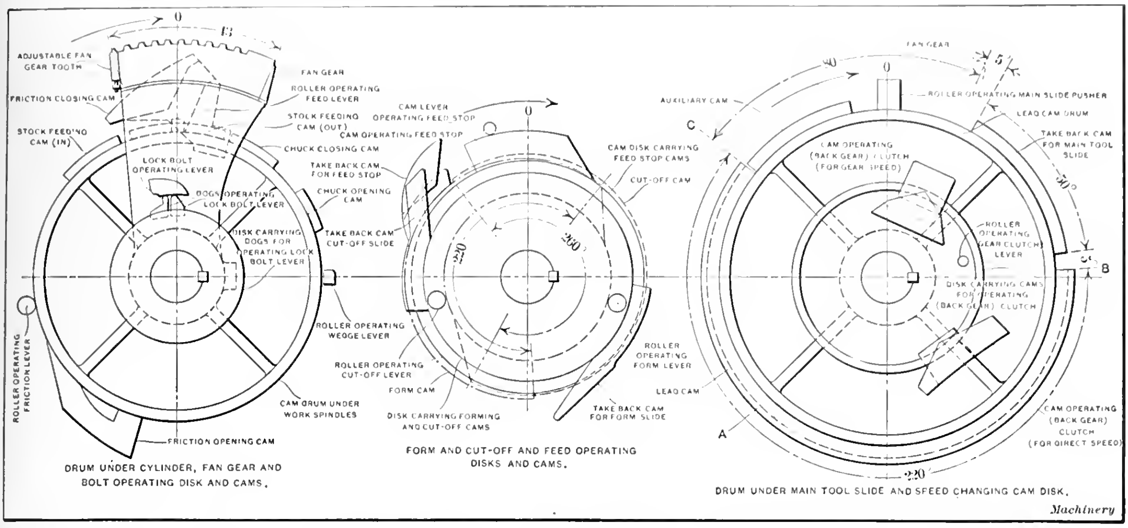
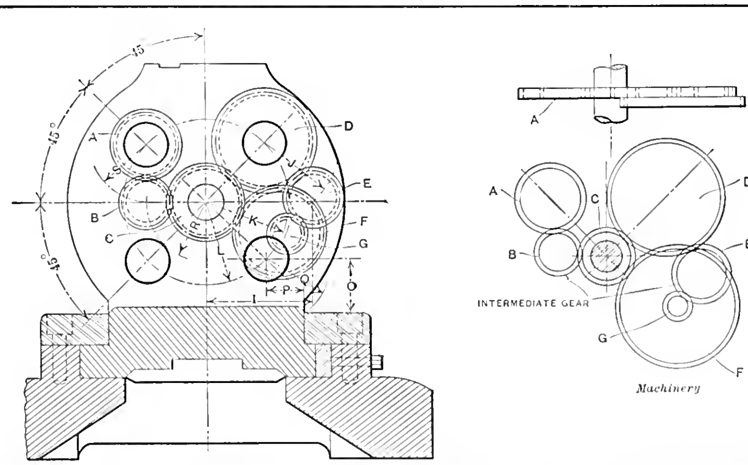


Fig. 10. End View of Cams and Drums located under Cylinder, Cut-off and Forming Tool-slide and Main Tool-slides on Nos. 54 and 55 Machines

TABLE III. PRINCIPAL DIMENSIONS OF BACK GEARS AND CENTER DISTANCES OF TOOL-SPINDLES



Number of Machine	A		B		C		D		E		F		G		Principal Dimensions in Inches								
	T	P	T	P	T	P	T	P	T	P	T	P	T	P	I	J	K	L	M	N	O	P	Q
51	24	16	17	16	24	16	34	16	17	16	34	16	18	16	2 3/32	1 19/32	1 13/16	1 13/16	1 1/2	49/64	1 9/32	1 9/32	1 9/32
515	22	12	16	12	20	12	34	12	16	12	36	12	14	12	2 25/32	2.083	2.333	2 1/4	1 3/4	31/32	1 15/32	1 1/2	1.583
52	24	12	18	12	22	12	38	12	18	12	40	12	16	12	3 23/64	2.33	2.583	2 1/2	1 11/16	25/32	1 1/2	1.666	1 3/4
53	26	10	18	10	22	10	43	10	15	10	45	10	15	10	3 1/2	2.90	3.35	3 1/4	2 9/32	1 5/16	1 7/8	2	2.20
54	36	10	21	10	26	10	55	10	20	10	54	10	17	10	4 9/16	3 3/4	4	4 1/64	2 21/32	1 23/32	2 9/32	2.35	2 7/8
55	36	10	21	10	26	10	55	10	20	10	54	10	17	10	4 9/16	3 3/4	4	4 1/64	2 21/32	1 23/32	2 9/32	2.35	2 7/8
56	33	8	22	8	26	8	54	8	22	8	54	8	16	8	5 7/16	4 3/4	5	5	3 7/16	1 3/16	3 7/32	3	3 7/16

T = Number of Teeth Gears P = Diametral Pitch in Inches

R. P. M., approximately. It might be mentioned here that in all future calculations particular reference will be made to the Nos. 54 and 55 machines, as these two sizes meet general commercial requirements. It might also be explained in regard to the tables that in all cases where the calculations for the gears do not work out to an even figure the nearest 5 or 0 is taken.

Calculating Speeds of Threading and "Second Position" Tool-spindles

A notable feature of the "Acme" multiple-spindle automatic screw machine is that, for threading, the work is stopped and the die is rotated, but in backing off the reverse is the case. In order to fulfill these requirements, it is necessary to gear up the threading-spindle to the main drive or top shaft. The diagram presented in connection with Table III shows the relation of the gears for rotating the threading-spindle and the spindle in the "second position." Two speeds for each speed of the top or main drive shaft are possible by shifting the gearing, one speed being obtained by driving direct through the sliding gear on the main drive shaft to the gear on the threading-spindle and the other by driving

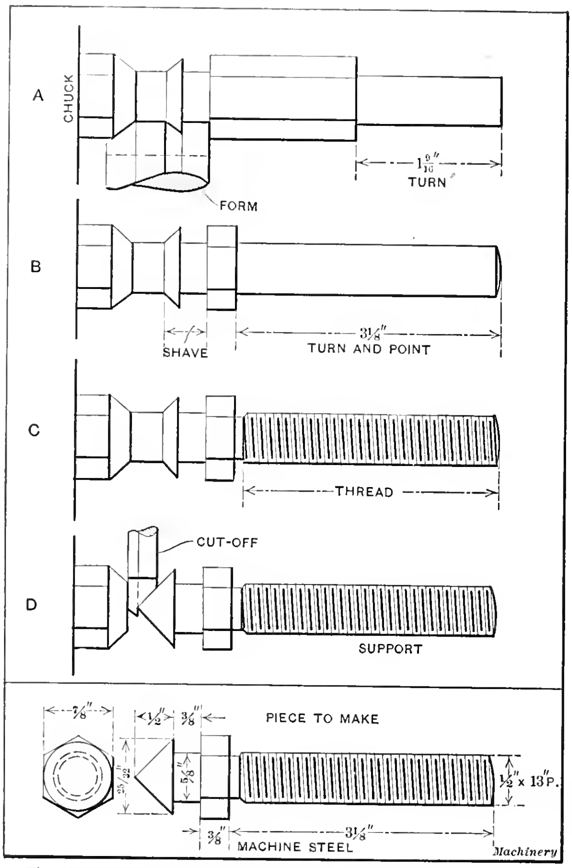


Fig. 11. Order of Operations followed in producing a Cone-headed Screw

through an intermediate and a compound gear. The following formula is used for obtaining the speed of the spindle when driven direct:

$$R_1 = \frac{r \times N_1}{t}$$

in which:

R_1 = R. P. M. of threading-spindle (direct drive);
r = R. P. M. of top or main drive shaft;
N_1 = number of teeth in sliding gear on top or main drive shaft;
t = number of teeth in gear on threading-spindle (also called direct gear).

As an example, assume that the speed of the top or main drive shaft is 480 R. P. M., then:

$$R_1 = \frac{480 \times 26}{55} = 227 \text{ R.P.M. approximately.}$$

(The numbers of teeth in these gears are listed in Table III.) The formula for obtaining the speed of the threading-spindle, when driven through the intermediate and compound gear, is as follows:

$$R_2 = \frac{r \times N_1 \times T}{n_1 \times t}$$

in which:

R_2 = R.P.M. of threading-spindle (gear driven);
r = R.P.M. of top or main drive shaft;

TABLE IV. TIME REQUIRED IN SECONDS TO PERFORM IDLE MOVEMENTS ON VARIOUS SIZES OF MACHINES

Number of Machine	Time in Seconds to complete Longest Single Operation	
	When Operation is performed from Main Tool or Form Slide	When Operation is performed from Cut-off Tool Slide
51	1.1	0.87
515	1.2	0.97
52	1.7	1.33
53	2.3	1.85
54	2.4	1.88
55	2.4	1.88
56	4.6	3.58

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N_1 = number of teeth in sliding gear on main drive shaft;
T = number of teeth in pinion gear;
n_1 = number of teeth in back-gear;
t = number of teeth in gear on threading-spindle (also called direct gear).

The "second position" tool-spindle which can be used for threading, if necessary, and which in many cases is used for driving small drills at their proper peripheral speeds, is also rotated from the top or main drive shaft through gears. The speed of this spindle can be obtained by the following formula:

$$R_3 = \frac{r \times N_1}{T_1}$$

in which:

R_3 = R.P.M. of "second position" tool-spindle;
r = R.P.M. of top or main drive shaft;
N_1 = number of teeth in sliding gear on main drive shaft;
T_1 = number of teeth in gear on "second position" tool-spindle.

For a practical example, assume that the speed of the main drive shaft is 480 R. P. M., then:

$$R_3 = \frac{480 \times 26}{36} = 346 \text{ R.P.M. approximately.}$$

Main Cam-shaft Computations

The main cam-shaft on the "Acme" automatic carries all the cams for operating the various slides, spindle stopping mechanism, etc., and also the fan gear for indexing the cylinder. As shown in Fig. 9, which is a developed plan view of the cam-shaft with the drums and cams on it, it will be seen that one revolution of this cam-shaft completes one cycle of the machine; that is, one revolution of the cam-shaft would mean the completion of one piece, or four revolutions the complete indexing of the cylinder. The rotation of the cam-shaft is not connected directly with the rotation of the work-spindles, but indirectly the cams on it govern the rate of travel of the tools on either the top- or side-working tool-slides, and also the end-working slide. It is therefore necessary to determine for each job the relation between the speed of the spindle and the speed of the cam-shaft in order to determine the production per hour, minutes or seconds.

The cam-shaft is driven from the main drive pulley through bevel gearing and a Johnson clutch. The clutch forms the connection between the direct drive and gear drive to the cam-shaft, so that it is possible to rotate the cam-shaft at a much higher speed for the idle movements than the speed at which it is operating when the tools are cutting. To obtain the speed of the cam-shaft in revolutions per minute, when

driven direct, we can use the first figures given in the first column of Table VI (see January number), as these will give the number of revolutions the cam-shaft makes in one hour. Dividing this speed—585—by 60, we find that the cam-shaft on the Nos. 54 and 55 machines makes 9.75 R.P.M. or 0.1625 revolution per second. As there are 360 degrees in a circle and as any point on the cam drum makes 0.1625 revolution per second, the number of degrees passed through in this time equals $0.1625 \times 360 = 58.5$ degrees, approximately. Now, if it takes one second for the cam-shaft to rotate through a space of 58.5 degrees, we can easily find the time required to complete the idle movements, when the number of degrees taken up by the idle or non-productive movements are obtained. By referring to Fig. 10, in which the various drums and cams have been laid out in their respective positions and at the point in their rotation at which the machine is indexing, we can see at a glance that the non-productive movements come in between the time that the lead cam A starts to operate and finishes. This applies when the longest single operation is performed by the end-working tools or from the forming slide. Where the longest operation is performed from the cutting-off slide, the idle time is less because there are 30 more degrees taken up on productive work. It is safe to

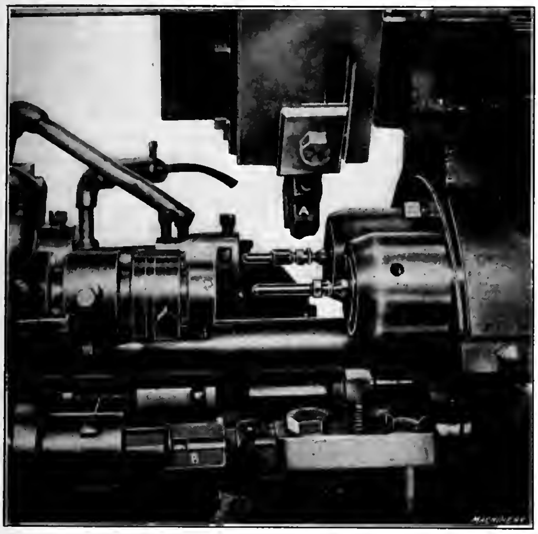


Fig. 12. The "Set-up" used for producing the Cone-headed Screw shown in Fig. 11

assume that on 75 per cent of the jobs set up on this machine the longest operation is performed from the end-working tool-slide; hence, we can base our calculations on the number of degrees of drum surface between the starting and finishing points of the cam. This we find is $360 - 220 = 140$ degrees. When the longest single operation is performed from the cut-off tool-slide, the idle movements occupy 110 degrees of the drum circumference.

Calculating the Time required for Idle Movements of Machine

The idle movements of the machine consist in advancing and withdrawing the tools to and from the work and indexing the cylinder. The stock is fed out and the chuck closed while the cylinder is indexing on the smaller machines and in the "first position" on the larger machines, but in all cases, as can be seen from a study of Fig. 10, the idle movements for which we have made provision more than compensate for the time required to feed out the stock. We therefore have three main idle or non-productive movements of the machine to take into consideration in calculating the actual time required. Upon referring to Fig. 10, we find that these movements are all confined to the space between B and C on the circumference of the cam drum. As all the non-productive movements are accomplished while the cam-shaft is being driven at its highest speed—direct through the Johnson clutch, and not through the chain gearing—it is necessary to find out what part of the cam circumference these movements occupy and also the speed at which the drum is being rotated when driven direct. We have just found that the idle movements or the space on the cam circumference from B to C equals 140 degrees, and that on the Nos. 54 and 55 machines the cam-shaft, when driven direct, is rotated at a speed of 0.1625 revolution per second. Then, if it takes one second for the cam-shaft to rotate through a space of 58.5 degrees, it will require $140 \div 58.5$ or 2.4 seconds approximately for the idle movements. This if added to the time required for the longest single operation will give the actual time required to complete one piece.

Example

In order to carry through the calculations which have just been given and to put them in such a form that they can be used in practice, it might be advisable to give an example. We will assume that it is necessary to make the cone-headed screw shown in Fig. 11, the tool "set-up" for which is shown in Fig. 12. The first point in the calculation is to determine the speed at which the spindle should be rotated for turning the material from which the screw is made, and also the longest single operation. This, of course, is the turning of the body. As a general rule, cold-rolled steel can be worked at a surface speed of from 90 to 120 feet per minute and the nearest speed on the No. 54 machine that we can use is 375 R. P. M. The distance that the first box-tool has to travel on the work is $1.562 + 0.038$ or 1.600 inch; then using a feed of 0.004 inch per revolution, we find that it requires 400 revolutions of the spindle to complete the first cut on the body of the screw. This is equivalent in time to 64 seconds.

Now, to obtain the time required for the idle movements, we calculate the time required for the cam-shaft to pass through 140 degrees, as was previously explained, and add the result to the time required for the longest single operation to obtain the time to make one piece. We found the time for the idle movements to be 2.4 seconds, so the total time required to complete one piece is $64 + 2.4$ or 66.4 seconds. Now to convert the time required to make one piece into production per hour, it is necessary to divide 3600 by 66.4, which gives a product of 54 pieces per hour. By referring to Table VI which appeared in the January number of MACHINERY, we find that the nearest product to the result of our calculations is 50 pieces per hour. As it is impossible to obtain a gear ratio to give the calculated product, it is necessary to do one of two things. First, if the box-tool performing the longest operation will stand a greater feed, we can raise the production up to 58.5 pieces per hour; if not, it will be necessary to drop down to 50 pieces per hour, and in so doing reduce the feed on the tools.

When the time required for the idle movements has once been calculated it is not necessary to go through this calculation again except in cases where special fixtures or tools are used that would necessarily require more than the usual clearance space, or where the lead cam is cut up to divide cuts, etc. As this is very infrequently the case, the actual time in seconds utilized in the performance of the idle movements is given in Table IV for the various sizes of machines.

As the various steps followed in setting up a job similar to the one illustrated in Fig. 12 on the "Acme" were described in the previous installment it will not be necessary to go into this subject here. This particular job differs only in two respects from the one previously referred to. Part of the head is finished by a shaving tool A and the work when being cut off is steadied by a support B to secure a good job. This support prevents the thrust of the cut-off tool from breaking the piece off before the cone-head has been completely formed with the cut-off tool.

Calculating Speed of Main Cam-shaft

The following formulas are used for calculating the speed of the cam-shaft when driven direct and when driven through the change gears. For direct speed:

$$R_4 = \frac{r_3 \times N_2}{n_2 \times W}$$

in which:

R_4 = R. P. M. of main cam-shaft;

r_3 = R. P. M. of clutch shaft;

N_2 = number of teeth in sprocket on clutch shaft;

n_2 = number of teeth in worm-gear sprocket;

W = number of teeth in worm-wheel on the cam-shaft.

For an example on the No. 54 machine, where the clutch shaft is rotated at 493 R.P.M., the result is as follows:

$$R_4 = \frac{493 \times 24}{16 \times 76} = 9.73 \text{ R.P.M.}$$

The formula for calculating the speed of the cam-shaft when driven through the change gearing is as follows:

$$R_5 = \frac{r_3 \times A \times D \times N_2}{C \times B \times n_2 \times W}$$

in which:

R_5 = R.P.M. of main drive shaft (gear driven);
r_3 = R.P.M. of clutch shaft;
B = first gear on clutch shaft (driven);
C = second gear on stud (driven);
N_2 = number of teeth in clutch shaft sprocket;
A = number of teeth in second gear on clutch shaft (driver);
D = number of teeth in first gear on stud (driver);
n_2 = number of teeth in worm-gear sprocket;
W = number of teeth in worm-wheel on cam-shaft.

With the aid of these formulas it is possible to calculate the production per minute or hour given in Tables II to VII in the January number of MACHINERY.

* * *

A FEW QUESTIONS ABOUT RING-OILING BEARINGS

BY A. DE SIGNER

One of the subjects about which there seems to be little reliable information in the way of results of actual tests, is concerning the ring-oiling bearing. Here are a few of the questions which arise in designing these bearings to suit certain conditions. What are the limits of speed at which it is safe to use this method of lubrication? It seems that there must be a high limit at which the oil would be thrown off the ring by centrifugal force before getting high enough to be deposited on the journal, or else the retarding effect of the oil in the reservoir into which the ring dips may slow it down so much, relative to the speed of the shaft, that it will not deliver enough oil to properly lubricate the journal. Then there must be a low limit at which the oil would run down the ring faster than the ring moves, and consequently too little oil would be delivered to the journal. It would not require very many experiments to arrive pretty accurately at these limiting speeds and the information might be very useful to the designer.

What is the best shape for the ring? I have seen rings of square and rectangular section, triangular section, half-round section and an inverted T-section made of two angles riveted together with the adjacent legs standing out from the journal. This last section is used by one of the largest engineering concerns in the country, yet I have known it to fail completely to deliver the necessary supply of oil. We replaced it by the rectangular section and had no further trouble. The triangular section was used on the outboard bearing of a direct-connected engine-generator running at moderate speed, which gave trouble by running hot from the very start. We replaced it by a ring of half-round section with very good results, the bearing running cool from that time on, with other conditions unchanged.

What is the best material for the rings? I have seen them made of cast iron, wrought iron and bronze, with apparently equal success. The cheapest rings I ever saw were made of half-round wrought iron in the rough, the only machine work being the joining of the halves and they were apparently very satisfactory. They were used on bearings from 2½ inches to 22½ inches diameter, with equally good results. My own opinion is that these were not only the cheapest but the best as well, because they could not be broken under ordinary running conditions, while I have seen broken rings of bronze. If made of good wrought iron, there is less danger of hard spots, which might cut the shaft, than there is with either bronze or cast iron. However, I don't think this a serious consideration, for there is little danger of any of them cutting a shaft. One of the very best rings I have seen was of rectangular section with the outer corners chamfered and was made of bronze. This ring was knurled on the inside, giving it the maximum driving power.

How many rings are needed for a given length of bearing? How far is it safe to figure on spreading the oil each side of the ring? To what extent does the diameter of the journal affect this point? It seems as if the area to be lubricated must have a considerable influence, and yet I cannot believe that the same area could be lubricated on a 2½-inch journal as on one 22½ inches in diameter. Of course, proper grooving must have a good deal to do with it, too.

What is the best grade of oil to use in a ring-oiling bearing? An oil that is too stiff might retard the ring to such an extent as to interfere with lubrication, while one that was too light might not be carried to the top of the journal and might be of insufficient body for lubrication. Where are these limits to be set? Other questions might be: the best depth to which the ring should be immersed in the oil; whether the diameter of ring (within reasonable limits) has any effect on its ability to deliver the oil; how much the ring swings to one side at different speeds. It is customary to allow rather a limited clearance for the ring in order to keep down the size of the bearing casing, but it is conceivable that the ring might rub against one side of the casing to such an extent as to interfere with its proper operation.

Another question which confronts the designer is: How large an oil reservoir is needed? In some bearings which I have seen, the object sought, apparently, has been to keep this down to a minimum, giving the bottom a cylindrical shape to conform with the shape of the ring, while others are made rectangular and have a capacity for a considerable quantity of oil. To my mind the latter is the right idea, since the oil will keep cooler and the flat bottom of the box allows quite a space for the collection of sediment before it will pile up sufficiently to retard the ring.

A little point which I have known to be overlooked is to provide a passage for the oil to flow from one end of the bearing to the other in the oil reservoir. With the ball and socket type this is not always easy, but I know from personal experience that it is advisable, having neglected it in some of my first designs, and had to connect the two reservoirs by a pipe afterward in order to prevent all the oil being carried to one end. Just why this action should take place, I do not see, but it certainly did.

It seems to me that most of the above questions might be systematically investigated to the advantage of the multitude of designers who are continually being called on to get out bearings for various duties. Why could not some of our colleges take this up and make systematic tests of different kinds of rings at different speeds and with different grades of oil? This is an investigation which would not require an expensive equipment and might furnish some very valuable data, and I commend it to the readers of MACHINERY in the hope that some of them may take it up. If such tests have already been made, I should be glad to see the results printed in these columns.

* * *

The New Britain Machine Co.'s plant in New Britain, Conn., built a year or two ago, is a four-story and basement building. The high price of land in New Britain made the factory type of building imperative. Plunger elevators are provided to serve the floors and an automatic system keeps the water pressure constant. The water is used over and over again, thus avoiding water waste and unnecessary expense. Employes use the elevators freely when going from floor to floor. Before the building of the new plant, they were not allowed to use the elevators because of the cost of power, attendance, etc. When making the plans, the management decided "that power generated in the power plant from coal is cheaper than that made from mince pie," and provided liberally for the substitution of mechanical power for human effort when travel vertically was necessary.

SOME MANUFACTURING KINKS USED ON CONTRACT WORK

WAYS AND MEANS USED IN MACHINING ADDING MACHINE PARTS AT W. H. NICHOLS CO.'S SHOP, WALTHAM, MASS.

BY CHESTER L. LUCAS*

In shops where contract work is done it is highly important that effective methods be used, thereby keeping the manufacturing costs down and leaving a margin of profit. The ways and means which must be devised for each job vary with the character of the work and the number of pieces required; therefore a great deal of ingenuity is required to get out tools which will produce the work without great expense or delay for initial equipment.

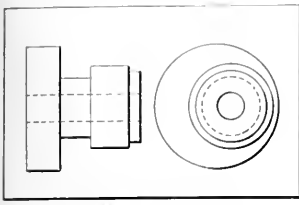


Fig. 1. An Eccentric Cam for Adding Machine Use

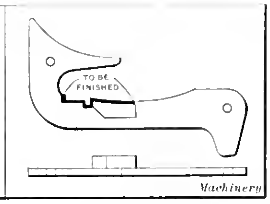


Fig. 2. Lever with Awkward Section to finish

Oftentimes, the methods which must be used for producing the parts may not appear to be quite mechanical, but considering the small number of pieces which are required and the limited expense for tools permissible, the unmechanical way is often the more practical. An example of this point is well illustrated in the turning of the eccentric cam that is reproduced in Fig. 1. This is a steel part for an adding machine, and its greatest diameter is 1¼ inch. The length is 1⅛ inch. A ¼-inch hole passes through the piece, being located 3/16 inch off center, and with the exception of the eccentric part, the rest of the piece is concentric with this hole. As the shop equipment did not include a large turret lathe at that time, it was quite a problem to produce these pieces without installing an expensive turret lathe that would handle 2-inch bar stock. The method finally adopted was to use 1¼-inch cold-rolled bar steel, which was first cut to lengths of 2¼ inches. A round block of steel was then threaded to the spindle of an ordinary 14-inch lathe, and in the working end an eccentric hole was bored to a diameter of 1¼ inch and a depth of 1 inch, the eccentricity agreeing with that of the piece to be turned. The 2¼-inch length of steel was then inserted in this improvised chuck and held by hollow set-screws. On the cross-slide of the lathe a forming tool was fitted that was shaped to turn down the entire width of the piece as shown in Fig. 4. Where the cross-slide was run in, this tool turned the stock down to the required size, leaving the original surface of the bar to form the eccentric part. By means of a drill in the tailstock, the central hole was drilled, and a cutting-off tool mounted on the cross-slide at the rear side of the work was set at the proper distance from the end of the piece to cut it off to the exact length when the cross-slide was withdrawn. Of course this method of doing the job resulted in a piece of stock one inch long being wasted for each piece made, but these ends were available for other work. In view of the number of pieces to be made, however, and the equipment at hand, it proved to be satisfactory.

Another little kink in turning which has helped in producing duplicate work is illustrated in Fig. 3. Many of the adding machine parts are roughed out on small screw machines and must be re-turned in bench lathes, usually being held on an arbor for the operation. In Fig. 3 is shown the method of locating the work in the lathe so that each piece will be gaged from the same point. The piece shown at *A* is held on an arbor *B* which, in turn, is held in the usual manner in the spring collet *C*. Before inserting the arbor in the collet a thin walled bushing *D* is introduced, which bears against the spindle of the lathe on one end and against the reverse side of a shoulder of the work at the other end. When the drawing-in bar of the lathe is tightened, it pulls the work firmly back against bushing *D*. As the turning tool has been set to perform the machining at an exact distance from the end of the bushing, the cuts must all be gaged from the face of the shoulder—that is, against the bushing. While comparatively unimportant, this is a good method to employ on bench lathe work of this kind.

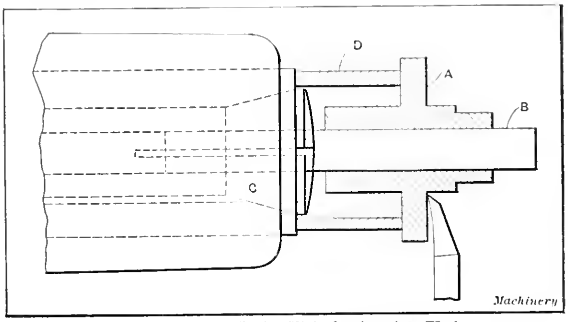


Fig. 3. A Bench Lathe Kink for locating Work

Fig. 4. Turning the Eccentric Cam in a 14-inch Lathe

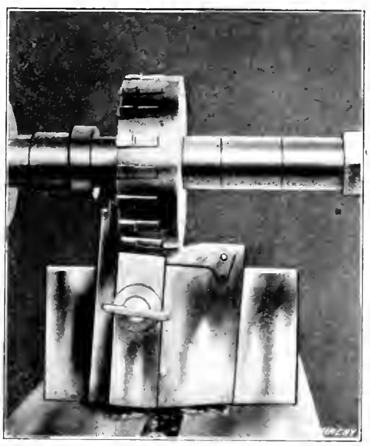


Fig. 5. Milling the Internal Section of a Computing Machine Lever

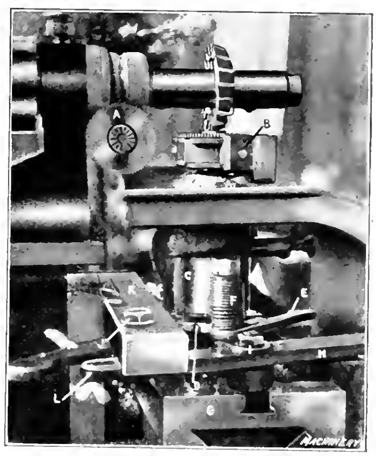


Fig. 6. Milling Ratchet Teeth on a Gear Blank

A puzzling proposition was presented in the machining of a steel computing machine lever. The surface to be finished is indicated by the heavy line on the work shown in Fig. 2. This piece is a hook-shaped punching upon which has been riveted a small block. After riveting, it is necessary to mill

* Associate Editor of MACHINERY.

the section indicated true with the two holes in the punching. Of course the natural way to do the job would be to mill it, but trouble arises because of the shape of the punching which extends back over the surface to be milled. Broaching would do the work satisfactorily, but would be a little slow and would require expensive equipment. As is the case in most of these contract jobs, the number of pieces

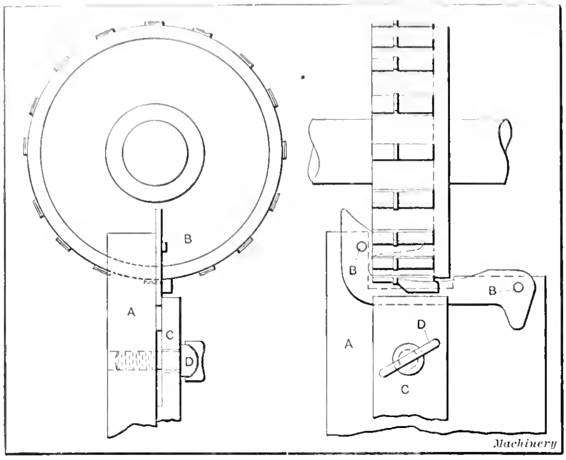


Fig. 7. Details of the Milling Fixture used in finishing the Computing Machine Lever

required was limited and it was doubtful if repeat orders would be called for; therefore it was necessary to devise a method requiring as inexpensive tools as possible. The method adopted involved the making of a special cutter which was recessed to clear the hook-shaped projection. The illustration Fig. 5 gives a general idea of the operation, and Fig. 7 shows the cutter and the method of holding the pieces. Obviously the pieces must be milled one at a time, because the interference of the cutter prevents a long table stroke.

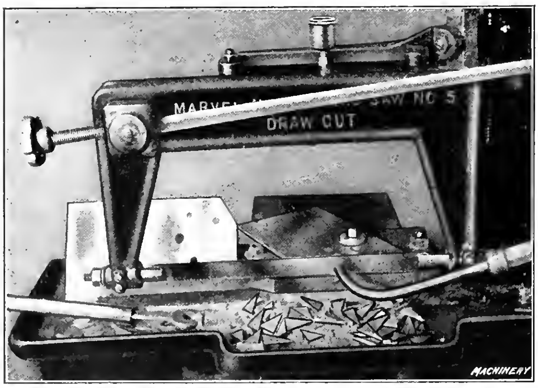


Fig. 8. Sawing the Corners from Steel Plates

The pieces are located on fixture *A* by means of two pins *B*, and are supported by clamp *C*, operated by thumbscrew *D*. The cutter is held upon an arbor in the usual manner. The work is hooked inside the cutter, set on the pins and clamped in place, and the milling cut started. The travel of the table is less than three-quarters of an inch, but it is enough to allow the surface to be milled properly. The piece is then removed and another blank inserted. It will be readily appreciated that the cost of tooling up for this job was not great, and the work produced was highly satisfactory.

Milling the ratchet teeth on the face of a gear blank, as shown at *A* in Fig. 6, is another machining operation that is handled very rapidly in this shop. The gears, as well as parts of adding machines, are turned with a raised panel around the central hole, and upon this panel ratchet teeth must be milled. The gears are located by means of three toothed blocks *B* which engage the teeth and hold the gear centrally upon the arbor *C*.

At the lower end of this arbor is an index-plate *D*, having equidistantly spaced notches; in this case there are fourteen. A pawl *E* engages this index-plate, and is mounted upon stud *F*, being kept constantly in contact with the index-plate by means of a spiral spring. The usual table feed mechanism is dispensed with and the table, which is indicated at *G*, is reciprocated by means of hand lever *H*, fulcrumed at bolt *I* attached to the T-slot of the table. The short end of the lever is slidably mounted on bolt *J* which passes through arm *K*, the latter being bolted to the frame of the machine. Also mounted on arm *K* is the indexing finger *L*, that, when brought into contact with the ratchet plate at each return stroke of the table, causes the arbor to turn one notch. The arbor is held stationary for the milling operation by pawl *E*. The milling of these ratchet teeth is performed as quickly as the operator can manipulate the lever, and after going once around the work a second cut is taken even more rapidly than the first, to remove any burrs and clean up the teeth.

Some excellent work is done on the "Marvel" draw-cut hacksaw and one of the sawing operations is shown in Fig. 8. This consists in sawing off the corners of steel plates 1/8 inch

Fig. 9. A Kink for holding Small Punchings on the Magnetic Chuck

thick, one of which is shown bolted onto a fixture on the farther side of the saw blade. Of course these corners could be clipped, but as one of the requisites is that the plate be perfectly straight and true when finished, sawing is considered the safer method of accomplishing this operation. The gear blanks, upon which the previously described ratchet cutting operation is performed, are cut from the bar on this

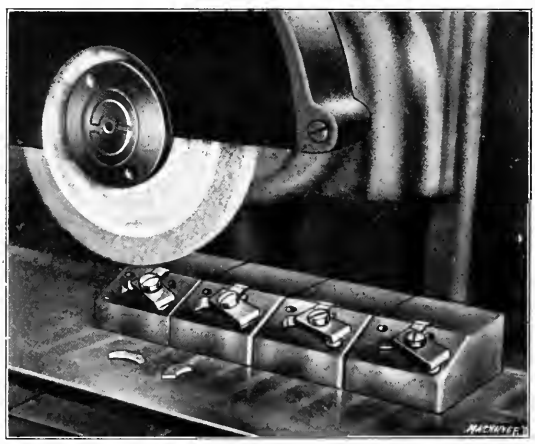


Fig. 10. Holding Small Punchings for a Bevel Grinding Operation

machine. A feature of its operation is that it automatically feeds the bar up after each cut and starts again, requiring no attention from the operator until the entire bar has been cut. The speed with which it works is extraordinary; on the gear blanks previously mentioned, which are 2 1/4 inches in diameter, the pieces drop from the saw every four minutes.

There are numerous surface grinding operations connected with the production of these adding machine parts, and Figs. 9 and 10 show two which are representative. In Fig. 9 a method of holding small irregular pieces on the magnetic chuck is worthy of note. These pieces are punchings made from 1/8-inch steel. They are held upon the magnetic chuck in strips which have punched holes of the same shape as the blanks. These strips are made from thinner stock than the steel punchings and the same blanking die is used. Afterward the openings are relieved by filing and allowing the blanks to fit in loosely. This is a very effective way of holding these parts, and has the advantage of being quickly provided.

Fig. 10 shows a grinding operation on the ends of the same pieces. These are beveled on each end at an angle of thirty degrees and the grinding is done after the pieces are clamped onto the inclined blocks shown on the chuck in the illustration. The pieces are located on pins and each is clamped in place by a single screw. Two finished parts may be seen lying in front of the blocks on the chuck.

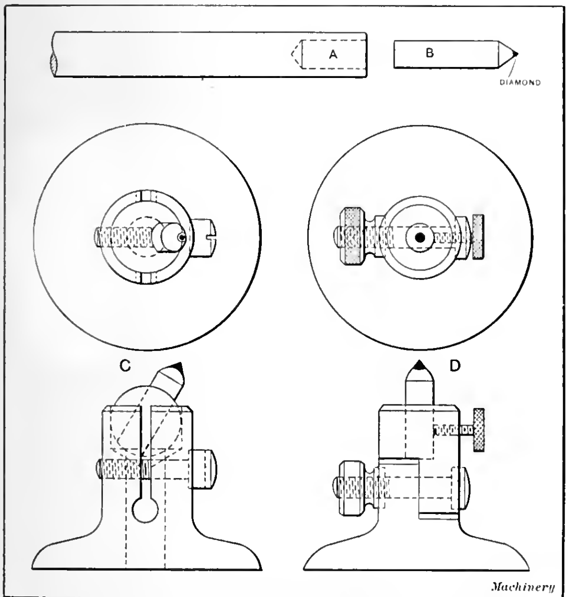
* * *

MOUNTING AND SETTING DIAMONDS

BY W. C. BETZ*

I have worked in a number of shops where a great deal of fine grinding was done, necessitating the use of diamonds for truing the wheels. C. L. L.'s article on the subject in the July issue of MACHINERY gave one good method of setting diamonds, but the writer would like to add the result of his experience in this work for the benefit of MACHINERY'S readers.

To reset a dull stone, the first step is to remove it from the holder which is drilled and reamed (as shown at *A* in the



Method of setting Diamond and Two Methods of mounting

accompanying illustration) to the proper size to receive a piece of copper rod *B* in which the diamond is set. The diamond is then gaged through an ordinary twist drill gage, the stone being passed through a hole in which it just clears at the point where it is mounted in the holder. If a new diamond is used the holder is drilled as previously described; the copper rod in which the diamond is mounted is then chucked in a lathe and drilled to receive the diamond, the drill being of the size determined by gaging the diamond in a drill gage. The hole is drilled to a depth of 1 1/4 times the length of the stone, after which the copper rod is thoroughly annealed.

A small asbestos pad is next prepared from fiber secured from a piece of sheet asbestos, this fiber being moistened with saliva to enable it to be worked up into a small ball. This ball is made of such size that it half fills the hole in the copper rod when pushed down into place. The diamond is now put in position in the copper rod, after which the metal is upset around the edge with a light hammer in order to prevent the stone from coming out while the next operation is being performed. While this work is being done the copper rod is held in a three-jaw lathe or miller chuck held in a bench vise. After the metal has been upset around the diamond, the copper rod is removed from the chuck and the metal worked in close against the diamond with a light hammer. Some of the asbestos will be forced out of the end of the hole as the hammering progresses and care must be exercised not to strike heavy enough blows to risk crushing the diamond. The copper rod is then replaced in the chuck to enable the metal to be worked down close around the diamond with a hammer and a carpenter's nail-set ground off square at the end.

Now for a brief discussion of methods of mounting. An improved mounting for truing the wheel of a surface grinder while in the regular position is shown at *C*. This mounting consists of an ordinary commercial steel ball 3/4 inch in diameter which is annealed to enable a 5/16-inch hole to be drilled and reamed through it. The stone is set in a copper rod 5/16 inch in diameter by 1 inch in length, the rod being a light driving fit in the hole in the ball. The base of the fixture is made either of cast iron or machine steel and it will be evident that the diamond can be brought into practically any position that is required by rotating the ball and then clamping it in place by means of the binding screw in the base. In this way the stone can be rotated from one position to another so that it is possible to bring a fresh edge into contact with the wheel as the diamond becomes dull. The form of holder shown at *D* possesses the same features which have been described for the preceding type of holder. In this case, the position of the diamond is changed by swinging the upper half of the holder about the pivot which secures it to the base. The diamond can also be rotated by loosening the small binding screw and then turning the copper rod in which the stone is mounted.

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STROBOSCOPIC ACTION OF MOVING PICTURE MACHINES

A curious action of the wheels of rapidly moving vehicles is often noticed in moving pictures of street scenes. The wheels are apparently standing still or moving slowly forward or backward. The reason for this strange appearance of wheels that are actually revolving rapidly forward is coincidence or near coincidence of spoke position and shutter action. Suppose that a carriage wheel has sixteen spokes and that it is revolving at the rate of sixty turns a minute or once every second. The average speed of moving picture film exposure is sixteen pictures a second. Under such conditions the spokes apparently will be photographed in exactly the same position at every opening of the shutter, and when projected on the screen the wheel will appear to be standing still although moving ahead with the carriage. If the rate of rotation is slightly out of step with the shutter action the spokes will then be photographed in slightly different positions, and the wheel will appear to rotate slowly ahead or backward, depending on whether the shutter action is slower or faster than the change of spoke position. The action is essentially the same as that of the stroboscope, a well-known scientific apparatus used to study the action of rapidly moving mechanism, engine governors, etc.

* * *

YEARLY INDEX OF MACHINERY

The yearly index of MACHINERY is ready for distribution, and copies will be sent to any address on request. Subscribers saving their copies are urged to bind them with the yearly index and thus preserve the volume so that its contents can be readily referred to.

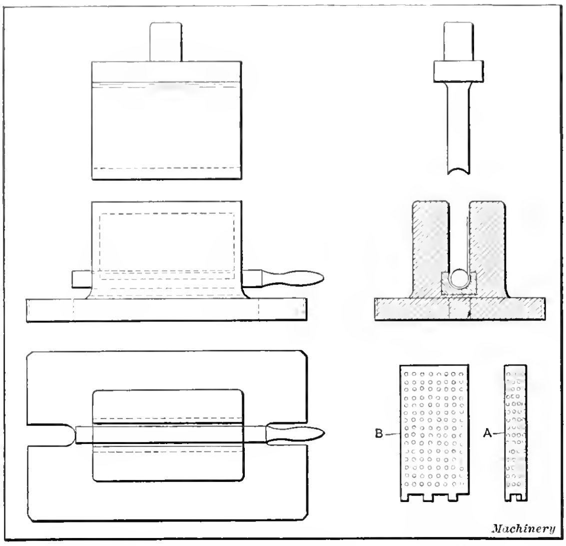
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

ROLLING TUBING FROM SHEET METAL

The accompanying illustration shows the tools used for rolling the perforated tubing *A*, the blank from which the tubing is rolled being illustrated at *B*. The design and method of using these tools will need little description to make the operation clear to the reader. The die was made with a tool-steel bottom inserted in a cast-iron frame to reduce its cost. The punch and die were finished to approximately the desired form, after which they were fitted together and the hole reamed to the required size of the tubing.

In operating the tool, the mandrel is placed in the die and a blank put in the position shown in the cross-sectional view. When the press is tripped, the punch descends and forces the blank down in such a way that it is rolled around the mandrel. When the ram has reached the bottom of its stroke, the pressure applied sets the joint so that the tube retains the desired form.



Tools used for making Tubing out of Sheet Metal—Blank and Finished Tube

Meriden, Conn. JAMES GALLIMORE

WHY UPPER FORGING DIES FILL BETTER THAN LOWER ONES

The question was asked in the April number of MACHINERY "Why are the impressions for bosses on drop-forgings preferably put in the upper die?" The reason suggested in the answer that inertia of the metal is more active in filling the upper die than in filling the lower die is not, in my opinion, correct. The reason the upper die fills with metal more easily and quickly than the lower die is that when the forging blank or bar is laid on or placed in the lower impression the lower die immediately begins to withdraw the heat from the piece to be forged. Consequently, the metal on the lower side of the forging is several degrees cooler than that on the upper part and at every stroke of the hammer the forging fits closer to the shape of the die, cooling with every stroke, thus retarding the downward flow of the metal. On the other hand, the metal on top is always hottest as the die, coming down and instantly rising again, leaves the metal about as hot as before it was struck. Thus the metal obeys one of the great laws of nature—it "follows the line of least resistance" and shoots up and fills the upper impressions easily. This has been our experience in the Union Forging Co.

C. F. BRAINERD,
Union, N. Y. Supt. Union Forging Co.

[The cooling effect of the lower die undoubtedly retards the filling of deep impressions. This is proved by the fact that if the piece being forged is lifted from the lower die after each stroke, the lower die will fill more rapidly and effectively than if it is allowed to remain closely in contact with the die. This is well understood by drop-forgers generally. Another very practical reason for placing deep impressions in the upper dies when possible is that it eliminates trouble from scale. Deep impressions in lower dies are very troublesome because of the scale collecting in them. If the scale is not swept out it quickly ruins the dies, causing them to crack, and produces a rough finish on the forging.—EDITOR.]

ETCHING RESIST AND SOLUTION

The following gives a formula which has been successfully used by the writer for etching operations:

The ground or "resist" is compounded as follows: Melt 2 ounces of white wax and add to it 1 ounce of gum mastic in powder, the gum mastic being added a little at a time and stirred thoroughly so that a uniform mixture is obtained. Then add 1 ounce of bitumen powder in the same way. This mixture is dissolved in chloroform or oil of lavender, when it is ready for use.

The formula for the biting solution is as follows:

Hydrochloric acid	100 grams
Chlorate of Potash	20 grams
Water	880 grams

In compounding the biting solution the water is heated, after which the chlorate of potash is added. After the chlorate of potash is entirely dissolved the hydrochloric acid is added to the solution. H. N. HAMMOND

Erie, Pa.

METHOD OF ETCHING BRASS

In the "How and Why" department of the August number of MACHINERY, I note that M. R. states that he has experienced trouble in etching brass and asks for information regarding a satisfactory method. If M. R. will follow the instructions given below, I think he will find the result entirely satisfactory.

The first step in etching is to see that the parts that are to be etched are carefully ground and polished. The only cleaning which will be found necessary can be satisfactorily done by wiping the work with a dry rag. The next step is to heat the work and then dip it into molten paraffine, after which it is removed and allowed to stand until cool. The pattern which is to be etched is marked in the paraffine in order to expose the metal.

The etching is done with undiluted nitric acid. If the etched lines are to be very deep, the work should be immersed in lukewarm water occasionally to remove the copper nitrate which forms in the etched lines. This will prevent the lines from spreading. It is only necessary to leave the work under water for a few seconds in order to remove the copper nitrate.

The preceding instructions also apply to etching steel with the important exception that the etching solution is composed of one part of nitric acid and one part of hydrochloric acid. The paraffine may be removed from the work by first dipping it in boiling water and then in cold water; this treatment causes the paraffine to contract and peel off.

East Orange, N. J. GEORGE GARRISON

ETCHING STEEL AND BRASS

In response to the request in the August number of MACHINERY for reliable methods of etching brass, I will describe my method of etching which has been successfully employed on all kinds of machinist's tools, also on brass and watch cases. First I heat the article slightly, making it just

warm enough to melt the beeswax with which the article is coated, care being taken to make the coating very thin and to apply it evenly. After the wax has cooled, I mark the design or name in it with a hard pencil having a very thin, sharp point. The design or letters are cut through the wax down to the surface of the metal and care should be taken to have the marking cleanly done so that no wax is left where the design is to be etched. The etching is done with a solution consisting of six parts of nitric acid and one part of muriatic acid. I use a glass medicine dropper to apply the solution, covering the design to be etched with the acid. After allowing the acid to etch about five minutes, it is removed with a piece of cotton waste, care being taken to soak up all the acid that can be removed. Then the wax is scraped off and the surface is cleaned with a piece of waste soaked in lard oil. The result will be a nice clean etching.

Of course, like everything else, etching requires some practice in order to insure a good job. I generally brush the surface of the article with lard oil where there is no beeswax. The oil prevents the fumes of the acid from penetrating the surface and the acid from adhering to the parts if it is inadvertently dropped on them. To etch brass requires from ten to fifteen minutes for the solution to bite.

I have etched levels, scissors, indicators, surface gages, scales, etc., for the company I work for with good results, using the method described in the foregoing. Etching tools is far better than stamping them with a steel stamp. A steel stamp will almost invariably damage the tool, whereas etching will not. In this connection I might say that I have known men to pay from 50 cents to $1 for an etching kit which was of little use for the purpose intended. Ten cents worth of the solution given above and five cents worth of beeswax is sufficient to etch one hundred or more names on tools and other articles.

Pearl River, N. Y. WALTER BUTZ

MAKING ECCENTRIC SCREWS ON AN AUTOMATIC SCREW MACHINE

In the following article, the writer wishes to describe a simple fixture used with great success on the Cleveland auto

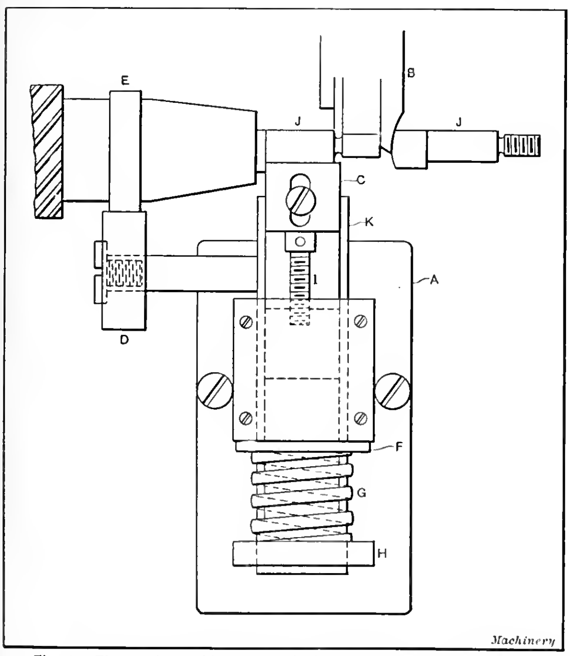


Fig. 1. Fixture for making Eccentric Screws on the Cleveland Automatic Screw Machine

matic screw machine in the manufacture of eccentric screws. Referring to Fig. 1, A is the fixture used to form the eccentric shoulder J, while at B a combination cut-off and form tool is shown which is used to sever the finished screw from the bar stock, and to form the small shoulder to be threaded on the next screw.

Before proceeding further, it should be mentioned that the chuck used on this job is central; thus it is understood that the threaded shoulder and the head of this screw are central, but the formed shoulder J is eccentric. The forming of the eccentric is accomplished by the form cutter C held in the fixture A, and adjustable by means of the screw I. An eccentric ring E is pressed over the spindle nose, as shown, and as the roller D is brought to bear against E by advancing the fixture to the work, the rotation of E causes the cutter C to form the eccentric portion of the screw as desired.

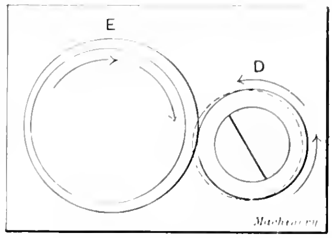


Fig. 2. Diagram showing Relation of Cam E and Roller D

A pin is shown at F fastened in the tool-slide K, which causes a compression of the spring G against the block H, serving to return the cutter C to the work when the small diameter of E is in contact with D. Thus it is understood

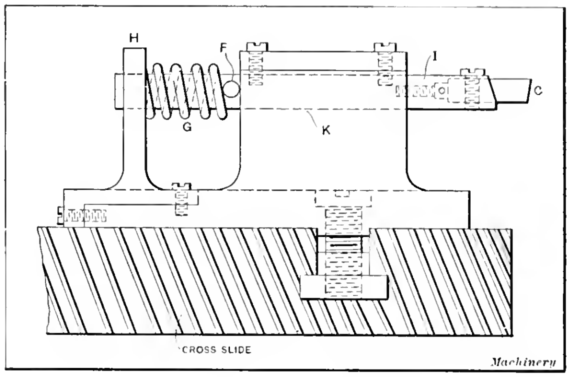


Fig. 3. Side View of the Eccentric Screw-making Fixture

that the forming of the work by the cutter is controlled by the relation of D and E, until the set-screw on the cross-slide stops further cutting and the fixture is tripped away to allow threading the small shoulder. Fig. 3 shows a side view of the fixture and Fig. 2 illustrates the relation of D and E to each other.

O. GORDON

CLUTCH DESIGN

The writer read Mr. J. W. Brassington's article on clutches in the August issue of MACHINERY and desires to comment on this interesting subject, not from the standpoint of an authority on clutch design but rather as an interested observer. In deriving formulas for the proper relative capacities of clutches, it appears that J. W. B. has failed in an important but seriously neglected point regarding the work done by a clutch, *i. e.*, the proper analysis of what constitutes the load. Taking the example cited by J. W. B. of a load of 10,000 pounds started from rest and accelerated to a velocity of one foot per second in one case, and to a velocity of three feet per second in another case, he arrives at the conclusion that a clutch of nine times the capacity of the one required in the first case is necessary in the second case.

The statement is then made that most clutch manufacturers would recommend a clutch of one-third the size required in the first case for the second case, owing to the higher speed. Assuming that loaded to 10,000 pounds means the tangential load or resistance at the periphery of the clutch—which it may be remarked is very much higher than the tangential load of any clutch that has come to the writer's notice—acceleration to a velocity of one foot per second makes the load $10{,}000 \times 60 = 600{,}000$ foot-pounds per minute.

$\frac{600{,}000}{33{,}000}$ = 18 horsepower (approximately). In the second case the speed is accelerated to 3 feet per second and it is thus obvious that the clutch is doing three times the number of foot-pounds of work in the same period of time, *i. e.*, 1,800,000 foot-pounds per minute or 54 horsepower. Now does it not seem rather unlikely that a lighter clutch would be recommended by a manufacturer for use in the latter case? Had the horsepower remained 18 and the speed been increased three times, then the torque would have fallen to 1/3 of 10,000 pounds and a much lighter clutch could have been used. Here is where the writer believes that many "get lost" on the speed proposition, but it is clearly explained by the somewhat antiquated theroem of the three constituents of work, *i. e.*, time, space and weight or resistance in pounds.

Regarding the question of the pick-up capacity of a clutch, it has always appeared to the writer that the starting resistance was not particularly destructive to the mechanism unless the leverages of the clutch were such that it "seized" suddenly. Automobile designers have decided that such a seizing action is only likely to occur when the angle of a cone clutch is less than 12 degrees or its equivalent on a clutch of the toggle type. In an improperly designed clutch where such an action can occur, the mechanism is not only subjected to a violent shock but the torque is also increased due to inertia. Aside from this consideration, the only difference which the writer has observed in the behavior of a clutch while starting or when under way is that the coefficient of friction of rest is somewhat higher than the coefficient of friction of motion, the stresses being somewhat greater in the former case.

In conclusion, it may be stated that the writer has obtained satisfactory results with friction clutches designed according to these principles, and that he has designed at least one clutch which all of the shop men were prepared to wager was too small for the load it had to carry. After this clutch had been placed in service, it was found to be quite satisfactory and afforded a surprise to the men in the shop who did not have a "speaking acquaintance" with our friends "time," "space" and "weight."

Cleveland, Ohio. J. E. McMahon

MACHINE TOOL COUNTERSHAFT

On large hand screw machines much time is lost because the belt from the countershaft to the cone pulley of the spindle cannot be shifted from one step to another. If it could be shifted quickly, the production of machines engaged on many classes of work might be considerably increased

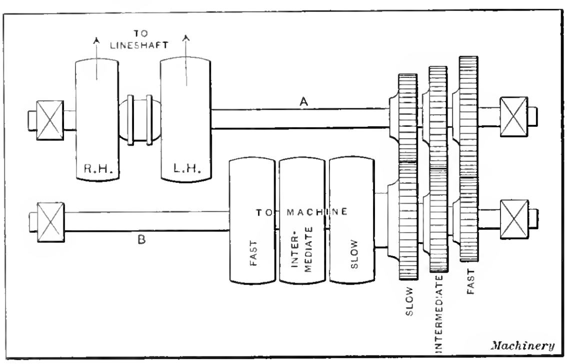


Fig. 1. Plan View of Machine Tool Countershaft

since some tools in the turret can be operated at a much higher surface speed than others. It is obvious that the speed of the spindle is limited by the speed that is suitable for the slowest tool in the turret.

The illustrations presented herewith show a countershaft which might be used to advantage in overcoming the difficulty referred to. It consists of two shafts *A* and *B* supported by double shaft hangers. The shaft *A* carries the regulation right- and left-hand pulleys with belts running to the lineshaft. This shaft also carries three gears (or chain drives as a substitute) which mesh with corresponding gears on the shaft *B*. Two of the gears on the shaft *B* are mounted on sleeves which run on rollers and have pulleys mounted on their opposite ends. The third gear is keyed direct to the shaft *B* and drives a pulley keyed to this shaft. A drum is mounted on the spindle of the machine in place of a cone pulley and the belt which drives the spindle runs from one of the pulleys on shaft *B* to this drum. As the belt can readily be shifted onto either of the pulleys on the counter-

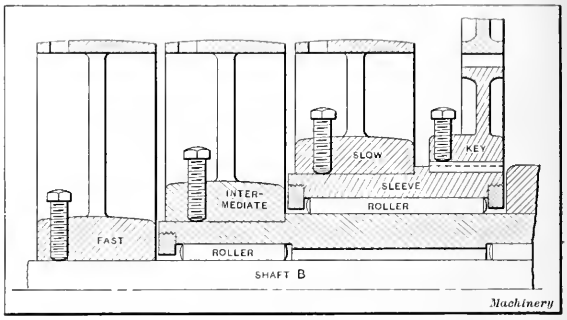


Fig. 2. Sectional View of Machine Tool Countershaft

shaft three speeds are provided for the spindle, which are in proportion to the ratios of the gears through which the pulleys are driven. The relative difference between the speed of adjacent pulleys is not great, so that the wear on the rollers and sleeves is reduced to a minimum.

The pulleys are crowned in the usual way and made about fifty per cent wider than standard pulleys for the width of belt which is used. The belt is moved by the usual form of shifter and the additional width of the pulleys enables it to get off the crown of one pulley before it goes onto the crown of the adjacent pulley. When the belt is shifted, the speed is gradually slowed down, or increased as the case may be, and as the belt is not on the crown of two pulleys at the same time it follows that the slippage and wear is reduced to a minimum.

Chicago, Ill. R. W. Ullmann

SIMPLE RULES FOR OBTAINING GEAR DIAMETERS

The rule of adding 2 to the number of teeth required on a gear, and dividing by the diametral pitch to obtain the outside diameter of a spur gear blank, is probably known to all mechanical draftsmen. There are two equally simple rules for obtaining the diameters of the circles representing the working depth of the teeth and their root diameters.

For the diameter of the circle representing the working depth of the teeth, subtract 2 from the number of teeth in the gear and divide by the diametral pitch; the result is the required diameter.

For the diameter of the root circle, subtract 2.314 from the number of teeth and divide by the diametral pitch; the result is the required diameter.

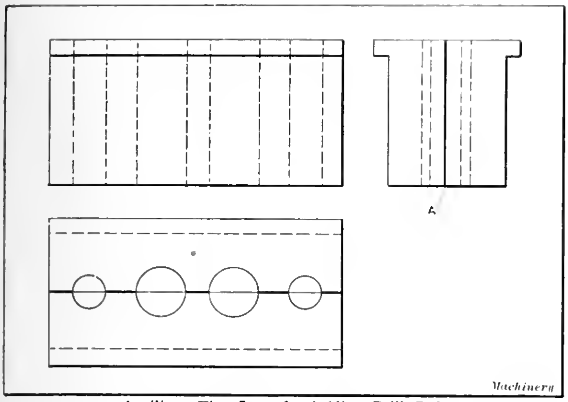
As an example, suppose a gear has 48 teeth and is of 4 diametral pitch; then $\frac{48+2}{4} = \frac{50}{4} = 12\frac{1}{2}$ inches outside diameter of the gear blank. And $\frac{48-2}{4} = \frac{46}{4} = 11\frac{1}{2}$ inches, diameter of circle representing the working depth of the teeth. $\frac{48-2.314}{4} = \frac{45.686}{4} = 11.4215$ inches, diameter of circle representing the bottoms of the tooth spaces.

Having never seen these rules in print, it occurred to the writer that they might be good enough to pass along to other draftsmen.

Los Angeles, Cal. John A. Wood

VISE ATTACHMENT FOR HOLDING DRILL ROD

A practical and very effective vise attachment for holding drill rod for cutting or finishing the ends is shown in the accompanying illustration. In order to make a vise of this kind, two pieces of machine or cold-rolled steel are planed to produce a shoulder 1/8 inch wide and 1/8 inch deep. The two parts of the vise are then placed together with a shim *A* about 0.010 inch in thickness between them as shown in the end view. They are then clamped in this position and the required number of holes to receive the standard sizes of drill rod for which the vise is to be used are drilled and



Auxiliary Vise Jaws for holding Drill Rod

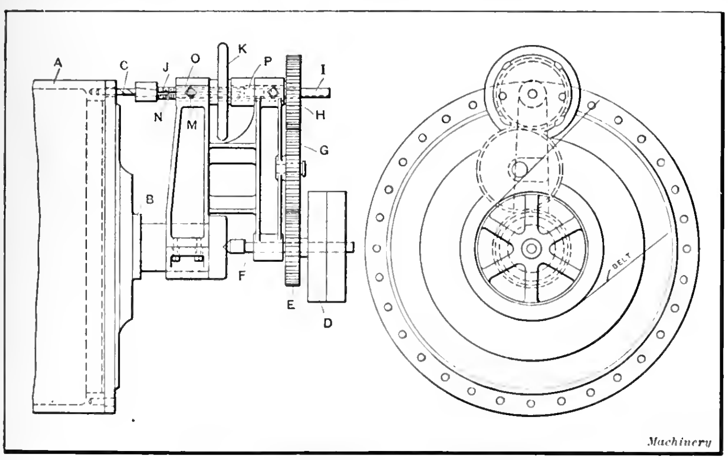
reamed. An allowance of 1/4 inch is made at either end and from 1/8 to 3/16 inch between the holes for adjacent pieces of drill rod to provide the necessary wall strength.

The vise jaws are now ready to use. They are placed in an ordinary bench vise or the vise of a milling machine and the shoulders hold them in place. The removal of the shim *A* allows the jaws to come closer together than the position in which they were machined, and consequently a very firm grip is secured on any size of drill rod for which the jaws are intended. When a large number of pieces of round stock are to be slotted in a miller, this is a very cheap and practical device and its use enables drill rod to be securely held without marring its surface in any way.

Union Hill, N. J. G. J. Johnson

FIXTURE FOR DRILLING LARGE CYLINDERS

Some time ago we had quite a large number of cast-iron cylinders to machine, the heads of which were fastened in place by thirty-two 3/4-inch cap-screws. The heads were easily drilled on a drill press, but we were "up against it" when it came to the cylinders. As this work was somewhat out of our regular line, we did not feel inclined to buy any new and expensive machinery for the purpose, and so it became necessary to do the work as best we could. The accompanying illustration shows a simple fixture that we made for handling this work, in which *A* is the cylinder to be drilled and *B* the cylinder head. After the head had been drilled, and two holes had been drilled and tapped in the cylinder with a ratchet drill, the cylinder head served as a jig for locating the remaining holes. The fixture was fastened to the journal of the cylinder head and could be swung about this center to bring the drill *C* into any position on the periphery of the cylinder. The drill was secured in a socket at the end of the shaft *I* which was driven by the tight pulley *D* through gears *E*, *G* and *H*. The tight and loose pulleys and gear *E* are mounted on the shaft *F*. It will be seen that the spindle *I* is partly enclosed by a bushing *J* which can be moved longitudinally along the spindle by means of the handwheel *K*, but is prevented from rotating by the set-screw *M* which fits in the slot *N*. The parts *O* and *P* form two oil chambers which were kept full of oil at all times. This fixture was quite inexpensive to make, and as we used gears from a lathe and took the pulleys from a pump that we had on hand, it will be evident that it was unnecessary to machine any expensive parts. The use of this fixture enabled two unskilled men to drill one end of a cylinder in one hour and fifteen minutes, and the design insured having the holes drilled perfectly straight.

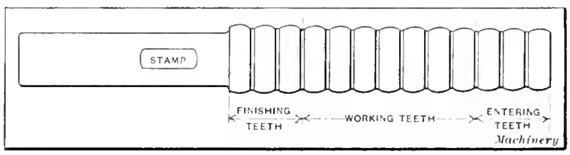


Fixture used for drilling Large Cylinders

Sherbrooke, Quebec, Canada. Olaf Melby

SMOOTH TOOTH BROACH

The illustration shows a broach of novel design which has the teeth rounded at the top instead of being finished to a cutting edge as in the ordinary type of broach. These teeth are highly polished, and experience has shown that the higher the degree to which this polish is brought, the better will



Smooth Toothed Broach used for machining Bearings

be the results obtained with the tool. It will be seen that the first few teeth are small enough to enter the hole which is to be broached, the intermediate teeth are of slightly larger diameter, and the last three teeth are of the size to which it is desired to finish the work.

This tool is used for broaching bearings and for operations on other classes of work where the metal is relatively soft, the tool compressing the metal, and thus giving it a surface hardness. This is of particular value in the case of bearings, on which class of work this broach has found wide application. The amount of metal displaced by the broaching operation is about the same as that removed by reaming, depending largely on the class of metal, lubrication and the construction of the broach. Although the tool is primarily intended for operations on babbitt and white bearing metal, it has been used satisfactorily for producing glazed surface on cast-iron bearings.

The distance from center to center of the teeth depends somewhat on the length of the work which is to be broached. It is desirable to have at least six or eight teeth working at all times. This broach is usually made according to the design shown in the accompanying illustration and is pushed through the work instead of being pulled in the ordinary way. An arbor or screw press may be used for this purpose and it is generally advisable to apply lubricant to the broach while in operation.

Hartford, Conn. S. Victor Brook

[The noteworthy feature of the operation of a broach of the type described in the preceding, as compared with an ordinary plug, lies in the reduction of friction. It will be evident that the teeth of this broach are fully as efficient as a plug for handling the class of work for which the tool is intended. At the same time, the area of the tool in contact with the work is greatly reduced, with a corresponding reduction of friction and the amount of power required to drive the tool. The provision of teeth also makes it possible to apply lubricant to the work, which could not be done if an ordinary plug were used.—EDITOR.]

REDUCING FLATS ON HOBBED WORM-WHEEL TEETH

The larger the diameter of a hobbed gear—the pitch remaining the same—the more closely the tooth outline approaches the shape of a rack tooth. The flats left on the teeth by the hobbing operation also become perceptibly less as the size of

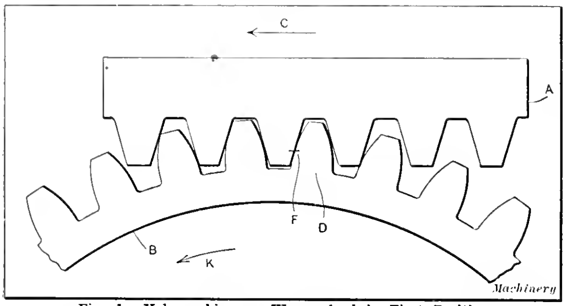


Fig. 1. Hob working on Worm-wheel in First Position

the wheel increases. The flats on the teeth of hobbed worm-wheels with a small number of teeth can be reduced by the use of a hob having a large number of flutes. Where a fly cutter hob is used, the flats can be further reduced by moving the hob along its axis after the first cut has been taken and moving the worm-wheel on its arbor a corresponding amount. By making five or six such shifts of the hob, a very smooth worm-wheel is produced. The fly cutter hob and gear blank must be geared together and the blank cut to depth before shifting the hob on its axis as previously described.

In Fig. 1, the tooth D of gear B is in contact with the hob A at the point F. In this position, a series of flats are produced on the gear as it revolves in the direction indicated by arrow K. By moving the hob along its axis a distance equal to a small fraction of the circular pitch in the direction

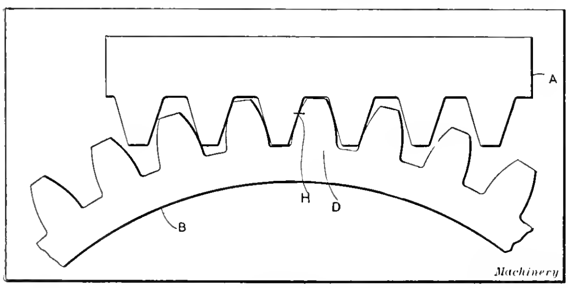


Fig. 2. Conditions after Hob has been shifted, showing Change in Relative Position of Hob and Work

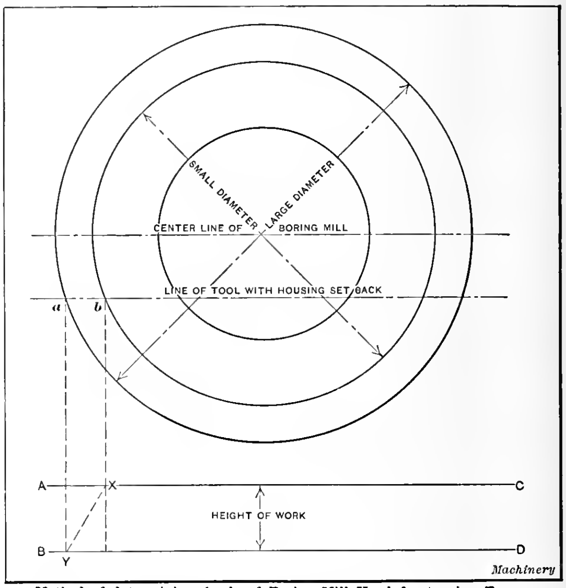
shown by the arrow C, the hob A is brought into contact with the tooth D at the point H as indicated in Fig. 2. A new series of flats is produced in this way causing the corners to be sheared off the flats which were produced when the hob was in the position illustrated in Fig. 1. By repeating this process, moving the hob along its axis a number of times, the flats produced in hobbing a worm-wheel in this way can be practically eliminated. The total distance through which the hob is moved is from one to two times the circular pitch. The movement of the hob along its axis can be accomplished automatically by suitable apparatus properly timed and operating in connection with the driving mechanism of the gear and hob. Although it takes slightly longer to hob wheels by this method, the increased accuracy of the work more than pays for the additional time which is necessary for the operation. This method of gear hobbing is used by the Boston Gear Works where a smooth worm-wheel is required.

Wollaston, Mass. GEORGE L. COLBURN

TURNING TAPERS ON A BORING MILL

In turning tapers on a boring mill with the housings set back, the determination of the proper angle at which the head should be set depends largely upon the judgment of the operator. It is a well-known fact that in operating a machine of this type with the cutting tool behind the center, the elements of the tapered surface are slightly curved instead of being straight lines, as they would be if a true conical surface were produced. This curvature is very slight, however, and does not cause trouble in turning such work as bells, bellhoppers, etc.

The accompanying illustration shows a method of determining the exact angle at which the head should be set for turning tapered work. First, draw a circle of any size to represent the table of the boring mill. Second, draw a line through the center of this circle to represent the center line of the machine. Third, draw a straight line parallel with the center line and at a distance from it which represents the distance that the housings have been set back, to some convenient scale. This line is called "the line of the tool" with the housings set back to the position indicated. Fourth, with the center of the table as a center, draw a circle which represents the



Method of determining Angle of Boring Mill Head for turning Tapers

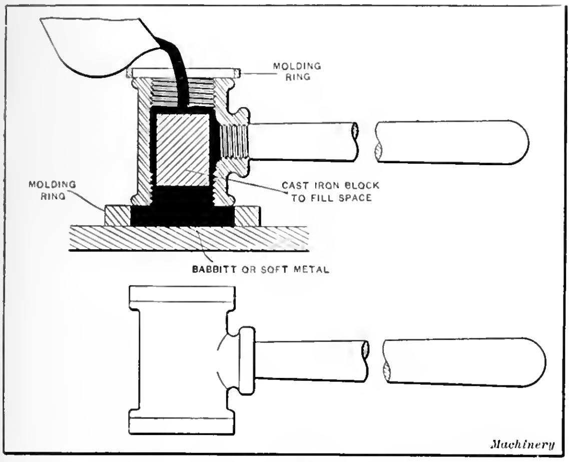
large end of the finished tapered work to scale. Fifth, with the center of the table as a center, draw a circle which represents the small end of the finished tapered work to scale. Sixth, draw the line AC parallel to the center line of the boring mill. This line is called "the line of the large diameter." Seventh, draw the line BD parallel with AC and at a distance from it which represents the height of the finished tapered work to scale. This line is called "the line of small diameter." Eighth, drop two perpendiculars from the line of the tool at the points where this line intersects the two circles which represent the large and small diameters of the work. It will be evident that the space enclosed between these two lines and the lines AC and BD forms a parallelogram. Ninth, lay a protractor on the diagonal XY and measure the angle which this line makes with the line BD; this is the angle at which the head must be set to produce the required angle on the tapered work with the housings set back the distance shown in the illustration.

Youngstown, Ohio. S. P. ROBINS

[In the October, 1911, issue of MACHINERY, the curve formed in turning tapers with the housings set back was discussed, and it was pointed out that this curve is a hyperbola. —EDITOR.]

SOFT-FACED MACHINE SHOP HAMMER

For fitting mandrels, and in any other work requiring heavy driving where work must not be marred or scratched, a simple and effective all-metal hammer may be inexpensively and quickly made of a standard T-pipe fitting as shown in the accompanying illustration. The dimensions, of course, will vary according to the work for which the hammer is intended. To make a hammer of this kind, turn a smooth handle of mild steel, thread one end with a pipe die, and assemble as shown in the illustration. Then, with a suitable mold to shape the faces, pour the tee full of lead or babbitt metal. To fill the inner space, any kind of scrap metal may be used inside of the pipe fitting. After the metal has cooled, and if the mold has left the faces rough, unscrew the handle, turn the soft faces smooth in a lathe, replace the handle, and you have a



All-metal Hammer, for use in the Machine Shop where Work must not be marred

hammer that is as serviceable as anything you could want.

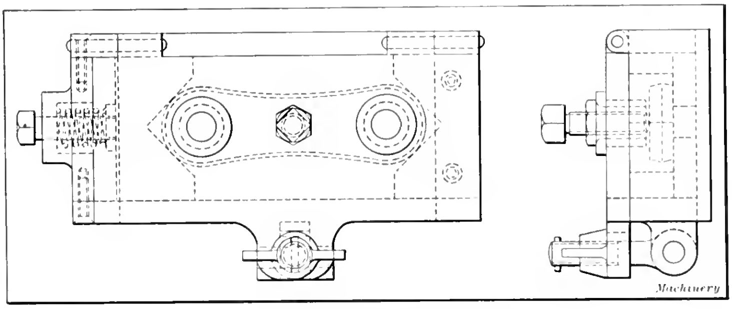
As soon as the faces are worn, it is a simple matter to repair them by throwing the whole hammer into the melting pot, melting out the soft metal, and remolding the hammer according to the preceding instructions.

Brooklyn, N. Y. W. F. SCHAPHORST

JIG FOR DRILLING AUTOMOBILE SPRING SHACKLE LINKS

Automobile spring shackle links are generally made from low carbon steel and are sometimes very hard, due to being improperly annealed after having been removed from the forging die. It will be obvious that such hard pieces of work would be very difficult to drill. The accompanying illustration shows a fixture which has been successfully used in drilling these automobile spring shackle links. It is of the box type and consists of a body, cover, end and two V-blocks. One of these V-blocks is fixed and the other adjustable for slight variations in the length of the work. The permanent V-block forms one end of the fixture while the adjustable V-block is held in position by a spring which brings it into contact with the end of the work. The cover of the fixture is hinged to the body and provided with a wing nut lock. A set-screw is carried in the center of the cover and tightened on the work to assist the V-blocks in holding it in position. The holes are drilled through the ordinary form of hardened bushings, and the same fixture can be used for reaming the holes by providing suitable bushings for this purpose. Where it is desired, however, the reaming operation may be done on the bench by hand.

St. Louis, Mo. C. T. SCHAEFER



Fixture for drilling Automobile Spring Shackle Links

WHERE IS THE FALLACY?

Replying to your question "Where is the Fallacy?" on page 50 of the September number of MACHINERY, I beg to submit the following explanation:

To repeat the last three lines of the "proof":

$$(a-c)^2 = (b-c)^2$$
$$a-c = b-c$$
$$a = b$$

The first equation is correct but the second one is not. After extracting a square root from the first equation the correct result should read:

$$\pm(a-c) = \pm(b-c)$$

thus giving us four possible combinations, namely:

$$a-c = b-c \quad (1)$$
$$a-c = c-b \quad (2)$$
$$c-a = b-c \quad (3)$$
$$c-a = c-b \quad (4)$$

Results (1) and (4) are absurd, but (2) and (3) are correct, each reducing to $a+b=2c$, or just what we started with.

The "proof," as stated in MACHINERY, will remain a proof as long as one forgets that extracting a square root always gives two answers, a positive and a negative.

Flint, Mich. M. TERRY

[Correct solutions of this problem were also obtained from G. Brunn, Wilkinsburg, Pa.; T. G. Carlbom, Meadville, Pa.; Asher Golden, New York City; Walter Gribben, Brooklyn, N. Y.; Miss Bernice Haynes, Oxford, Ohio; R. A. Jewett, Rochester, N. Y.; S. G. Koon, Boston, Mass.; Arthur C. Maxfield, Providence, R. I.; E. F. McCaleb, Erie, Pa.; Bernard W. Noel, St. Louis, Mo.; Elof Nordstrom, Hartford, Conn.; R. J. Quinlan, Peterboro, Ontario, Canada; Percival K. Reed, Philadelphia, Pa.; W. A. Rose, Bridgeport, Conn.; J. R. Sheldon, New Haven, Conn.—EDITOR.]

TWO SHOP FORMULAS

The writer was interested in several shop formulas which were presented by Mr. Jos. H. Cheetham in the June issue of MACHINERY. The following gives formulas for two solutions which have been found particularly useful for stripping brass or copper plate from iron or steel articles and for removing rust or scale from various classes of work. The stripping solution is compounded as follows: Dissolve ½ pound of cyanide of potassium and ¼ ounce of cream of tartar in 1 gallon of water. The pieces to be stripped are immersed in the solution and allowed to remain until the plating has been removed. The solution will not injure the work in any way and will leave it nearly as bright as it was before being plated.

The solution for removing rust or scale from iron or steel pieces consists of acetic acid. The work is immersed and allowed to remain until the necessary result has been obtained.

Winsted, Conn. CHARLES W. RICHARDS

* * *

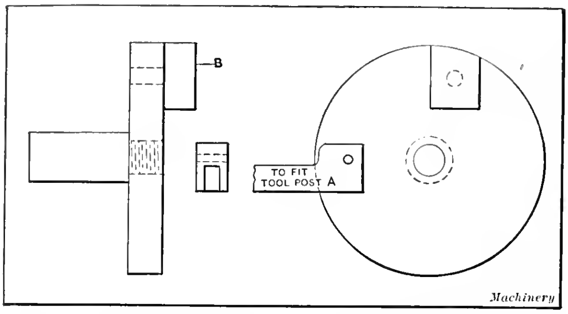
It is difficult to keep a machine from rusting and depreciating in value when it stands idle for a long time. The same is true of men.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

CUTTING OFF PINS ON A BENCH LATHE

A convenient bench lathe attachment for cutting off blanks for pins or rivets is shown in the accompanying illustration. The operation of this device will be readily understood by any mechanic after referring to the illustration. The block *A* is carried by the toolpost of the lathe and has a hole drilled in it of the same diameter as the wire from which the blanks are to be cut. The wire is carried on a reel mounted in some convenient position at the end of the lathe. The block *B* shears the wire off when it comes into contact with block *A*. Block *B* is made of the same width as the length of the blanks which are required. The operator keeps the wire pushed against the faceplate and a blank is sheared off for each revolution of the lathe. The writer operated a machine at 900 revolutions per minute and was able to cut off a blank at each revolution, which gave a productive capacity of 900 blanks per minute.



George R. Haub

Bridgeport, Conn.

ERASING INK FROM DRAWINGS

In the April issue of Machinery I noticed two methods described for erasing ink marks on tracings. E. C. McMeans tells of using a blotter to blot out the ink before it gets dry. This I have found by experience to work very well, but, supposing a man cannot find his blotter in time, what then? My experience has been that to wipe the ink off with your fingers before it gets dry is the best method in preserving the gloss on tracing cloth.

As to the method of using water before erasing, I would suggest the use of apple juice or vinegar; this will remove all ink without erasing and the effect on tracing cloth is about the same as that of water. If a number of changes have to be made it is time well spent to make an entirely new tracing, thus avoiding confusion and the consequent possibility of making errors.

P. P.

CURVE FOR DRAWING AUTOMOBILE SPRINGS

The writer recently had occasion to draw a number of automobile springs of the form shown in Fig. 1, and as an ordinary irregular curve was not suitable for this purpose, he designed the special curve shown in Fig. 2. This curve is made from a 12-inch hacksaw blade, the ends of which are connected by fine wires and a turnbuckle as shown in the illustration. The screw of this turnbuckle was made from the familiar form of screw used in dry batteries, and by regulating the turnbuckle, the curve could be adjusted to the shape of the various leaves of the springs. In this way it became a very easy matter to make the necessary drawings, as the lines could be swept out at one stroke of the ruling pen.

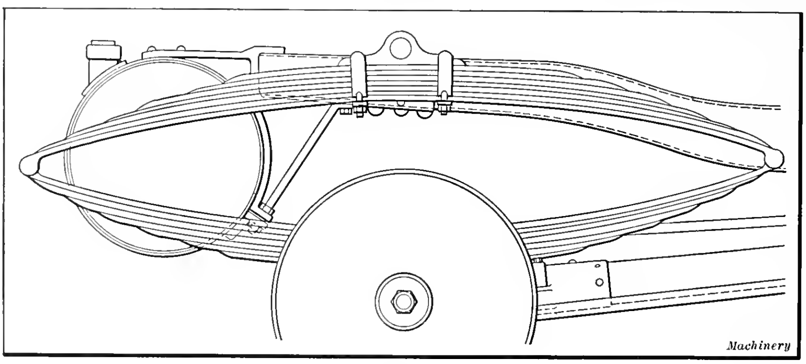


Fig. 1

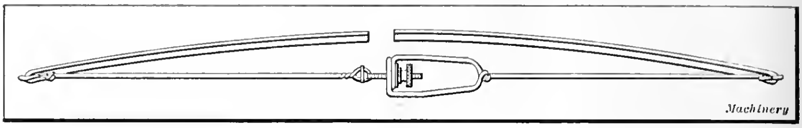
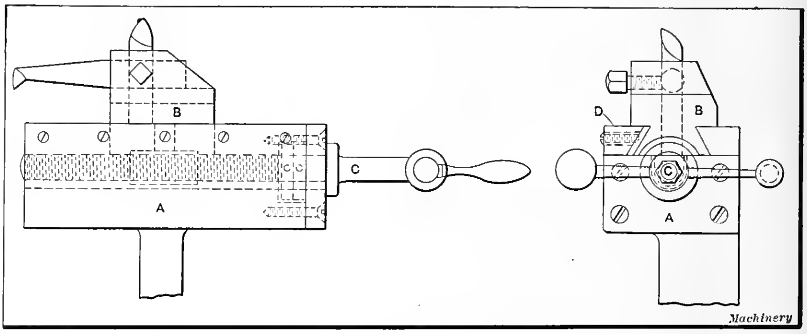


Fig. 2

Jackson, Mich. Alex. Moncrieff

AN AUXILIARY COMPOUND REST

On some of the old types of lathes, it is found very awkward when a job comes along that requires a short taper hole to be bored or an angle turned when the machine is not equipped with a compound rest. In order to overcome this difficulty, the rest was designed that is shown in the accompanying illustration. *A* is a forged block with a shank to fit the toolpost of the lathe. The block *B* slides in *A* and is operated by the screw *C*. There are two holes in *B*; the one parallel to the slide is for a boring tool and the one perpendicular to the slide is for the turning tool; one set-screw locks either tool. To set the rest at the required angle, it is necessary to have a bevel protractor of some sort, the setting being done from the faceplate of the machine, or from an arbor which is between centers and the face *D* of the block *A*. This auxiliary rest will be found handy where there is no lathe available with a compound rest.



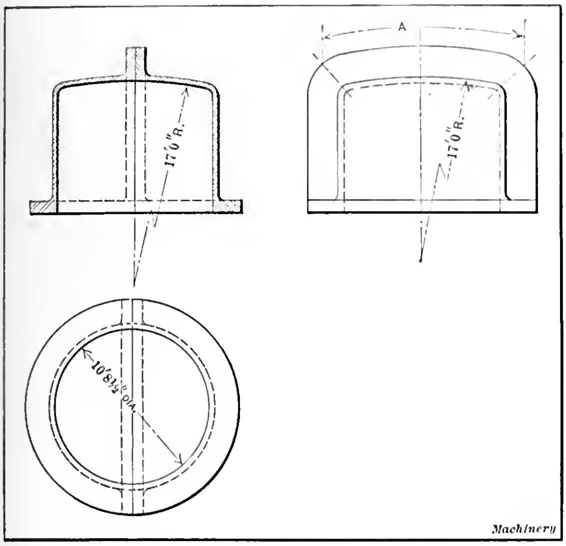
New Britain, Conn. W. C. Betz

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

BOLTS REQUIRED TO JOIN RECEIVER PARTS

W. N.—What is the proper way to figure the number and size of bolts required to unite the flanged halves of a receiver over the spherical part marked *A* in the accompanying illustration? The receiver is of cast steel and carries an internal



pressure of 125 pounds per square inch. In making calculations, allow 12,000 pounds per square inch fiber stress in the cast-steel bosses and 15,000 pounds per square inch fiber stress in the bolts. I would like to see a discussion of this problem by MACHINERY'S readers.

A PROBLEM IN "HEXING"

H. L. B.—We have received an order for 10,000 machine steel plugs like that shown in Fig. 2, which is shown in actual size. We wish to tool-up for this job as there is a likelihood

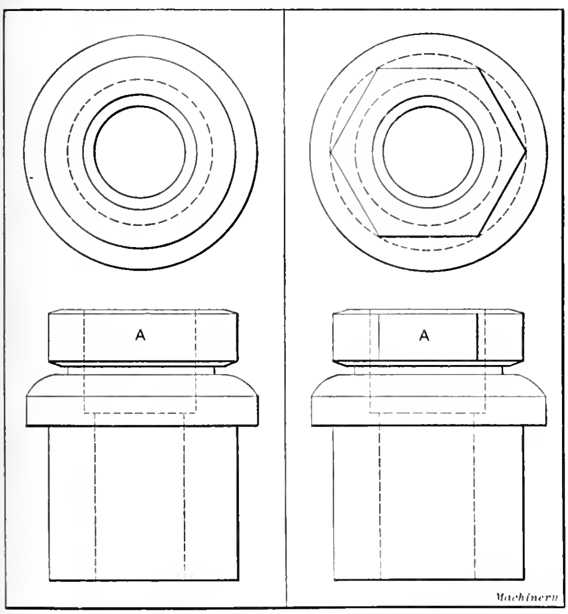


Fig. 1 Fig. 2

that we will receive similar orders of 10,000 lots from time to time. At the same time we cannot go to the expense of making a single-purpose machine unless very simple. We have already the average machine shop equipment, screw machines, power and hand millers, etc. Of course, we know that the job is a plain screw machine proposition as far as shown in Fig. 1, but the phase of the matter which is troubling us is milling the hexagon of the part *A*. We want to do this economically and accurately, although the presence of tool marks on the finished work will not be objectionable. The main thing is to get the pieces out quickly and without a great expense for special fixtures, as competition is very keen on this particular product.

DOUBLE-PLY BELT DRIVE

J. W. W.—I have the care of a belt drive 42 feet from center to center of shafts, the driver being an 18-inch diameter, 24-inch face paper pulley and the driven member a 48-inch cast-iron pulley. A double belt 24 inches wide and ½ inch thick connects the pulleys, and runs at a speed of 3390 feet per minute, the smaller pulley running at 720 R.P.M. I have been unable to keep the belt glued together in the center and will appreciate an expression regarding the cause of the difficulty.

A.—The quality of belt glue and workmanship is of first importance in joining heavy double-ply belts. These must be of the best, but even if they are, the opinion of power transmission experts is that a 24-inch pulley is too small for a half-inch, double-ply belt to run successfully without riveting in the center.

* * *

BROACHING AT THE BOSTON AUTO SHOW

The commercial development of the broaching machine has been coincident with the development of the automobile. The broaching machine is applied to the cutting of square holes in

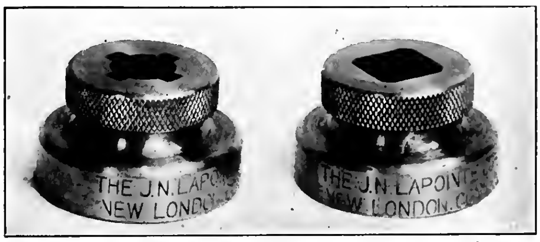


Fig. 1. Paper Weights broached at the Boston Auto Show in Thirty-five Seconds each

gears and multiple keyways for splined shafts characteristic of the design of gear boxes, etc. The J. N. Lapointe Co., New London, Conn., exhibited one of its broaching machines at the Boston Auto Show, in operation, broaching samples similar to those shown in Fig. 1, which were given away to

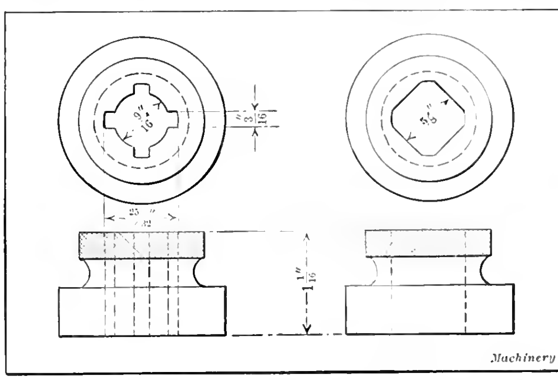


Fig. 2. Showing Dimensions of the Broached Holes and Spline Ways

be used as desk weights. Fig. 2 gives the dimensions of the broached holes and spline ways. The samples shown in Fig. 1 were broached in the remarkable time of thirty-five seconds each, including putting on the broach and removing from the machine.

* * *

Some great and revolutionary improvements in machinery or methods are so simple that when demonstrated we wonder why they were not thought of before. The greatest improvements are often of the simplest character.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

PRATT & WHITNEY HORIZONTAL SURFACE GRINDER

For a number of years the Pratt & Whitney Co., Hartford, Conn., has been manufacturing surface grinders equipped with cup wheels which are well adapted for work on simple, plane surfaces. This machine was not, however, adapted for grinding work having surfaces lying at different heights or angles, and work of this character was slow and expensive

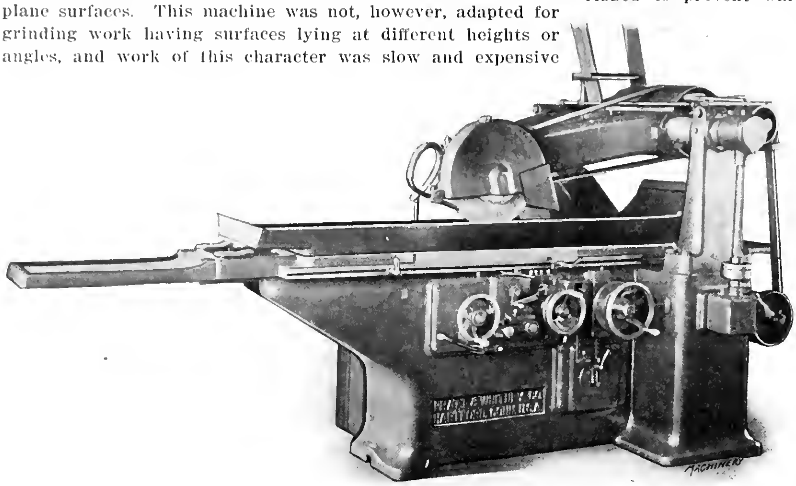


Fig. 1. Front View of Pratt & Whitney Horizontal Surface Grinder

to handle. Either the planer type or tool-room type of surface grinder has been used for such work. The wheels of both types of machine are mounted on slides which provide either vertical or horizontal adjustment, or both. The design is usually such that the wheel has an unsupported overhang, and in order to get accurate work, the adjustment of the slides must be maintained very closely. Trouble has also been experienced from wear in the slides resulting from emery dust or water getting into them.

With the view of eliminating these troubles the Pratt & Whitney Co. has developed the horizontal surface grinder shown in the accompanying illustrations. This machine is adapted for general classes of surface grinding, although it has been designed particularly for grinding work with surfaces lying at different heights or angles. This machine is equipped with large wheels which are powerfully driven and the design has been worked out to provide the maximum rigidity and also to enable a liberal supply of water to be utilized during the grinding operation. During recent tests to which machines of this type have been subjected in the factory of the Pratt & Whitney Co., it has been fully demonstrated that they are capable of handling grinding operations on surfaces lying in different planes, with great efficiency.

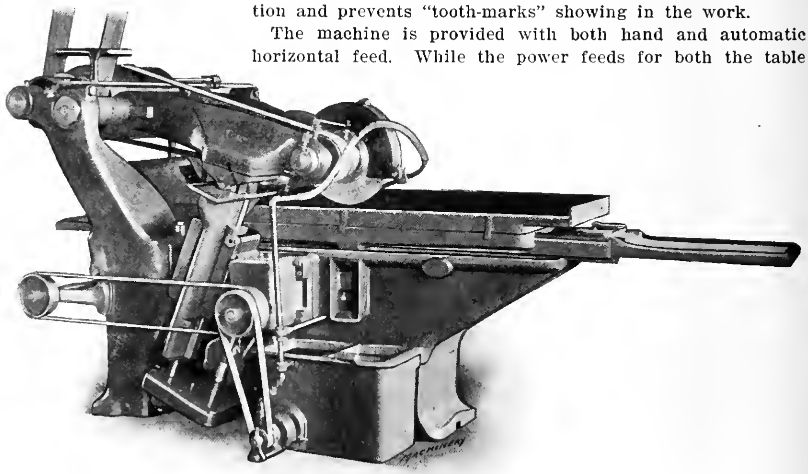


Fig. 2. Rear View of Horizontal Surface Grinder

The bed is very massively proportioned and internally braced in a manner that insures ample rigidity and permanent accuracy. It is very compact in design, the various units being located so as to be conveniently accessible. Wide bearing surfaces of the vee and flat types are provided. Oil reservoirs are located in the bed to provide for automatically oiling the ways by means of rolls. The pan which surrounds the rear of the bed for collecting the water and receiving the chips is of liberal proportions and is easily accessible for cleaning. The table is of heavy construction and powerfully ribbed to prevent warping and to resist torsional strains. Both the bed and the table are scraped perfectly true by means of masters, the table being slightly longer than the bed; and the traveling action tends to keep these members perfectly true. The table is provided with guards at each end, which, at all times, cover and protect the bearing surfaces from injury. A spacious water pan is cast integral with the table.

The table is provided with automatic reciprocating motion, any length of stroke up to four feet being readily obtainable by means of adjustable table dogs. The table feed mechanism is of a most efficient and substantial design. It is made in a simple, compact unit which is very easily accessible. Two table feeds are provided, both of which are instantly controlled by means of a lever conveniently located at the front of the machine. This lever when adjusted to the central station also serves as a means for stopping the table; when adjusted to the upper station the slow feed is engaged, and the lower station engages the fast feed in a similar manner. The table is driven through a rack and pinion vertically located, which eliminates vibration and prevents "tooth-marks" showing in the work.

The machine is provided with both hand and automatic horizontal feed. While the power feeds for both the table and horizontal wheel movement are engaged through the same trip, the feed units are entirely independent of each other. This is very important, as by having a separate mechanism for each feed there is no extra load thrown upon the table feed mechanism when the wheel feed is engaged, and it is a well-known fact that when intermittent loads are thrown upon the grinding table it will invariably show in the work.

The feed mechanism operates a screw mounted inside the hollow arbor upon which the arm is mounted. This screw engages a nut clamped to the arm, both the screw and nut being of liberal proportions and easily accessible. It will be observed that the feed mechanism is entirely enclosed so that it is impossible for emery or dirt to injure it in any way. Any variation of feed is readily obtainable by means of a ratchet wheel and pawl. The feed is operative in either direction and is governed by the direction in which the pawl is engaged. A safety device is also provided, which prevents injury to the feed mechanism in case the arm should come into contact with the uprights, due to neglecting to disengage the feed mechanism. The feed, however, may be very accurately governed by means of a handwheel, the periphery of which is graduated in thousandths; and the diameter of this wheel is so large that these graduations may very readily be observed. The feed operates at the end of each stroke when the wheel is entirely clear of the work.

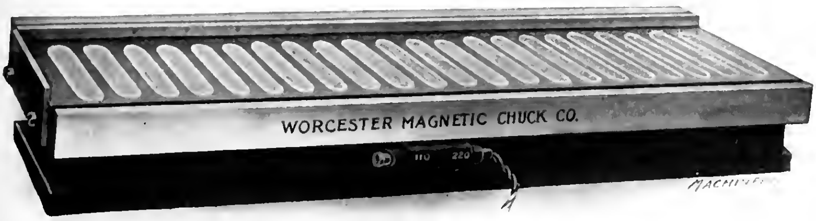


Fig. 1. Worcester Magnetic Chuck for use on either 110 or 220 Volt Circuits

The vertical wheel feed is through hand only, a graduated handwheel being conveniently located on the front of the machine for this purpose. The inclined ram, by means of which the wheel is raised or lowered, is rigidly supported in long bearings. The construction is such that this ram is raised or lowered by means of a heavy screw and nut, the screw being driven through a worm and worm-wheel, actuated by the handwheel referred to. A hardened and ground plate is mounted on top of the ram, which engages a similarly treated block on the under side of the arm. The construction is such that the block always has a full bearing on the plate, irrespective of the height or horizontal position of the wheel. The ram and block take the full weight of the arm, which entirely eliminates backlash in the mechanism. This is a most important feature and one directly conducive to accurate work.

A most important and original feature is the method of mounting the wheel in an arm, which entirely eliminates the use of a slide construction. The arm has a perfect fit on an arbor, which is substantially supported upon two uprights, both the arm and the arbor being proportioned to insure absolute strength and rigidity. With this construction, the wheel is adequately supported without overhang. Furthermore, it simplifies the control of both the vertical and horizontal feeds. It will be noted that the arm has a liberal bearing on the arbor, the bearing surfaces being absolutely protected by means of wipers.

The spindle is of tool steel, hardened, ground and lapped, special treatment and care being exercised to insure the highest possible efficiency of this important member. The boxes are made of bronze and mounted in conical seats. They are made and located so as to be easily accessible for adjustment, and are absolutely dust- and water-proof. Extra precautions have been taken to insure proper lubrication, large self-feeding oilers being provided. The wheel-mount is self-contained and constructed so as to hold the wheel firmly and perfectly true. The spindle end is made conical and provided with a key for the accommodation and positive driving of the wheel-mount. The machine is designed with a view of using wheels up to 18 inches diameter by 2-inch face. Suitable packing rings, however, are provided which permit the use of wheels as thin as 1-inch face.

The wheel spindle drive is of liberal proportions throughout, so that there is no question as to whether the wheel will have sufficient power for any requirement. Two speeds are provided by means of a two-step cone, so that when the wheel is reduced by wear, its speed may be increased. The mechanism for shifting the belt to obtain the increased speed of wheel is so designed that it also becomes necessary to proportionately decrease the table feed. The wheel is driven from a drum, which is finished perfectly true, so that there is no vibration.

A most important feature in these machines is the liberal and perfectly controlled water supply. It is well known that in order to keep the wheel free and prevent clogging, as well as to prevent heating of the work, a liberal supply of water is absolutely necessary. The type of pump used is made and located so as to entirely dispense with the usual idler pulleys. It is capable of supplying an abundance of water for any condition under which the grinder may be operated. An exceptionally large water tank is located on the back of the machine, where it is in an accessible position so that it may be readily cleaned. This arrangement also permits the return of the water without requiring it be carried through pipes; in fact, the design is of such a nature throughout as to make the collection of dirt or grit in inaccessible places impossible. The pipe through which the water is conveyed to the wheel is attached to the guard and may be easily adjusted or instantly removed as desired. Both the table and wheel are provided with guards to prevent the escape of the water.

WORCESTER MAGNETIC CHUCKS

Two forms of electro-magnetic chucks which are now being manufactured by the Worcester Magnetic Chuck Co., 47 Hermon St., Worcester, Mass., are illustrated in Figs. 1 and 2. Referring to these illustrations, it will be seen that the faces of the chucks are designed with "holding spots" which are made of steel. These holding spots are at the ends of the pole-pieces about which the electro-magnetic fields are wound. The use of steel for this purpose has two advantages; it adds to the wearing capacity of the chuck and also affords a stronger magnetic action. As each pole constitutes an independent unit, any accident which may put one pole out of commission does not affect the efficiency of the other poles. The chuck is both heat- and water-proof and does not require ventilation.

Fig. 2. Worcester Round Magnetic Chuck

Fig. 2 shows a round chuck which is capable of holding work as small as rings of $1\frac{1}{4}$ inch diameter. Each of the electro-magnetic coils in these chucks is enclosed in a fiber case which makes it impossible to ground the chuck. The rectangular chuck (Fig. 1) is designed to hold pieces from ½ inch in diameter up to the full size of the chuck. This chuck is wound for connection to either 220 or 110 volt circuits. In order to change from one voltage to the other, it is only necessary to take off the "volt box" on the side of the chuck and change the wires. No resistance is required with these chucks.

"NATIONAL" HEAVY-PATTERN FORGING MACHINE

On account of the general adoption of high-carbon and alloy steel in engine and machine construction, a gradual development has taken place in the design of machine tools to increase their power and capacity. In the railroad, automobile and industrial shops, for instance, there is a general tendency to use forged parts made from wrought iron, soft steel, high-carbon and alloy steel, to replace castings of iron, steel and malleable iron, due to the greater strength possessed by forged parts, and also to the fact that forgings last longer and are much cheaper when produced under proper conditions. The automobile industry particularly has made a great advance in the adoption of forged parts made from alloy steels, and heretofore forging machine equipment has not had the capacity or strength for making these parts economically.

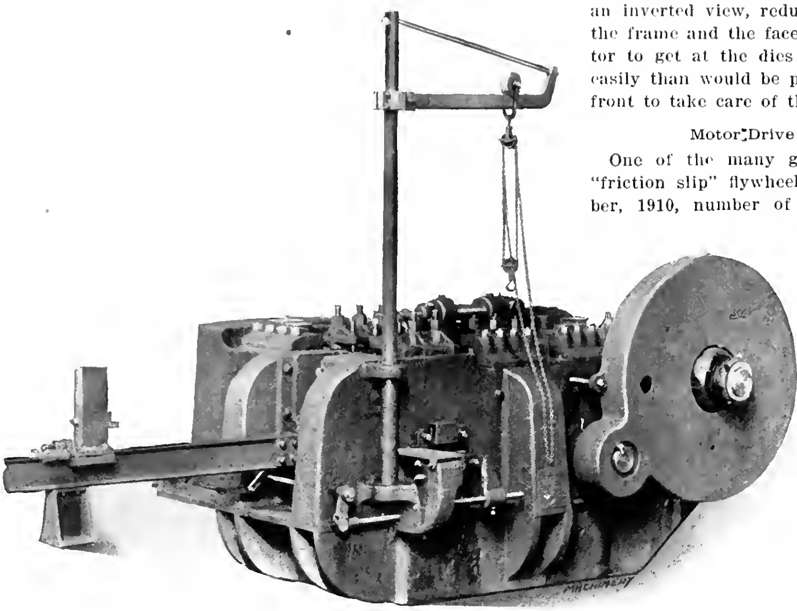


Fig. 1. "National" Four-inch Heavy-pattern Forging Machine

The National Machinery Co., Tiffin, Ohio, manufacturer of bolt, nut and forging machinery, has recently brought out a new design of forging machine which embodies some radical departures in its construction. It has been designed not only for handling forgings much more economically than machines formerly built, but will operate on high-carbon and alloy steels with the same facility as on wrought iron or mild steel. It is designed along lines that give it a higher factor of safety than is customary in forging machines, and it is provided with reliefs on the gripping and heading slides.

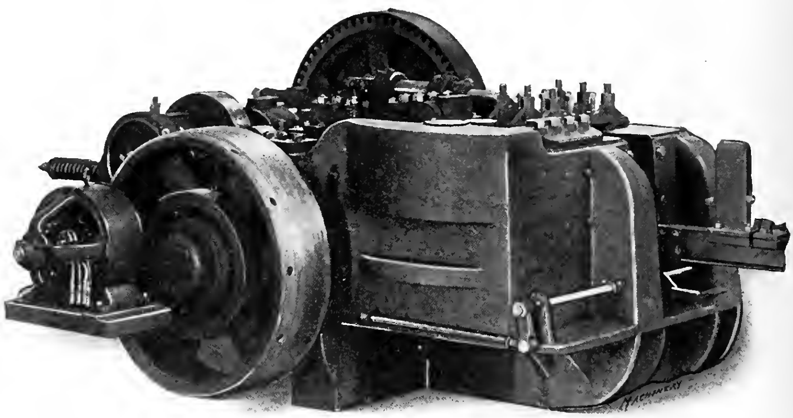


Fig. 2. "National" Four-inch Heavy-pattern Forging Machine with Direct Motor Drive, the Motor being geared directly to the Friction Slip Flywheel

Bed-frame Construction

Figs. 1 and 4 show the bed frame construction which extends considerably below the floor line, is heavily ribbed and is of trussed frame section. This bed frame is one massive steel casting of heavy pattern type designed to secure a high degree of stiffness, as well as great strength. The aim in designing this frame has been to distribute the metal in the paths of the stresses so as to overcome the objectionable spring prevalent in forging machines made from steel beds of lighter design. It also eliminates the use of tie rods and similar stiffening members, making the machine much more accessible. By carrying the frame below the floor line, and providing the ribbing illustrated clearly in Fig. 4, springing at the gap of the bed is eliminated. This is a very important feature in a forging machine, because if the bed frame is not rigidly constructed near the gap, it weakens the gripping power of the machine, allowing the work to slip and produce excessive fins and flashes on the work. Making the bed frame like the construction illustrated in Fig. 4, which is an inverted view, reduces the distance between the front of the frame and the faces of the dies, thus enabling the operator to get at the dies and operate the machine much more easily than would be possible if the frame were built out in front to take care of the stresses mentioned.

Motor Drive and "Friction Slip" Flywheel

One of the many good features of this machine is the "friction slip" flywheel, which was described in the November, 1910, number of MACHINERY. While this flywheel is intended primarily to furnish a means for safety or relief on the heading movement, it also provides an element of elasticity which is highly essential between the motor and a machine of this type. This is due to the varying strains thrust upon the motor by the gripping and heading movements, and especially when the machine is accidentally "stalled" by cold stock or excessive metal. The motor carries a rawhide pinion that meshes directly with a gear bolted to the flywheel. This forms a compact and simple design, insures quiet operation and eliminates the excessive upkeep incident to the chain or flexible joint drive.

Automatic Grip Relief

The top view of the machine, Fig. 3, shows the gripping dies in their closed position and the heading tool or plunger just as it starts gathering the stock on the upsetting stroke. The heading slide is actuated by a crank, while the gripping slide is controlled by two cams, one effecting the closing of the dies and the other serving to open the dies. By employing two cams for the operation of the gripping dies, the opening and closing movements are so timed as to secure practically the entire stroke of the heading tool for useful operation. This gives the machine an unusually large gathering capacity, that is, the ability to upset a large amount of stock at one stroke of the heading plunger. The double cam mechanism also enables the dies to be opened wide, and this, with the large gathering capacity, makes this machine capable of handling large and difficult shaped forgings.

The safety relief for the gripping slides as shown in Fig. 3 consists of a by-pass toggle, the action of which is illustrated in the diagrams Figs. 5 and 6. This relief is so designed that but a small part of the gripping pressure or power is dependent upon the toggle and spring which holds the toggle

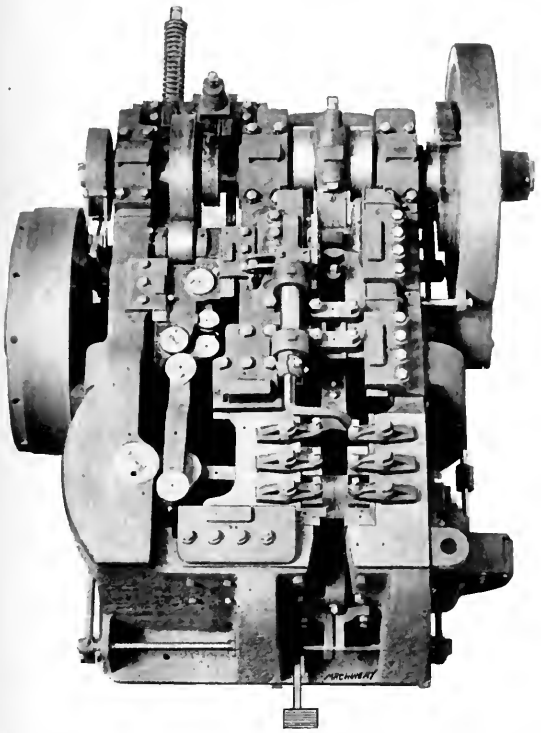


Fig. 3. Top View of "National" Heavy-pattern Forging Machine, showing Method of operating the Gripping Mechanism and Heading Slide

in the normal position, and does not relieve the machine until the same strains are secured in the dies, which in ordinary relief designs would shear the breaker bolt or pin. This design provides for a powerful gripping action in the dies and also enables squeezing or swaging operations to be performed

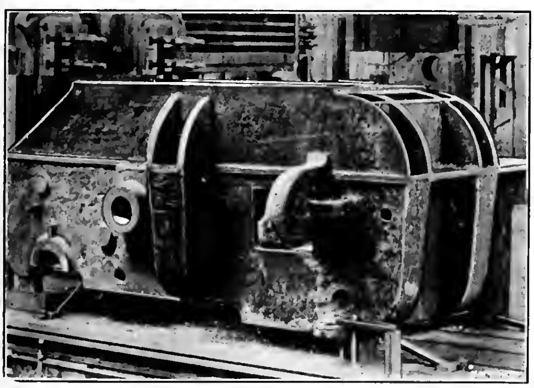


Fig. 4. Steel Bed Casting of National Heavy-pattern Forging Machine, showing the Heavy Under-ribbing that extends below the Floor Line

between the opposing faces of the gripping dies, as is illustrated by the examples shown in Fig. 7. These bars range from 2 to $3\frac{1}{2}$ inches in diameter and were flattened or squeezed in a heated state between the surfaces of the dies in one operation. The ability to handle such squeezing or swaging operations enables a wider range of work to be accomplished, and this feature has met with much favor by forge-shop superintendents.

Briefly stated, the automatic grip relief operates in the following manner: When a piece of stock or other object becomes caught between the gripping dies, or in shop vernacular, the operator gets a "sticker" in the dies, the gripping action continues until the strain incurred in the dies exceeds the combined gripping power derived from the main or fixed toggle and the by-pass toggle, causing the by-pass toggle to open and compress the relief spring, thus stopping the movement of the gripping slide. The heading tool or plunger, however, completes its full stroke, and upon the return stroke of the machine the by-pass toggle resets automatically, without any attention on the part of the operator. This, of course, eliminates all shutdown, which is necessary with the ordinary safety devices, such as the breaker bolt, etc., sometimes provided.

Suspended Gripping and Heading Slides

Another valuable feature that has been incorporated in this design of forging machine is the suspended type of head-

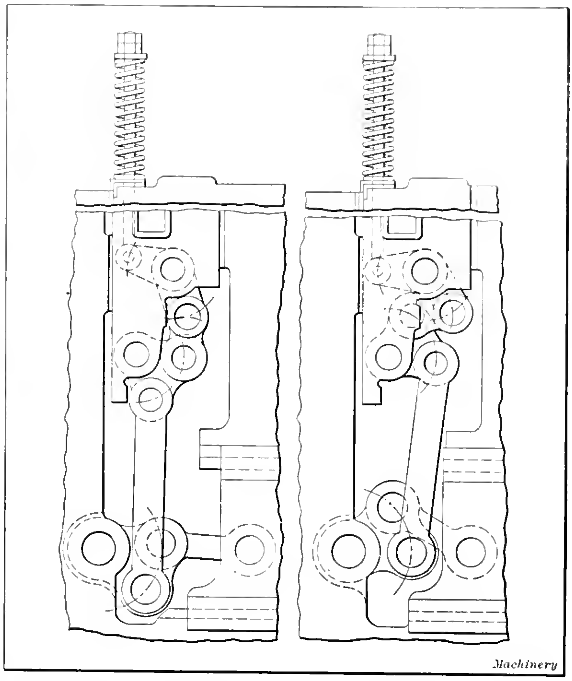


Fig. 5. Automatic Relief for Gripping Slide in its Normal Position

Fig. 6. Automatic Relief in its Tripped Position

ing and gripping slides as shown in the sectional views Figs. 8 and 9. In this type of slide it can be seen that the supporting bearings are at the top instead of at the bottom. This feature removes the bearings from the line of water and scale, increases perfect lubrication and eliminates the causes of "cutting out," as it prevents the water and scale from getting in between the working surfaces. With the ordinary

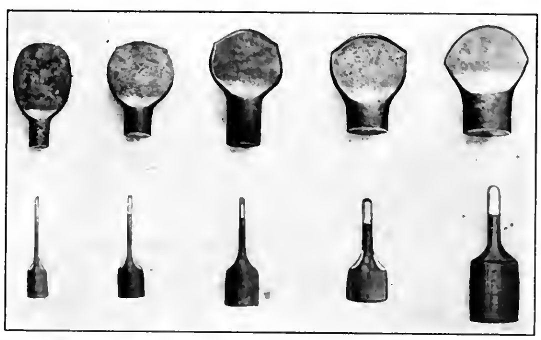


Fig. 7. Squeeze Jobs or Swaging Operations accomplished between Gripping Dies of National Heavy-pattern Four-inch Forging Machine

type of slide where the bearings are at the bottom, water and scale drop down upon the ways and are picked up by the reciprocating movement of the slides, thus causing friction or abrasion with attendant wear. This makes it difficult to maintain alignment. Figs. 7 and 8 also show the wedge

construction back of the side liners on the heading and gripping slides. With this construction shimming can be added when needed without removing the slides or liners, thus providing an easy means of maintaining a snug contact between the slides and liners, and preserving perfect alignment.

Miscellaneous Features

The slide, toggle and shaft bearings are of especially large area and a special effort has been made to minimize the wear by facilitating lubrication. Large oil boxes provided with covers furnish a means of lubricating the slides and main shaft, and oil cups with connecting ducts take care of the bottom toggle bearings and the suspended slides, thus eliminating the source of the greatest trouble in the lubrication of forging and upsetting machines. This new heavy-pattern forging machine is built in sizes ranging from 2- to 5-inch capacities, but due to the larger movement and greater strength of this design, the range of all sizes is increased so that they will safely handle any forge-shop work that has been taken care of on so-called 6-inch machines, and various smaller sizes. A 5-inch "National" machine will easily handle work that has heretofore been only possible on a regular 6-inch machine. A number of these 4-inch machines have been supplied to the automobile trade for use on high-carbon and alloy steels, and have been viewed with interest by shop managers and superintendents when in operation in the shop of the manufacturers where demonstrations are made at the completion of each machine.

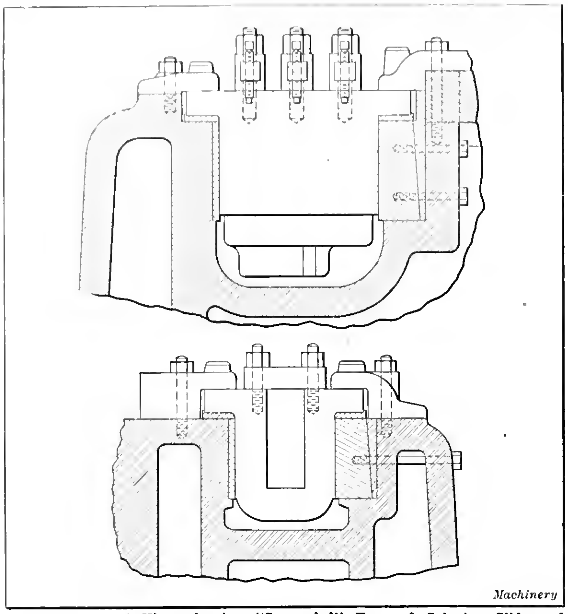


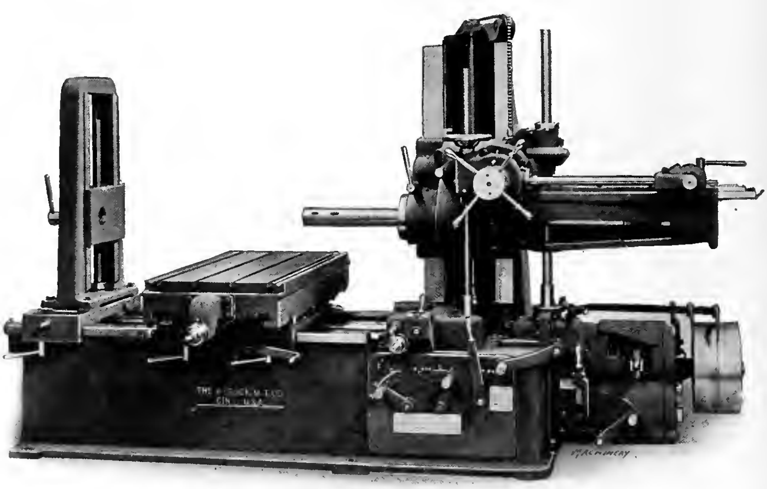
Fig. 8. Sectional View showing "Suspended" Type of Gripping Slide and Method of lining and gibbing
Fig. 9. Sectional View showing "Suspended" Type of Heading Slide and Method of lining and gibbing

FOSDICK BORING, DRILLING AND MILLING MACHINE

The No. 0 horizontal boring, drilling and milling machine shown in this connection is a product of the Fosdick Machine Tool Co., Cincinnati, Ohio. This company has been manufacturing a machine of this type for several years, but the present design has been improved in many ways. Among these improvements may be mentioned: The control has been centralized to facilitate convenience in operation; all gears are of steel and the bevel gears are planed to a theoretically correct outline; self-oiling bearings are used which are provided with phosphor-bronze bushings; all clutches, gears and other moving parts are thoroughly incased; and precision micrometer dials are provided which can be set back to zero from any position.

The bed is of deep section and well ribbed to provide adequate rigidity without the use of any special foundation. Chip chutes are provided which carry the chips and dirt away to the rear of the machine. The head and outer support are raised and lowered simultaneously by means of a rapid power traverse, by hand or by the feeds, the elevating screw being suspended from a ball bearing at the top in order to avoid buckling. Automatic safety trips are provided at both extremes of the travel. The spindle is driven by two long keys and slides in a sleeve with a phosphor-bronze bearing, which is tapered to provide compensation for wear. The thrust is taken on a ball bearing. The quick advance and return turnstile is placed at the front of the head where it is within easy reach of the operator. The sleeve surrounding the spindle is so designed that the spindle is held in perfect alignment regardless of wear.

The table is of heavy construction and is scraped so that it is absolutely square with the spindle. It is provided with an oil channel running all the way around and has automatic safety trips at either extreme of its movement. The feed mechanism is enclosed, all of the feed gears being of steel. The changes are made by means of two handles at the front without the necessity of stopping the machine. A safety friction device, which is adjustable from the outside, prevents the possibility of damage to the feed mechanism. The rates of feed are given on a metal feed-plate and are the same for the spindle, table and saddle or head, so that the selection of the proper feed is made by means of only one handle. This makes it impossible to get any but the desired movement. The direction of the feed reverses when the spindle is reversed and stops when the spindle is stopped.



Fosdick No. 0 Combination Boring, Drilling and Milling Machine

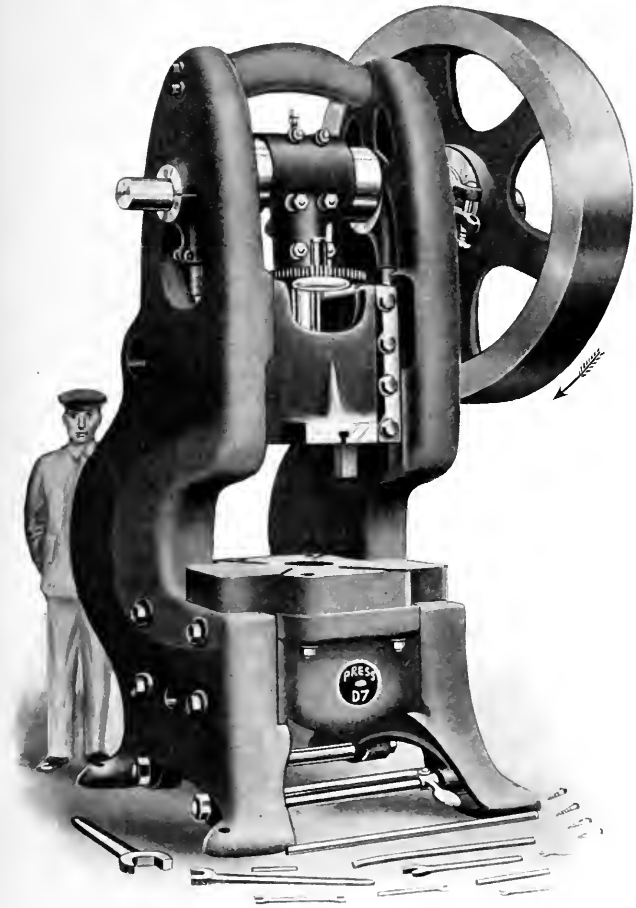
An independent feed reverse lever is provided and power rapid traverse for all members of the machine is always in the opposite direction to the feed.

The drive is direct, so that no countershaft is required, and the machine is equipped with a direct reading index over the speed-changing handle which gives the revolutions per minute of the spindle. An overtake clutch keeps the machine running at a reduced speed while making changes, so that any possible shock is reduced to a minimum. A re-

verse mechanism is embodied in the construction and is operated by a lever located at the front of the machine. All levers are secured by latches. Motor drive may be added to this machine at any time, a five-horsepower constant-speed motor of the required speed being suitable for this purpose. The principal dimensions of the machine are as follows: Traverse of the spindle, 26 inches; vertical adjustment of the head on the column, 25½ inches; maximum distance from the table to the center of the spindle, 26 inches; cross travel of the table, 30 inches; longitudinal travel of the table, 32 inches; number of feeds, 18; range of feeds, 0.004 to 0.396 inch; approximate net weight, 8500 pounds.

FERRACUTE SINGLE-ACTION PRESS

The Ferracute Machine Co., Bridgeton, N. J., has recently brought out a line of throated, single-action power presses which are made in sizes capable of exerting pressures of 100, 150 and 200 tons. These machines are built with either a heavy flywheel or gearing, the flywheel type being shown in the illustration, which shows a machine capable of exerting a pressure of 150 tons.



Ferracute Single-action Power Press equipped with a Pin Clutch

The shaft of this machine is a high-carbon steel forging which is 6½ inches in diameter at the journals and 7½ inches at the crank. The hole through the bed is oblong in shape, being 20 inches from front to back and 18 inches from right to left. The distance between the columns is 32 inches and the throat—from the center of the ram back to the frame—is 15 inches. The height from the bed to the ram when at the top of its stroke and adjustment is 21 inches; the stroke of the ram is 3 inches and the maximum adjustment of the ram 4 inches. Machines can be built with different lengths of stroke to meet the requirements of individual cases. The flywheel is 55 inches in diameter by 10 inches face width and weighs 2600 pounds. The bolster is 4½ inches thick and measures 28 inches from front to back by 26 inches right to left. The total weight of the press is about 26,200 pounds.

POTTSTOWN AUTOMATIC VALVE MACHINE

The illustration shows a semi-automatic 4-inch valve tapping, reaming and seating machine which has been brought out by the Pottstown Machine Co., Pottstown, Pa. It is intended for finishing semi-steel valve bodies, pieces with flanged or threaded ends, split return bends and similar work which requires two or three operations in one chucking. The machine is of heavy construction, which gives such rigidity that any possibility of the work shifting while the machine is in operation is practically eliminated. Eight spindles are provided, either or all of which can be used according to the work on which the machine is engaged.

The turret is revolved and indexed by means of a pneumatic cylinder. This turret has four sides, each of which is provided with chucks, the work in three of the chucks being operated upon while a piece is being set up in the fourth. The first operation is performed on the work at the left-hand side of the turret, where the three roughing tools enter the valve and remove all scale surfaces. The work is then carried to the second position, where the finishing tool at the rear (which does not show in the illustration) comes into action. Two spindles are provided in this position—one horizontal and one vertical—for finishing either straight through or angle valves. After the work has been carried to the third position, two facing tools come into action which finish the male and female members. The turret then moves to the fourth position where the finished valve is removed and a fresh casting mounted in its place.

On the right-hand side there is an additional wrist plate, cam and lever mechanism. This is the tapping side of the machine. It is possible to throw the automatic reversing mechanism out of commission and make the spindles rotate in one direction only, thus permitting finish-facing tools to be mounted in these spindles for machining flanged work. The machine is shown operating in this manner in the illustration. By disconnecting the wrist plate, placing lead-screws on the spindles and putting the reversing mechanism into commission, the machine is made ready for operations on tapped openings.

The turret is held and indexed by means of a substantial latch bar and is further supported by an automatic locking device which holds it securely to the main frame of the machine. This arrangement insures absolute alignment and accurate work. The turret may be revolved without the tools coming into operation as long as the cam trip is not pressed down. After the work has been placed in the chuck and the turret moved to its first position, the machine passes through the cycle of operations which is necessary to finish the piece. After the tools have been set, there is nothing further to be done except to take out the finished work and replace it by a new blank.

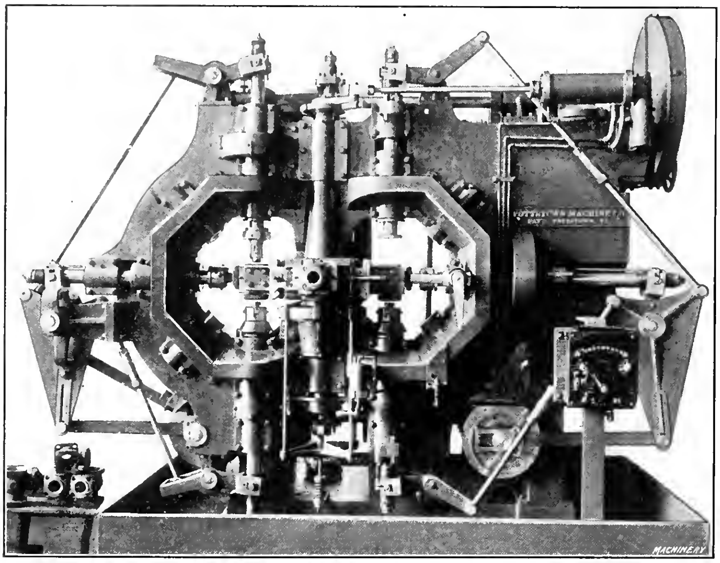
The adjustments are adequate for the range of the machine from the largest to the smallest sizes of work. In order to secure rigidity, the chucks are provided with right- and left-hand screws that are coupled in the center by a sleeve; this sleeve receives the two ends of the screws which are machined to fit it. The action of the wrench on one end of these screws is to tighten the jaws on the work, causing them to separate slightly in the middle and come up solidly at either end of the chuck. No dependence is placed on a bracket or collar to provide the necessary rigidity. Consequently, when the work is fastened in the chuck, it is practically as solid as the turret itself.

Solid taps are used, the taps being fed in by adjustable lead-screws. In order to facilitate gaging, the leader nuts

are castellated and the use of a spring latch enables the nuts to be revolved from one notch to another to regulate the depth of thread. The lead-screws are removable and can be readily changed for different pitches. The taps are started automatically by the cam-shaft, but the reversing is done by a stop carried on the reversing disk. Any depth of thread can be cut by simply adjusting these stops. The variation in the thread is adjusted by the lead-screws as explained.

The four-sided turret used on this machine enables the work to be brought close to the operator, and thus greatly facilitates chucking. The simplicity of the method of setting up the machine for different jobs is also a material advantage. In starting on a piece of work, the turret can be moved back and forth to the different tools so that all testing and gaging may be done on the first piece. The ability of the machine to perform the third operation described in the cycle is also a valuable feature. For machining globe valve bodies, roughing tools may be used to remove the surplus stock and for rough-reaming, while finishing tools are used for accurately finishing all of the openings at a single chucking. When handled in this way, the work will be more accurate and the tools will last longer.

All gears used in this machine are made of either cast or forged steel with cut teeth. All of the clutches are made of



Pottstown Machine for tapping, reaming and seating Valves

hardened tool steel and the spindles are of a special steel which is particularly adapted for this purpose. The spindles are provided with taper bushings for taking up wear. All of the bearings are of ample proportions and provided with oil grooves to facilitate lubrication. The hand levers which govern the various movements of the machine are conveniently placed for the operator. The floor space occupied is

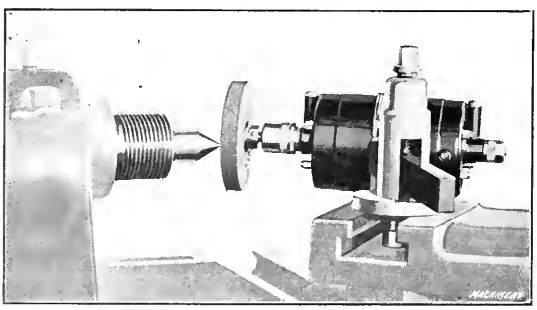


Fig. 1. Method of using Racine Lathe Center Grinder

9 feet 6 inches by 6 feet 1 inch and the weight of the machine is 20,800 pounds. During a recent test, the machine turned out 2-inch semi-steel valve bodies at the rate of twenty per hour.

RACINE PORTABLE ELECTRIC GRINDERS

The Racine Electric Co., Racine, Wis., with sales offices in the Matthews Building, Milwaukee, Wis., is now manufacturing the portable electric grinders shown in Figs. 1 to 4.

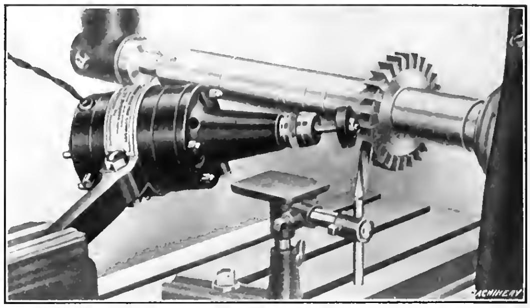


Fig. 2. Grinding a Milling Cutter with the Racine Toolpost Grinder

Referring to these illustrations, it will be seen that one of these tools is intended for grinding lathe centers while in position and that the other is a toolpost grinder. The illustrations show several uses to which this grinder can be put.

Fig. 1 shows the method of using the lathe center grinder, the operation being obvious to any mechanic without requiring a detailed description. It is merely necessary to place the grinder at the proper angle in the toolpost and drive the lathe and grinder in opposite directions. In this way, lathe centers can be ground in far less time than it takes to remove them from the machine, draw the temper and true them in the ordinary manner. The grinder is equipped with a 3½ by ½ inch wheel and the spindle runs in adjustable bearings. The motor develops 1/6 horsepower and drives the wheel at 6000 revolutions per minute. This grinder is adapted for use in any standard sized lathe and can be used for large internal and external work in addition to grinding centers.

Figs. 2 to 4 show another portable electric grinder of this company's manufacture engaged on three typical operations. In Fig. 2, the grinder is shown sharpening a cutter while in place on the milling-machine arbor. Used in this way, the tool is capable of producing very accurate results and saves the time necessary to take the cutter off the machine and set it up on a tool grinder. Fig. 3 shows the grinder engaged upon internal work. For this purpose, wheels

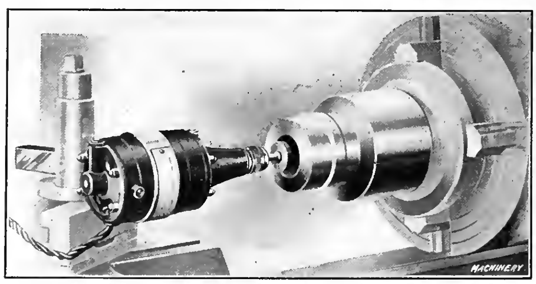


Fig. 3. Racine Toolpost Grinder engaged on Internal Work

ranging from ¼ inch to 2 inches in diameter can be used, and for very small work an extension is furnished. For work on which a very smooth surface is necessary, oil-stone wheels can be used. In Fig. 4 it will be seen that the grinder is mounted in the toolpost of a shaper and is engaged in grinding a plane surface. Many dies and other hardened pieces warp slightly during the heat-treatment, and by using the grinder in this way, a convenient means of eliminating such errors is provided.

The following gives a brief description of the construction of the motors used to drive these tools. The armature is built up of thin laminations of steel and is pressed onto a steel shaft which has been ground to an accurate finish. The windings are of double silk-covered wire and are thoroughly impregnated with insulating varnish. The commutator is built up from twenty-four hard-drawn copper segments separated by mica insulations. The brushes are made of carbon and provided with means for automatic adjustment. The armature spindle bearings are lined with babbitt of a special mixture adapted for high speed; after the babbitt lining has been put in the bearings, the motor casing is chucked in a screw machine and the bearings are reamed, burnished and faced. By this method perfect alignment of the bearings is insured. The motors are "universal" in that they are capable of operating on either alternating or direct current of 100 to 130 volts.

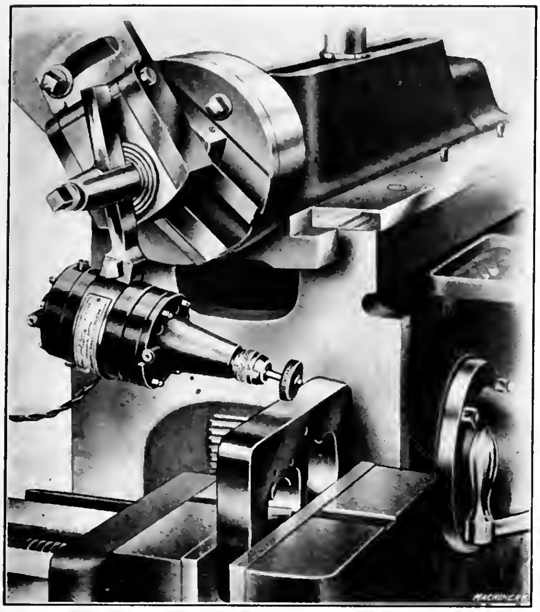


Fig. 4. Grinding a Plane Surface with the Racine Toolpost Grinder

DRESES SIX-FOOT UNIVERSAL RADIAL DRILL

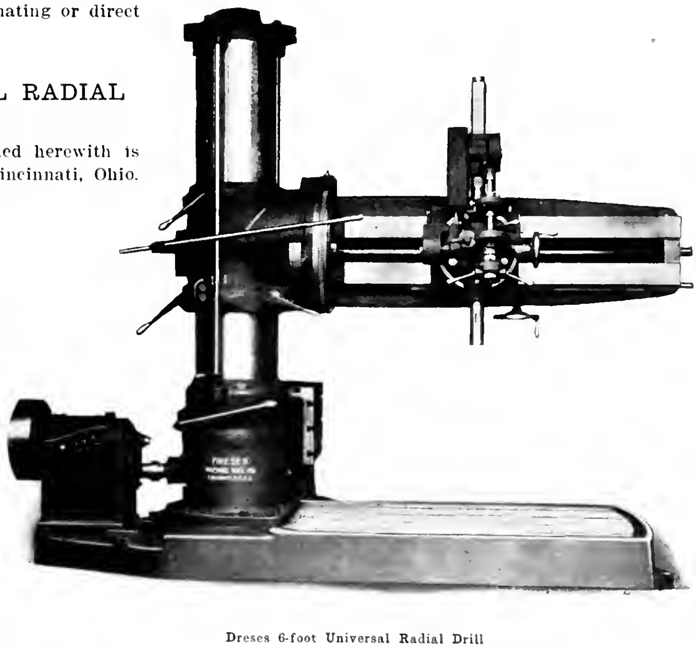
The six-foot universal radial drill illustrated herewith is a product of the Dreses Machine Tool Co., Cincinnati, Ohio. Referring to the illustration, it will be seen that the base is high and is provided with an oil groove running all the way around it. The oil drains into this groove which carries it away to a reservoir under the table. The outer column swings on a fixed inner column and both are made of particularly large size at the lower end to provide for the application of a roller bearing which supports the outer column. The inner column also carries an annular ball bearing at the top to insure an easy movement of the arm.

The arm is double webbed and strongly ribbed, and a shoe attached to the saddle and fitting between the two faces of the arm combines them into a solid box section when the saddle is clamped. The arm is lowered at twice the speed at which it is raised, and automatic knockouts are provided at either extreme of the travel. One of the special features of this machine consists of the design of the arm girdle. The socket which receives the arm is offset to one side of the center of the column to allow a long central shaft to be used in the head saddle and also to bring the spindle more nearly in line with the center of the column. The head is graduated for angular setting and can be swung through a complete circle.

The spindle is provided with twenty-one speeds and the quick advance and return mechanism has two handles, either of which instantly engages or disengages the feed. The feed mechanism is of novel design. A dial plate is provided on the feed shaft and makes one-quarter of a revolution for each revolution of the shaft, the movement of the dial being provided by means of planetary gearing and a pinion cut directly on the feed shaft. A fixed dog on the dial plate acts upon a lever and stops the feed automatically. There are eight changes of feed—four in a series—which are operated by the small handle on the left-hand side of the feed shaft, the number of feeds being multiplied by the horizontal handle above the handwheel.

The initial driving and speed mechanism is located at the rear of the arm girdle which simplifies the construction. The back gears are of the automobile transmission type, three changes being provided by means of the small lever at the front of the girdle which shifts the gears. The tapping, starting, stopping and reversing mechanism is of the friction type described in connection with one of this company's drills which was shown in the "New Machinery and Tools Section" of the November, 1911, number of MACHINERY. This mechanism is operated by the long telescopic lever which is always within reach of the workman. All of the gearing is completely enclosed and runs in oil.

The speed variator is of the well-known tumbler type; it has seven changes, and by means of a self-releasing overtake clutch the machine is run at the slowest speed when making changes in order to decrease the momentum and consequent shock as far as possible. All of the gears are hardened and the teeth are of the 20-degree involute pointed form to give added strength and to insure easy engagement. The pulley shaft has an annular ball bearing to reduce friction which would otherwise be very pronounced owing to the heavy lateral belt pull. All high-speed bearings are lined with removable bronze bushings and ball bearings are provided at points where the service is severe. Machines of this type are built in four-, five- and six-foot sizes and are furnished with cone, motor or speed variator drives to meet the requirements of different shops.



Dreses 6-foot Universal Radial Drill

DIAMOND FACE GRINDING MACHINE

The grinding machine shown in the accompanying illustrations is a recent product of the Diamond Machine Co., Providence, R. I., and is particularly adapted for grinding railway locomotive guide bars. By using the face of the 30-inch ring wheel with which this machine is equipped, the entire surface of the guide is ground at each traverse of the table. The machine is also well suited for a variety of heavy surface grinding operations.

One of the most interesting features of this machine is the method by which the reciprocating motion of the table is

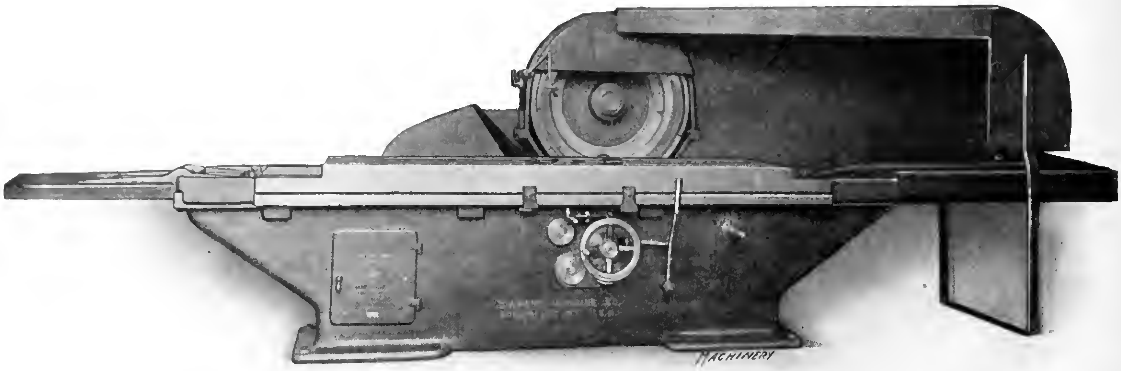


Fig. 1. Front View of Diamond Face Grinding Machine

obtained. The arrangement is similar to the familiar form of planer belt shifting mechanism, but has been modified to adapt it for use on a grinding machine. A three-step cone pulley fastened to the rear end of the spindle transmits power to an intermediate shaft on the right-hand side of the machine. From this intermediate shaft the drive is carried back to the left-hand side of the machine by means of

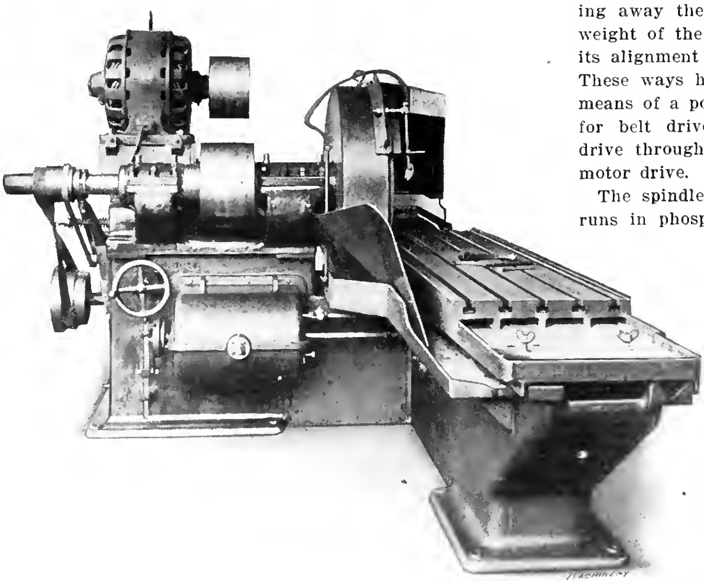


Fig. 2. Left-hand Side of Grinding Machine

two-inch open and crossed belts, which pass through the column to the table driving shaft. A detail of this construction is shown in Fig. 3, where it will be seen that two loose pulleys are arranged at each side of a tight pulley. So far the arrangement is similar to the planer drive, the distinctive feature lying in the fact that the dogs do not carry the shift of the belt but merely actuate the shifting mechanism. For this purpose a fourth pulley is loosely mounted on the table driving shaft, this pulley being driven from the intermediate shaft by means of an open belt. This pulley drives the spiral cam at its right-hand side by means of friction. When the tripping dogs come into action, the cam is released and carried through one-half revolution. During this movement the cam pulls over the lever which shifts the driving belts in the same way as on an ordinary planer drive. By this arrangement the shock of shifting is not felt by the table, and, at the same time, the operation of the mechanism is absolutely positive. The table drive is direct through a four-shaft reducing train.

The bed of the machine is of heavy construction and internally ribbed to give sufficient stiffness to prevent the slightest vibration when the machine is engaged upon heavy work. The ways are of ample proportions, a vee being used at the front and a flat bearing at the rear. The column is of the same form of ribbed construction as the bed, to which it is securely bolted. The table has five T-slots planed from the solid metal, and large runways are provided for draining away the water which is supplied to the wheel. The weight of the wheel-head is borne by the column ways, but its alignment is preserved by means of narrow inner ways. These ways have a taper gib and any play is taken up by means of a powerful spring. The machine may be arranged for belt drive from an overhead countershaft, for motor drive through a belt to the spindle, or for direct-connected motor drive.

The spindle is of 0.50 per cent carbon machine steel and runs in phosphor-bronze bushings which are cast in halves and provided with means for adjustment. These bearings are of ample size to insure permanent alignment. The thrust load is carried by a ball thrust bearing, and any end play which may develop is taken up by threaded collars. The wheel chuck is made of cast iron and carefully turned to insure perfect balance. The body of the chuck is tapered on the outside and slotted so that it may be compressed by a steel ring, which is drawn up on the taper by bolts to give the chuck a secure grip on the wheel. A backing plate, which is adjusted by means of studs, brings the wheel forward as it wears, and, in addition to serving this purpose, it affords additional support. A feature of this method of holding a ring wheel is that a narrow wheel, which removes the stock with less drag and heating, may be safely used.

Another feature of this machine is the provision for control from either the front or rear. This saves the time that is lost by the operator in walking around the machine or leaning over to watch the progress of the work. The customary procedure on work requiring a relatively long time for grinding is for the operator to place the work in position

and adjust the dogs for the required travel. He then goes around to the rear of the machine while the grinding is being done. Without the provision of control at the rear of the machine, it would be necessary to walk around to the front in order to stop the machine. The automatic feed is located at the rear of the machine, as this is the normal position for the operator when using this device. When two machines are used, they are usually placed back to back so that one operator can control both of them. The front and rear spindle bearings are lubricated by the ring-oiling system and the ways are grooved to facilitate oil travel. Oil pockets with broad rollers are also provided in the bed to insure efficient lubrication.

In face grinding the provision of an adequate supply of water for the wheel is of particular importance. The water performs three functions: it keeps the wheel clean so that it will cut freely at all times, it keeps the work cool and settles the dust. In order to provide an ample supply of water, this grinder is equipped with a centrifugal pump which is driven from the spindle by means of a cone pulley and belt. The stream of water is delivered diagonally onto the wheel, and the amount supplied can be adjusted to meet the requirements of different classes of work. It has already been mentioned that runways are provided in the table to carry away the water. These runways deliver it to troughs under the table from which the water flows into a settling tank where the emery and metal dust is removed. The clean water flows back to the main tank where it is ready to be delivered to the wheel as required. Water guards are fastened to the ends of the table and cover the ways at all times. A guard is also placed on the left-hand side of the machine; this guard is close to the hood and in front of the rear control, thus completely preventing the water being splashed onto the operator. The main water guard is located on the right of the machine and catches all water that is thrown off by the wheel. This guard empties into a water trough.

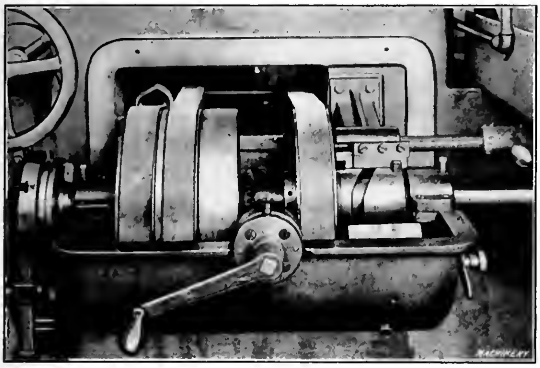
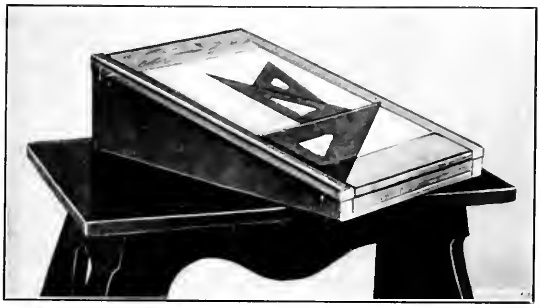


Fig. 3. Belt-shifting Mechanism of Diamond Grinding Machine

DOWD "NO-TACK" SKETCHING BOARD

An entirely new idea in the way of a drawing or sketching board is being placed on the market by Albert A. Dowd, Bridgeport, Conn., and the illustration shown herewith gives a general idea of its appearance. This board was primarily designed for the use of estimators, engineers, chief draftsmen, and tool designers, but it is also very convenient for others having occasion to make small drawings or free-hand sketches. A notable feature of the board is its freedom from obstructions of any kind, no thumb-tacks being necessary to hold the paper in position. This point will be appreciated by those using the ordinary type of small drawing board in which the protruding thumb-tack heads are a great nuisance, giving continual trouble by interfering with the free use of the T-square and triangles. No T-square is needed for this board, as the mahogany straightedge along the left-hand side is trued up along its inner side so that a large triangle may be placed against it, and used in place of the T-square. It will be noted by referring to the illustration, that the straightedge extends far enough below the end of the paper to insure a good bearing for the triangle, even when work is being done at the extreme lower edge.

The board is made in one size only, for drawings 9 by 12 inches or smaller, and the paper is carried on a roll underneath the upper end of the board or it may be used in small sheets if desired. Space is provided to accommodate a fifty-yard roll of paper. When it is used in the roll, the paper is pulled up through the spring actuated wing at the top of the board and drawn down across it and through the slot at the bottom, where there is another wing similar to that above. Rubber disks are inserted in the edges of these wings and they hold the paper in such a way that it may be stretched as tightly as a drum-head. The convenience of the board and the rapidity with which drawings and sketches may be made upon it are points which will find favor with those using it.



Dowd "No-Tack" Drawing Board for making Rapid Sketches

INDUSTRIAL PEN LIFTER

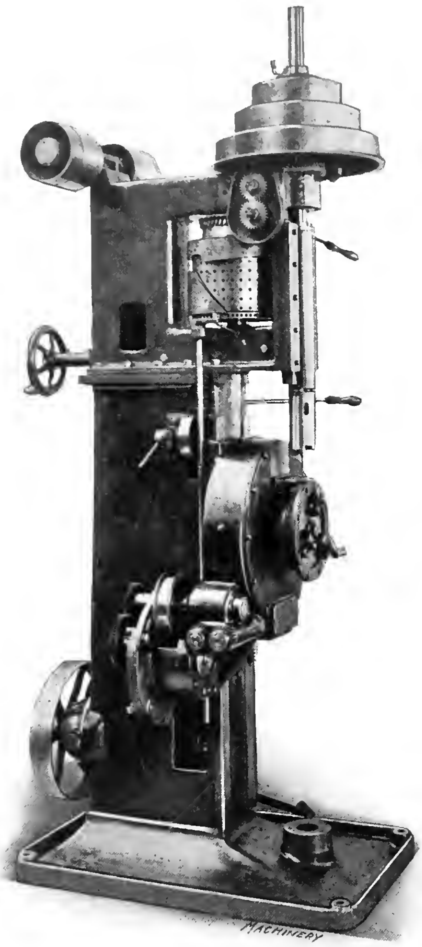
The Industrial Instrument Co., Foxboro, Mass., has just perfected a new attachment for use on the recording meters of its manufacture. This attachment is styled an automatic release pen lifter and is illustrated herewith. It is a simple device consisting of a strip of German silver pivoted on a holder, which is secured by one of the screws that holds the chart disk. By exerting a slight pressure on a small lever, this strip of German silver is raised and lifts the pen out of contact with the chart. The lifting device is held up by friction, so that both of the operator's hands are left free to remove the chart and place a fresh one in its place. When the door of the meter is closed, the pen arm is automatically released and the pen returns to its marking position on the chart. This automatic feature makes it impossible for the operator to leave the instrument out of commission. In addition to the convenience of this attachment when changing charts, its use does away with the necessity of handling the pen arm, and the consequent danger of straining it and thus affecting the accuracy of the instrument.

Pen Lifter for use on Industrial Recording Gages and Meters

BAKER AUTOMATIC DRILLING MACHINE

The accompanying illustration shows a development of the automatic drilling machine built by Baker Bros., Toledo, Ohio, which is intended for drilling radial holes in a flange or similar part. The operation of this machine is entirely automatic, the spindle being fed in to the work and returned by means of the cams located near the top of the machine, while the indexing is done by an index plate and change gears. Any number of divisions may be obtained. For this purpose it is, of course, necessary to set the change gears. After this adjustment has been made, it is merely necessary for the operator to remove the finished piece and replace it by a fresh blank.

The illustration shows the machine set up for drilling twenty-four radial holes in a flange, these holes being 7/16



Baker Bros. Automatic Drill for drilling Radial Holes in Flanges

inch in diameter by 7/16 inch deep. During a recent test to which this machine was subjected in the manufacturers' shops, the holes were drilled in a twenty-four hole flange in fifty-five seconds. From this it will be evident that the operation of the machine is very rapid, and the design is such that the holes are accurately spaced without requiring the use of a jig. The capacity of the machine is for flanges ranging from 3 to 24 inches in diameter. In addition to drilling radial holes in flanges and similar classes of work, the machine can be arranged to drill individual pieces held in a series of chucks mounted on the periphery of a disk. This machine is equipped with radial ball bearings which reduce friction and make it well adapted for operation at high speed.

NIAGARA FOLDER AND BENDING BRAKE

The folder and bending brake illustrated in Fig. 1 is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. Examples of the bends which can be made on this machine are illustrated in Fig. 2, from which it will be seen that a large variety of work can be handled. Close edges can be turned for making lock seams and work with circular bends can be formed with equal facility. The machine can

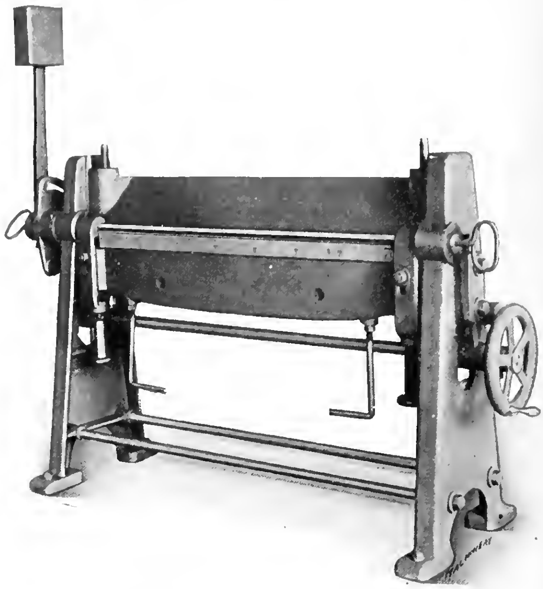


Fig. 1. Niagara Folder and Bending Brake

also be used as an ordinary bending brake, and tubes can be formed over a mandrel of suitable diameter. The production of circular bends is accomplished by mounting the folding and lower clamping bars in such a way they can be set up 2 inches below the folding axis. This adjustment is obtained by means of bevel gears and screws actuated by a handwheel, both ends of the clamping bar being adjusted at the same time. The ends of the folding bar are adjusted separately by means of screws. The upper clamping bar can be

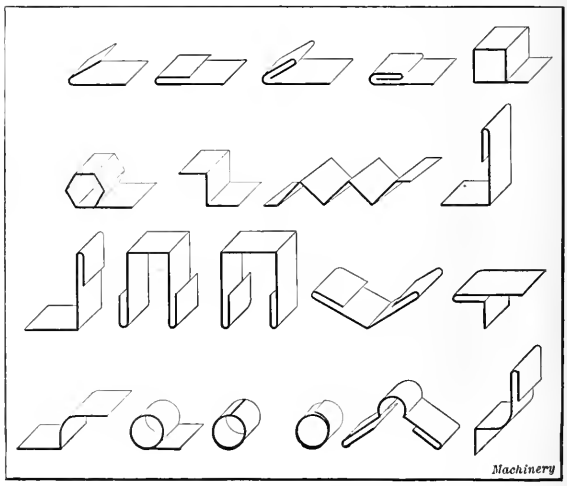


Fig. 2. Examples of Work done on Niagara Machine

raised to a height of 4 inches above the folding axis, thus affording ample space for a variety of sizes of mandrels about which the work is to be formed.

The construction of the machine is simple and rigid, the proportions being such that no tie-rods are necessary. A quadrant gage is provided at the left-hand end of the machine and is equipped with adjustable stops to regulate the motion

of the folding bar. The edge of the regular folding bar is ⅜ inch wide and a removable angle shaped bar is provided for forming heavy material. The folding bar is so attached to the upper clamping bar that it may be instantly removed.

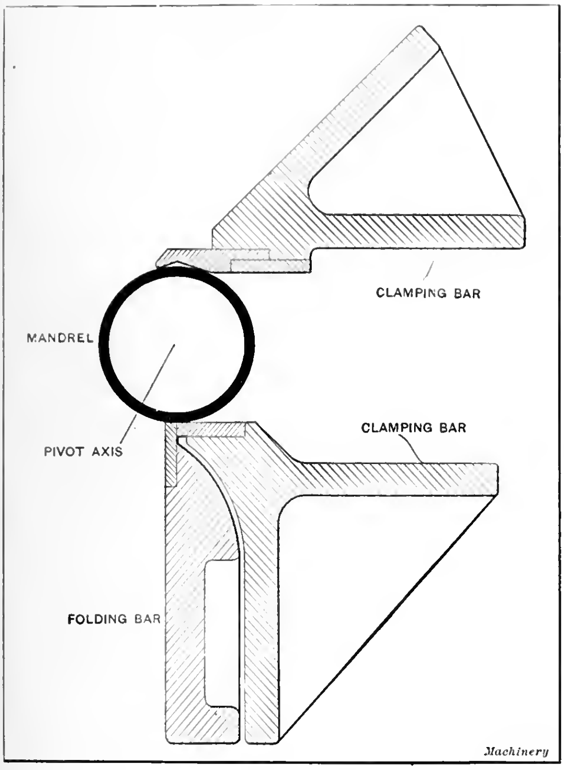
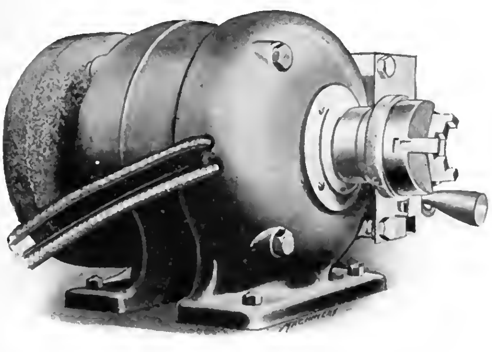


Fig. 3. Cross-sectional View through Clamping and Folding Bars arranged for Circular Bends

Using the ⅜-inch edge of the folding bar, the machine will handle stock up to 18 gage, while the use of the angle shaped bar increases the capacity up to 16 gage stock.

FORBES & MYERS POLISHING MACHINE

Forbes & Myers, Worcester, Mass., have recently added to their line the electrically driven polishing machine illustrated herewith. This machine is designed for finishing small parts which can be held in either a 2-inch scroll chuck or a ½-inch spring chuck with which the machine is equipped.



Forbes & Myers Combination Polishing, Grinding and Buffing Machine

The illustration shows the machine with a chuck at one end of the spindle and a small grinding wheel at the opposite end. This makes a useful form of equipment, but when so desired either a buffing wheel or a second chuck can be mounted in place of the grinding wheel.

The motor is of the same type that is used on the standard motor-driven grinders of this company's manufacture. It is of the squirrel-cage induction type and is capable of furnishing ½ horsepower intermittently, as in the case of ordinary polishing work. The motor is suitable for use on two or three phase sixty-cycle circuits of any voltage. The customary operating speed is 3600 revolutions per minute, but when so desired these machines are built with motors running at 1800 revolutions per minute. The motor is started or stopped by means of a switch lever, and in stopping, this lever applies a brake at the same time that it breaks the electric circuit. This automatic brake action adds greatly to the productive capacity of the machine, as it does away with the necessity of waiting for the spindle to come to a stop.

BROWN ELECTRIC PYROMETER

Fig. 1 shows an electric pyrometer for measuring temperatures up to 3300 degrees F., which has been brought out by the Brown Instrument Co., Philadelphia, Pa., and an instrument is shown in Fig. 2 with the case removed in order to give an idea of the construction of the mechanism. The distinctive features of this pyrometer are that the spindle which carries the indicating needle is mounted in jeweled

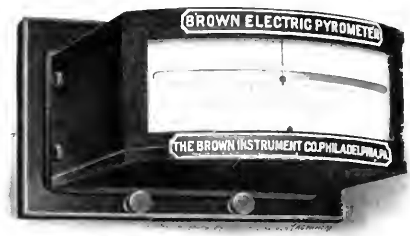


Fig. 1. High Resistance Type of Brown Electric Pyrometer

bearings and that the resistance of the instrument is made sufficiently high so that changes in the lengths of the leads running from the thermocouple to the instrument do not affect the accuracy of the indications.

The resistance of the instrument is about 100 ohms and changes of from 1 to 1000 feet in the lengths of the leads will not affect the indications as much as 5 degrees F. Changes in the temperature of the leads are also of no

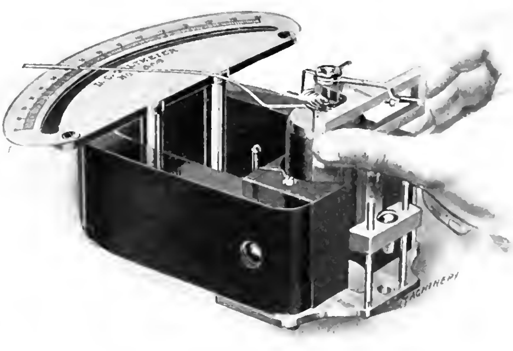


Fig. 2. Brown Pyrometer with Case removed to show the Mechanism

importance. This is due to the fact that the resistance of the instrument is very high as compared with the resistance of the leads. By having the moving element mounted in jeweled bearings, the instrument is also made more serviceable for shop use, as it is not easily damaged and does not have to be placed quite level in order to give accurate results. The scale is made of sufficient length to give the necessary interval between graduations and a mirror is provided under the scale in order to enable the needle to be lined up with its image. These two features facilitate making accurate readings.

OESTERLEIN UNIVERSAL AND PLAIN MILLING MACHINES

The universal and plain millers illustrated in Figs. 1 and 2 are representative members of a new line of milling machines which has been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio. They are known as "Ohio" milling machines and each style is built in five different sizes. One of the distinctive features of these machines lies in the fact that the heavy table and knee of the plain type of milling machine has been adapted for use on the universal machines. Practically the only difference between the plain and universal machines lies in the addition of the swivel saddle and table in the latter case. This arrangement has effected a great saving in the cost of production, as it is only necessary to provide jigs and fixtures for the manufacture of a single machine.

Universal milling machines are generally required to handle a variety of tool-room work. In order to adapt the present machines for this class of service, the construction has been worked out along lines which provide ample rigidity so that there is no vibration when taking heavy cuts on tool steel. As the ability to turn out work rapidly is proportional

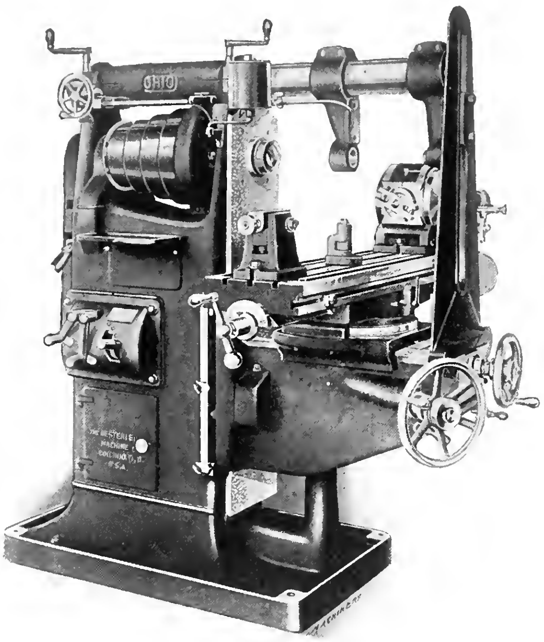


Fig. 1. Oesterlein Universal Milling Machine

to the amount of power delivered to the cutter, the provision of a cone with large belt contact, which is backed up by a construction of adequate rigidity, assures efficient operation and a high rate of output. In connection with the design of the universal machines, it may be mentioned that the swivel is clamped to the saddle in such a way that there is no possibility of movement. Oil pads and grooves are provided for lubricating the bearing surface of the swivel and table.

The plain milling machines of this line are essentially manufacturing machines. In order to make them well suited for this class of service, a number of features have been embodied in the design which add to the efficiency with which the machines operate. Among these, the belt shifting device which enables any speed to be instantly obtained is an important feature. The design of this belt shifting mechanism will be described in detail in a later paragraph, but it may be mentioned here that the method of operation is so simple that the workman will not hesitate to run his machine at the most suitable speed for the work upon which it is engaged.

Having touched upon the general characteristics of this line of milling machines and the distinctive features of the plain and universal types, a detailed description will now be given of different parts of the mechanism which are common to both the plain and universal machines. This can be conveniently done by following the course by which power is transmitted from the countershaft to the spindle and feed mechanism. Figs. 3 and 4 illustrate the arrangement of the cone-pulley and the countershaft, and clearly show the mechanism by which the belt is shifted. One complete turn of the handwheel on the machine shifts the belt from the center of one step on the cone-pulley to the center of the next step. A

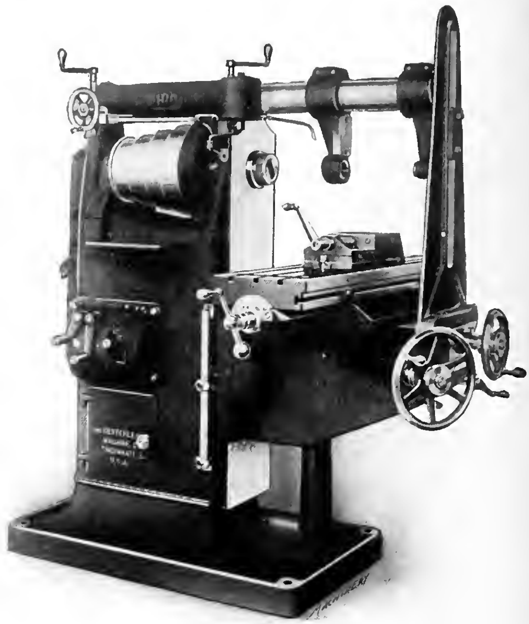


Fig. 2. Oesterlein Plain Milling Machine

simple lever equipped with a straight line motion shifts the belt to the desired position on the countershaft. By this means the required speed is obtained at once, without the necessity of making any intermediate changes. The operation of the mechanism is so simple that it is quite safe for an unskilled workman to make the change without any danger of damage to the machine. It will be noticed from the illustrations that there is but a slight difference in the diameter of adjacent steps on the cone pulley.

The spindle is made of special steel and runs in bronze journals which are lubricated by oil supplied from reservoirs

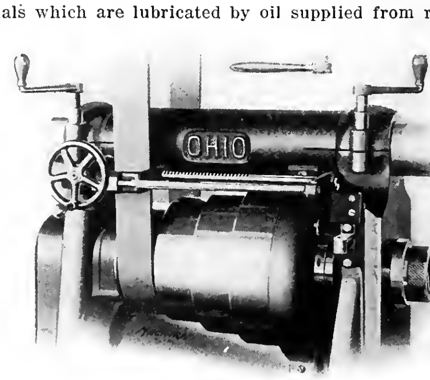


Fig. 3. Belt Shifting Mechanism on Oesterlein Millers

in the column. It will be noticed from the illustrations that the spindle nose is recessed, the purpose being to provide a positive drive for the cutter arbor. An adjustable bronze bearing 3 inches in length provides the front support for the arbor and an intermediate bracket is furnished for use when the machine is engaged upon extremely heavy cutting;

this bracket supports the arbor at a point close to the milling cutter. The back gear is mounted on a shaft inside the column of the machine. The gears are all cut with single-purpose, 14½-degree cutters which assures silent operation under all conditions.

The feed mechanism is driven from the spindle by means of a Diamond steel chain, the interior of the feed box being shown in Fig. 5. All gears and shafts in this box are of hardened steel and the shafts run in bronze bearings. The gears run in oil so that ample lubrication is assured. Two gears are keyed to the sprocket shaft and either of these gears can be engaged with the tumbler shaft. From this shaft, the drive is across the cone of gears to either sliding gear on the rear shaft, from which power is transmitted to the reverse gears in the knee by means of a universal joint. At this point, all of the feeds may be reversed by a lever on the front of the knee. The feed is carried from the knee through the saddle to the lead-screw.

A detailed view of the table and knee is shown in Fig. 6, from which it will be seen that the table has a bearing across

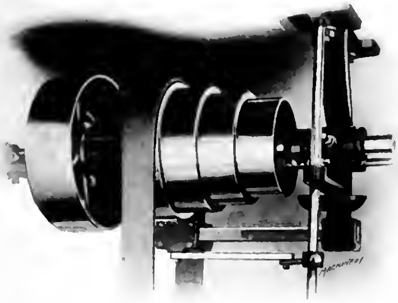


Fig. 4. Countershaft and Belt Shifter for Oesterlein Millers

its entire width. Ball bearings take the thrust of the table and means are provided for taking up any wear which may be developed in the table bearings. The table is supported by an exceptionally rigid saddle and knee, and as the construction is identical for both the plain and universal milling machines, the dividing head may be attached to either type of machine without disturbing the quick return mechanism.

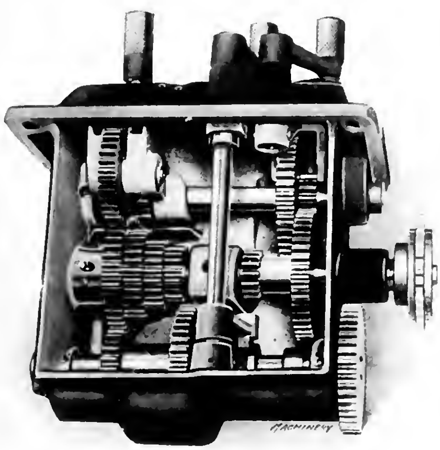


Fig. 5. Feed Box used on the Oesterlein Millers

Cross and vertical adjustments are made by means of handwheels that may be disengaged by means of clutch collars at the front of the wheels, so that the settings cannot be disturbed. Dials reading to 0.001 inch provide for accurate settings of the table and saddle. The knee is of heavy box section and stoutly ribbed to give adequate support to the table. When a setting is made, the knee may be locked to the column by means of a sliding taper gib which extends the entire length of the knee and is controlled from the front of the machine. The entire length and width of the table is used as a working surface.

The spiral dividing centers used on these machines are carefully tested before leaving the factory so that their accuracy is assured. The index crank is mounted directly on the worm-shaft instead of being connected by gearing. Without the use of tools, the spindle may be instantly freed so that it may be revolved by hand for direct indexing, the spacing being read by graduations on the flange of the spindle nose.

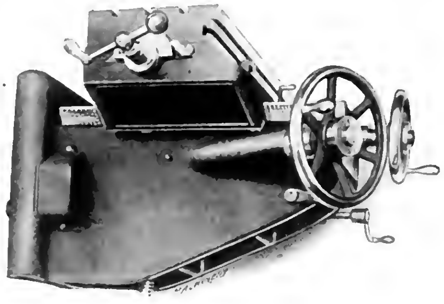


Fig. 6. Knee and Table of the Oesterlein Millers

PEDRICK PORTABLE TURNING MACHINE

The illustrations show several applications of a portable turning machine which has recently been placed on the market by the Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa. This machine may be used for a variety of purposes, among which turning crankpins of locomotives and other side crank engines; turning center crankpins, journals, shafts and axles, and reboring crankpin holes may be mentioned. In most cases, it is not necessary to remove a crankshaft or other piece from its regular position on an engine, in order to true it up on this machine.

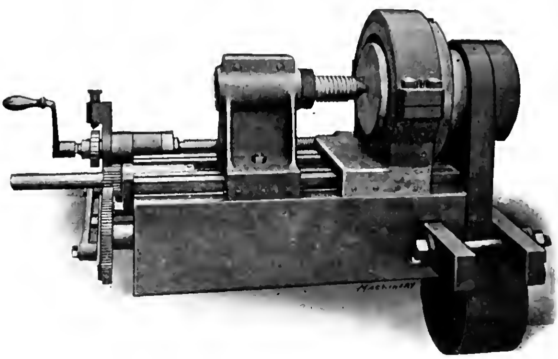


Fig. 1. Pedrick Machine set up for truing a Side Crankpin

Space is provided at the front end of the machine for clamping bars and other means of attachment to the work. The feed-screw is located at the back of the machine and is actuated by a ratchet and pawl mechanism of simple design. Variable and reversible automatic feeds are obtained. The crankshaft shown in the illustration provides for quick return of the cutter-slide and is also used for setting the tool against the work. The driving shaft is located beneath the cutter-head, where it is supported by bearings of ample dimensions. This position of the shaft permits a lighter construction to be used than would otherwise be possible and also adds to the convenience with which the drive may be taken from a motor mounted on a bracket attached to the frame of the machine.

The cutter-head is split to enable it to be put over the shaft or other member that is to be trued up while in position on a machine. The design of the cutter-head has been worked out in such a way that the split construction does not weaken it. The tailstock may be located at any point

along the bed to meet the requirements of different classes of work. When using the machine for reboring crankpin holes, the tailstock is placed in front of the cutter-head, in which position it affords a rigid guide for the boring-bar. The setting-heads are bored concentric with the center of the machine and are provided with set-screws by which the machine can be attached to an unworn part or set according to the center in the tailstock to secure the desired alignment. In cases where the work extends over the driving shaft so that a pulley cannot be used, the machine may be driven by a telescopic shaft with universal joints.

Five typical operations performed on this machine are shown in the accompanying illustrations. Fig. 1 shows the ordinary equipment used for truing up a side crankpin in its regular position. In this case, the movable tailstock with its adjustable center is placed in position, the adjustment of the tailstock adapting the machine for work of different lengths. Fig. 2 illustrates the machine set up for reboring crankpin holes after the crankpin has been removed. It will be seen that the tailstock is placed in front of the cutter-head. In this case, the cutter-head is only used to drive and feed the boring bar which is supported by the tailstock.

Fig. 3 shows the equipment used for truing up center crankpins. For this purpose, the mechanic lays off and drills centering holes for the pin on the outside of the cheeks of

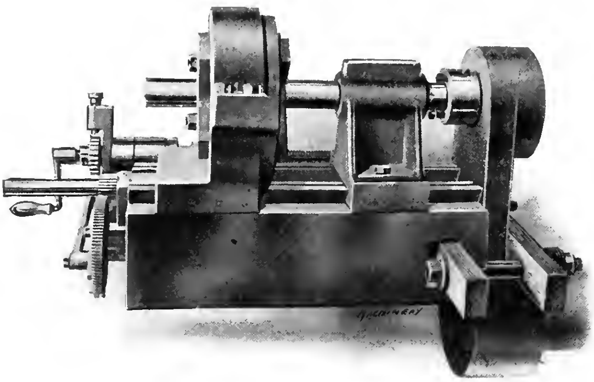


Fig. 2. Reboring Crankpin Hole on Pedrick Machine

the crank. The machine is then set up with two tailstocks which engage in these centering holes. Cutting tools can be used on either side of the cutter-head and where the distance between the cheeks is small, the cut may be started at the middle of the pin and run over to one side. The tools are then placed on the opposite side of the cutter-head and run across to the other cheek of the crankshaft.

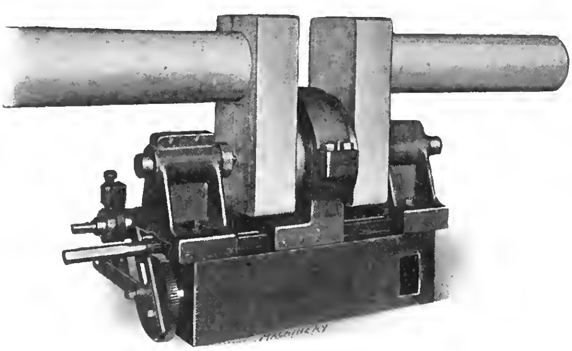


Fig. 3. Truing up a Center Crankpin

Fig. 4 shows the application of the machine for truing up large shafts, axles and similar parts. For this purpose, it will be seen that the machine is equipped with two setting-heads and a cutter-head. These three parts are all split so that they may be placed around the shaft regardless of any obstructions at either end. The machine may be fitted to the work by set-screws in the setting-heads or by making two sleeves with outside diameters the same as the diameter of the setting-heads and inside diameters the same as the shaft which is to be turned. In case the latter method is used, the sleeves are split and placed around the shaft, after which the machine is set up in the usual way. The setting-heads are bored concentric with the machine, thus providing the necessary alignment.

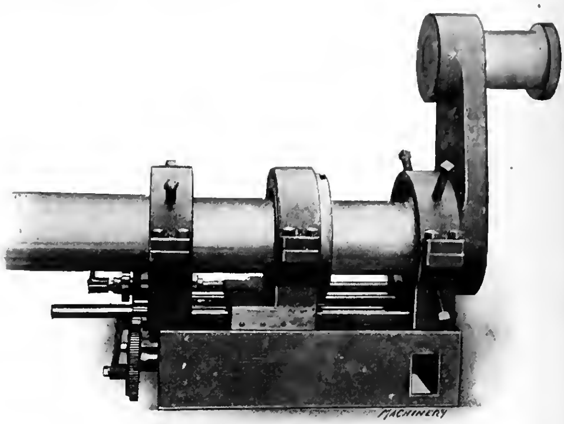


Fig. 4. Truing up a Large Shaft

Fig. 5 shows the arrangement employed for truing up the main bearing of an engine crankshaft or similar part. By referring to this illustration, it will be seen that the obstruction at either end of the shaft did not prevent the machine being used, due to the fact that setting- and cutter-heads are not slipped over the shaft, but placed around it. In some cases the machine will be worked upside down when there is not sufficient room for the bed of the machine between the pedestal and the crank-cheek or for similar reasons. This does not affect the accuracy of the work which is produced.

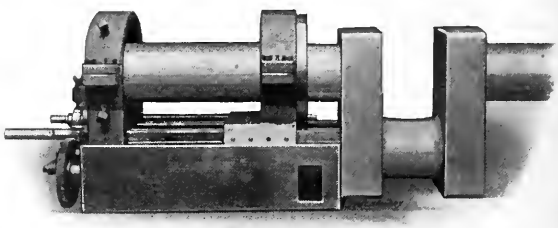


Fig. 5. Truing the Bearings of an Engine Crank

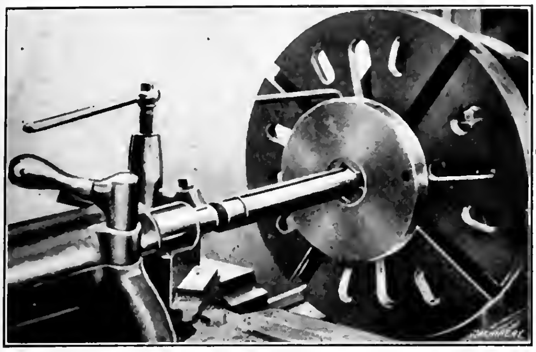
A study of the illustrations will doubtless suggest a variety of other purposes for which this machine is suitable, the illustrations merely showing a few typical operations for which it is adapted.

ONEIDA NATIONAL SAFETY LATHE DOG

The Oneida National Chuck Co., Oneida, N. Y., is now manufacturing the safety lathe dog illustrated herewith. This dog has been designed with the view of guarding all projecting parts, so that it is impossible for the operator's clothing to be caught or for him to be struck by set-screws, etc. This dog is made with hardened steel jaws which are tightened on the work by means of hardened steel adjusting screws. Two springs provide for opening the jaws when the screws are released.

The entire mechanism is enclosed in a pressed steel case, the construction being clearly shown in the illustration. This case is screwed onto the body of the dog and holes are provided through which the adjusting screws can be manipulated. These holes are large enough to admit the adjusting wrench but are not large enough to pass the screws, so that it is impossible for them to project through the cover. The driver is protected at the rear of the dog.

Two holes are provided through which the guard can be bolted to the lathe faceplate. This saves the time that would be lost in changing when duplicate parts are being machined, as the dog is held in a central position ready to receive successive pieces. This arrangement is the means of effecting

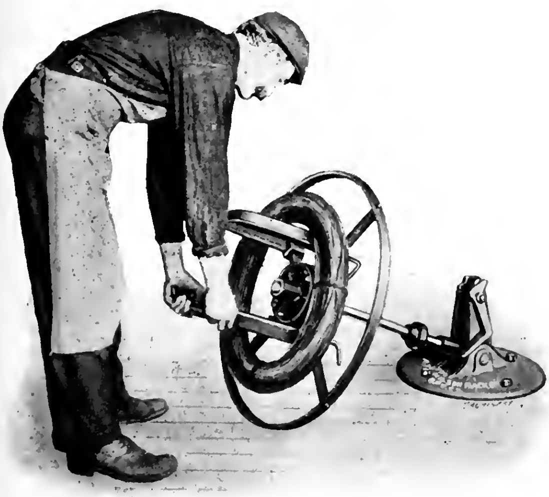


Oneida Safety Lathe Dog showing use of Wrench to tighten Jaws

a material saving of time in the production of repetition work. The assurance of safety afforded by this dog also adds to the normal rate of production of a workman as he is not kept on the "lookout" to prevent being injured.

NILSON TILTING WIRE REEL

In using the ordinary type of wire reel in connection with wire-forming machines and presses, it is difficult to place heavy coils of wire on the coil-holder. This is due to the fact that the coil-holder is fixed in a horizontal plane and at a distance of two or three feet from the floor. In order to place a heavy coil of wire on the reel two men are generally required to lift it into the required position.

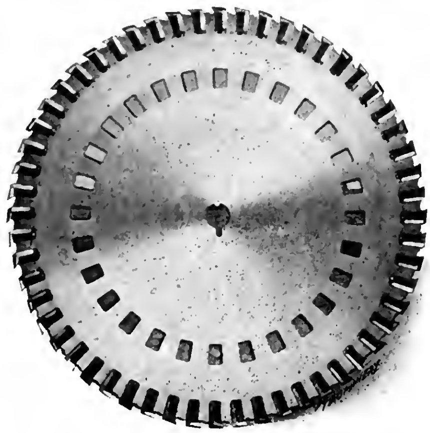


Nilson Wire Reel which facilitates placing Coils of Wire in Position

The A. H. Nilson Machine Co., Bridgeport, Conn., has brought out a reel which is designed to avoid these difficulties. Referring to the illustration, it will be seen that the standard which carries the reel is constructed in such a way that it can be tilted over to enable a coil of wire to be slipped onto the reel. When the reel is tilted over in this way, the coil can be rolled along the floor and put in place on the reel without requiring the services of more than one man. The illustration shows the reel on which a coil of wire has been mounted and the workman is about to lift it back into the operating position. When the reel is brought back to the vertical position it is automatically locked, and is thus ready for use. In order to tilt the reel over to put a new coil in place, the locking mechanism is released by means of a treadle which will be seen at the side of the machine close to the base.

HUNTER INSERTED TOOTH SAW BLADE

The Hunter Saw & Machine Co., Pittsburg, Pa., has recently brought out an inserted tooth saw blade suitable for use on sprocket-driven machines such as the Higley, Lea Simplex, and Lea-Courtenay machines. Heretofore this type of blade has not been adopted for use on sprocket-driven machines, owing to the fact that the teeth were so far apart that the operation of the machine was "jerky" when cutting the smaller sections. It was also considered impracticable to make a blade thick enough to withstand the strain at the sprocket holes and still operate without requiring the power of the machine to be increased. These objections have been overcome in the present design of blade, which has an ample number of teeth to insure smooth operation and is made



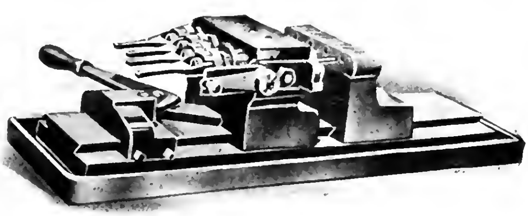
Hunter Inserted Tooth Saw Blade for Sprocket Drive Machines

thin enough so that the power required to drive the saw is not abnormal.

The body of the saw is made of heat-treated vanadium steel quenched in oil. This greatly reduces any chance of the tool pockets spreading or of the sprocket holes becoming distorted. The saw teeth are made of high-speed steel. A tool steel wedge is placed at the back of each tooth to hold it securely in place, and a brass screw is fitted in the body of the saw beneath each tooth to provide for regulating the height of the teeth. These saw blades are suitable for cutting structural steel, forgings, steel castings and a variety of other classes of work.

BICKFORD TAP FLUTING ATTACHMENT

The illustration shows a milling machine attachment for fluting machine screw taps which has been added to the line of the Bickford Machine Co., Greenfield, Mass. It will be seen that four taps are fluted simultaneously; the taps are



Bickford Milling Machine Attachment for fluting Machine Screw Taps

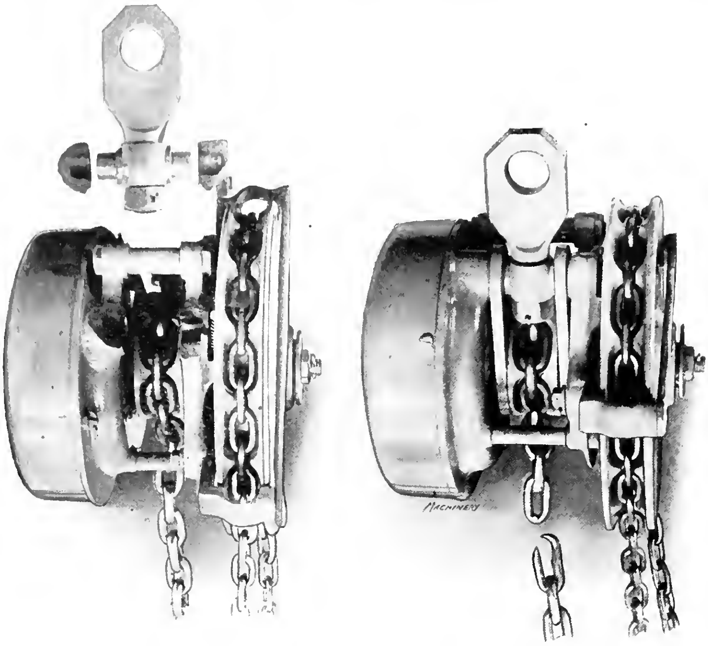
held in spring chucks with their point ends supported in bushings. The regular head center block is used and the indexing is accomplished by either a complete or a half turn of the crank.

The chucks are opened by raising the levers which are

seen projecting from the rear of the fixture. The head center block is operated by a lever after the taps are tightened in the chucks, thus bringing them into the bushings which are grooved to admit the fluting cutters. Small centers inside the spring chucks receive the end thrust. The attachment can be used on any milling machine.

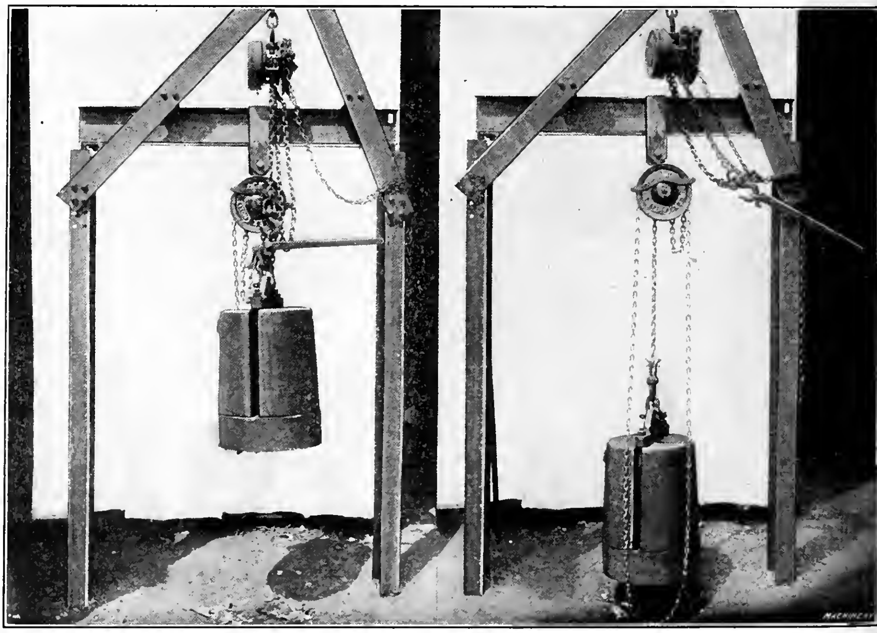
YALE TRIPLEX BLOCK

Owing to the constantly increasing tendency to speed-up the work in manufacturing plants, the need of equipment of greater strength becomes more and more urgent. When working fast, the operators are bound to exercise less care and provision must be made to avoid accidents due to the failure of the equipment.



Figs. 1 and 2. Shock Tests on Cast-iron and Steel Blocks showing Relative Strength

In order to obtain greater strength and safety in operation, the Yale & Towne Mfg. Co., 9 E. 40th St., New York City, has designed the Yale triplex hoist which is from hook to hook a line of steel. Fig. 1 shows a one-ton cast suspension block. This block was tested by raising a load of one ton on an auxiliary hoist and allowing it to drop in such a way that the shock came full upon the block. In the test illustrated, the load was dropped from a height of 16 inches and it will be seen that the cast-iron suspension member broke, although the chain is still intact. The Yale triplex block of steel construction is shown in Fig. 2. This block was tested in the manner previously described, and the one-ton load dropped from a height of 26 inches without injury to the gears and suspension plates. The only part affected was the load chain. This will withstand a drop test of 25 inches, however.



Figs. 3 and 4. Method of making the Shock Test

The method by which these tests are made is clearly illustrated in Figs. 3 and 4 where the arrangement of the auxiliary hoist and the location of the weight before and after the test are clearly shown. It will be seen that the top and bottom hooks were replaced by suspension eyes in making these tests. This is due to the fact that the hooks are designed in such a way that they start to open when subjected to a load of three times the rated capacity of the hoist. This arrangement has been adopted to constitute a safety device which will protect the equipment from damage that might be caused through careless operation.

The Yale & Towne Mfg. Co. has adopted the use of the long ton (2240 pounds) in rating hoisting equipment for two reasons. For equipment sold in the United States, ratings based upon the long ton are entirely satisfactory as such a rating merely affords a greater factor of safety. In England and several European countries, the long ton is in general use and consequently it is desirable to have equipment sold in such countries rated upon this basis. The mechanical efficiency of this hoist is such that a pull of 82 pounds by the workman is sufficient to lift 2000 pounds. In operating the hoist, 31 feet of chain are pulled through the block in order to lift the weight 1 foot.

NILSON FOUR-SLIDE WIRE FORMING MACHINE

In bringing out the new four-slide wire forming machine, the A. H. Nilson Machine Co. of Bridgeport, Conn., has incorporated a number of features new to this class of machinery. In general, the design of the machine is similar to that of other machines of this type, as will be noticed from the halftone illustration Fig. 1. By referring to Fig. 2, however, it will be seen that the distribution of the working members over the top of the frame is slightly different from the usual arrangement. The forming opening is at the center and

ll of the forming slides are of the same length or prac-
ically so. On most other machines the right-hand and ack slides are made considerably shorter owing to the act that the feed, grip and cut-off mechanisms require o much room that the slide space is thrown over to the ight and back of the machine. The slides are indicated t *A*, *B*, *C* and *D* in Fig. 2, and it will be seen that they ave long and equal bearing surfaces. They are supported ver their entire length by extensions from the bed. On each lide is cast an oil reservoir which furnishes a constant

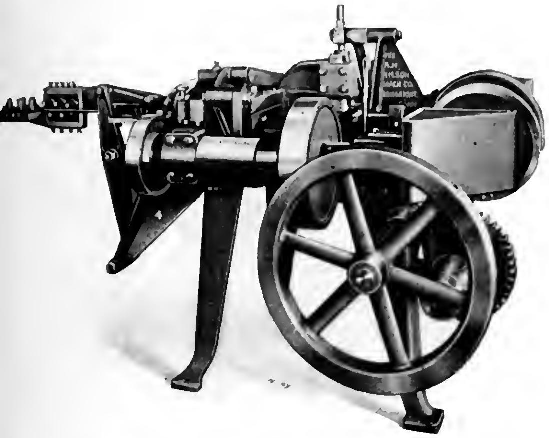


Fig. 1. Nilson Four-slide Wire Forming Machine

upply of lubricant for the cam roll studs. From Fig. 2 it vill also be seen that the forces which act upon the wire ine, namely, the feed, grip, etc., are as far as possible, n direct alignment; this is especially true of the feed it-elf. The wire line is indicated at *E*, and it will be seen hat none of the forces that act upon it are far removed from his line. The feed will be described in detail later on.

Referring to Fig. 3, which shows the plan view of this nachine, the idea of the central location of the four slides s clearly shown. As in other machines, the four cam-hafts are at the sides of the bed. The cams that operate

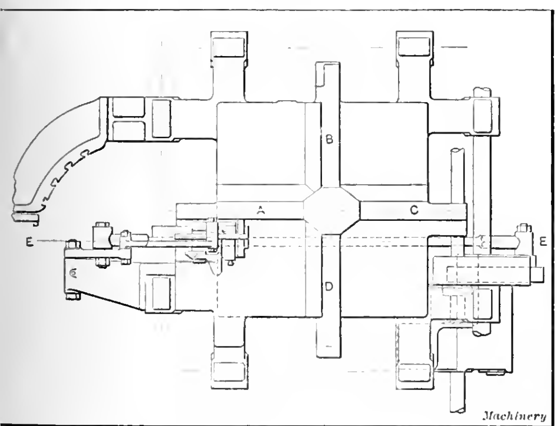


Fig. 2. Arrangement of Slides on Nilson Wire Forming Machine

the four slides of the Nilson machine are lined with tool steel plates, which give long wear and greater accuracy to the movements of the machine. The former bracket which is shown at the upper right-hand corner of the bed is particularly open in its design, being supported so that it overhangs the rear slides and does not in any way conflict with the adjustment or operation of the tools. The stripper lever, which is operated through the former, is carried on an independent bracket. Into this fits a block which holds the stripper pin. As the block is held in the yoke of the stripper lever, a better balance is secured, and the tools will operate with less vibration than with the old style of side connection. The stripper lever and bracket are illustrated in Fig. 5

The grip and feed may be seen in Fig. 3, but they are best illustrated in Fig. 4. Here the feed operating rod is shown at *A*; this is the same rod that may be seen directly beneath the wire line, extending over to the right-hand side of the machine in Fig. 2. It should be especially noticed that this rod is in direct line with the wire; the rod is operated through a geared connection with the driving wheel which is shown in Fig. 1 at the lower right-hand corner. Instead of the offset bracket which is usually employed for operating the feed on wire forming machines, the Nilson machine uses a practically straight line lever shown at *B* in Fig. 4, whereby all cramping action of the old-time feed movement is eliminated. From this lever the force is transmitted to the

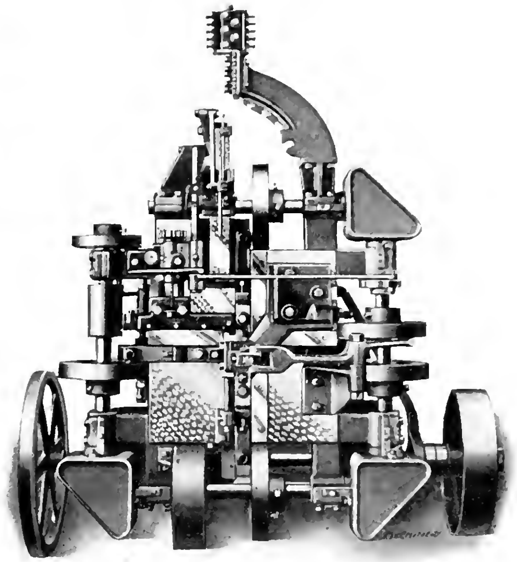


Fig. 3. Plan View of Wire Forming Machine

smaller lever *C*, which operates directly upon the wire-feeding mechanism. The feed finger *D* may be thrown out of engagement with the wire at any time by simply operating the spindle *E*, which is in an accessible position near the front of the machine. This feature of disengaging the wire feed with a plunger is quite novel. Upon the cut-off bracket is mounted the gripping lever that may be seen extending over to the rear cam-shaft of the machine. The cam on this shaft operates the gripping mechanism in the usual manner. The cut-off adjustment is secured in a very satisfactory way by means of a handwheel, which may be seen at the left of

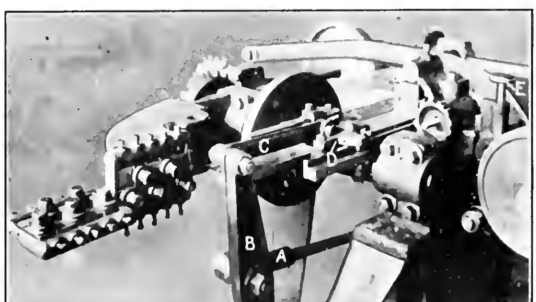


Fig. 4. View of Gripping and Feed Mechanism

the bracket. This handwheel operates the screw so that a very close adjustment of the feed may be obtained without resorting to guesswork.

Another interesting feature is the lever by which the cut-off blade is operated. Cut-off movements on wire forming machines have usually been unsatisfactory because the action

given to the cut-off blade has not been in line with the action of the tool. The cut-off must necessarily be above the line of the cam-shaft. This means that a bent cut-off slide and inefficient movement had to be used. The cut-off mechanism of the Nilson machine is clearly shown in Fig. 6. Here the cut-off slide is shown at *A*, and the operating cam at *B*. The operating cam, however, does not act directly on the cut-off slide, but its motion is transmitted to the arm *C*, which receives the motion at its lower end and transmits it from a point about half way up, to the end of the cut-off slide. The cut-off slide is brought back after its operation by means of the arm *D* which is operated from the opposite side of the cut-off cam. This arm serves as a confining member, making the lever *C* positive in its action. The cut-off slide is kept in contact with lever *C* by means of a stiff spiral spring. These machines are built in seven standard sizes, which form wire from 1/32 inch to ½ inch in diameter, and have a capacity for wire lengths from 4½ to 22 inches.

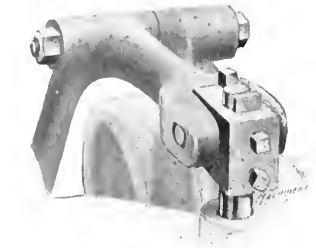


Fig. 5. Detail of Stripper Lever and Bracket

GARRIGUS NO. 2 HAND MILLING MACHINE

The illustrations show a machine known as the No. 2 Bristol miller which has recently been placed on the market by the C. G. Garrigus Machine Co., Bristol, Conn. This machine is adapted for a variety of milling operations on small work, among which may be mentioned: hobbing worm-wheels, profiling, cam cutting and keyseating. Such work is conveniently handled on a hand milling machine and the provision of both lever and crank feed on the present machine adds to its convenience of operation.

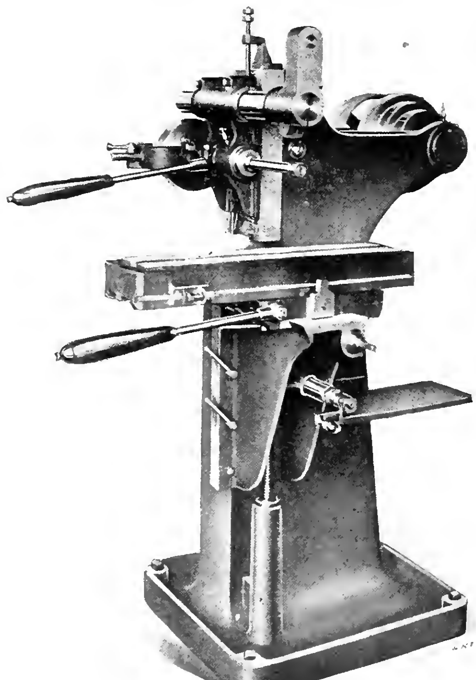


Fig. 1. Garrigus No. 2 Hand Milling Machine

The following gives a brief outline of the features of the design of this machine. The spindle has double tapers at each end, and adjustment for wear is made by means of check-nuts which are capable of compensating for any amount of wear which the machine may develop. The spindle bearing is bronze-bushed and a reservoir which holds one-half pint of oil is located at the center of the bushing, thus insuring adequate lubrication. The geared head on the spindle provides ample power for the heaviest cuts that a machine of this size will be called upon to handle. The cone pulley back-shaft is fitted with New Departure double-row combined radial and thrust bearings. The machine is furnished either with or without power feed.

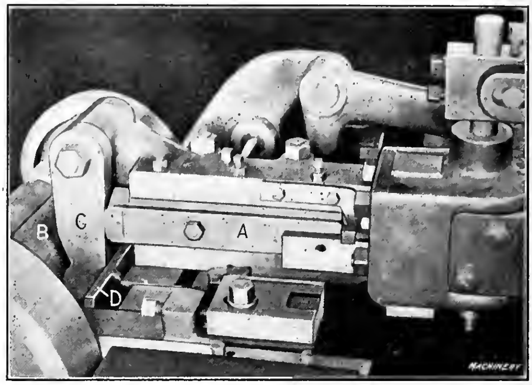


Fig. 6. Cut-off Mechanism of Nilson Wire Forming Machine

The distance from the center of the spindle to the under side of the arm is 3⅞ inches, and the distance from the end of the spindle to the center in the arm is 12 inches. The spindle has either No. 9 B. & S. taper or No. 3 Morse taper. There are six changes of spindle speed. The maximum lever feed is 6 inches and the maximum crank feed is 18 inches. The table is 7 by 25 inches in size and has one T-slot ⅝ inch wide. The maximum distance from the top of the table to the center of the spindle is 17 inches. The transverse movement of the table is 6½ inches. The machine

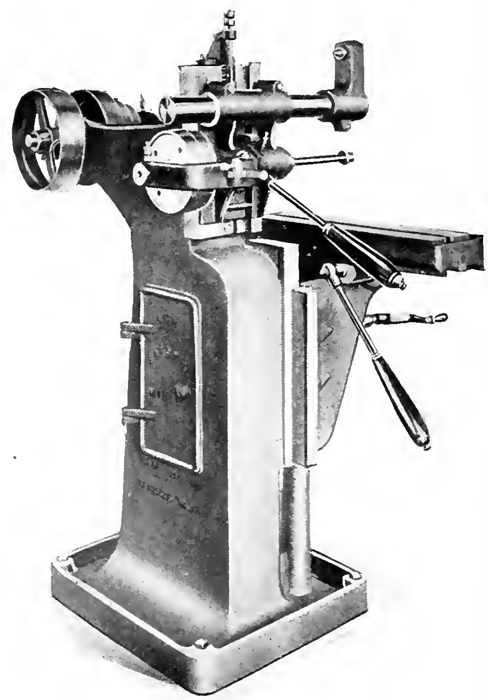


Fig. 2. Rear View of Garrigus Miller showing Arrangement of Drive

occupies a floor space of 30 by 46 inches and weighs 1112 pounds.

CINCINNATI GEAR CUTTER GRINDER

The illustrations show front and rear views of a gear cutter grinder for formed cutters which is a recent product of

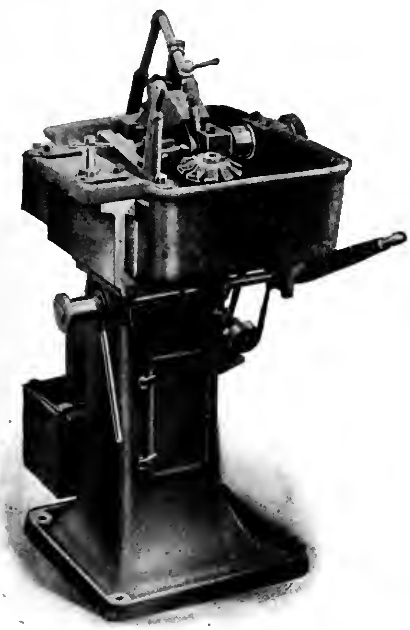


Fig. 1. Front View of Cincinnati Gear Cutter Grinder

the Cincinnati Gear Cutting Machine Co., Elam St. and Garrard Ave., Cincinnati, Ohio. It is a well-known fact that formed cutters for cutting gear teeth must be ground so that the axis of the cutter lies in the plane of each of the tooth faces, and it is to provide for grinding these radial faces of the teeth that this machine has been designed. The principal claims made for the construction are simplicity and the fact that the work-slide is located outside of the pan so that it is not exposed to damage from water and grit.

Adjustments are provided for centering the work with the wheel, and for regulating the position of the work-slide, cutter diameter, depth to which the tooth is ground, thickness of the cut, inclination of the cutter, and to provide for feeding the cutter to the grinding wheel. Indexing is done by means of a pawl which bears against the heel of the cutter. The following advantages are claimed for this method of indexing. It is not complicated, can be rapidly effected, it is not necessary to secure the cutter to its arbor by means of clamping nuts and consequently the cutter can be instantly removed for gaging or inspection, and inaccuracies in the cutters due to hardening or other causes may be corrected.

The work-spindle is hardened and ground and runs in bronze bushings that are carefully protected from grit and provided with means of adjusting for wear. The work-slide has a long bearing on the pan of the machine and is provided with a taper gib for taking up wear. The machine is equipped with a wheel truing device for keeping the grinding face of the wheel accurate. Water is supplied to the wheel by means of a centrifugal pump, which draws the water from a reservoir to which it is delivered from the settling tank, where emery dust and grindings are removed.

The machine is driven from a countershaft which has tight and loose pulleys 8 inches in diameter by 2¼ inches face, the countershaft being driven at 350 R. P. M. The machine occupies a floor space of 31 inches by 41 inches and the total weight of the machine and countershaft is 1200 pounds. The

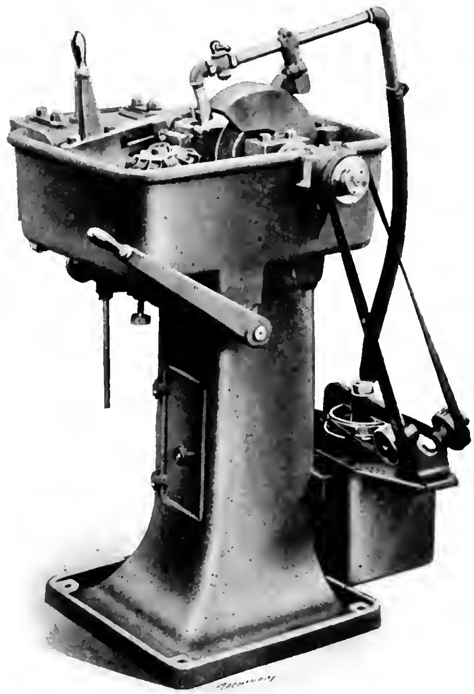
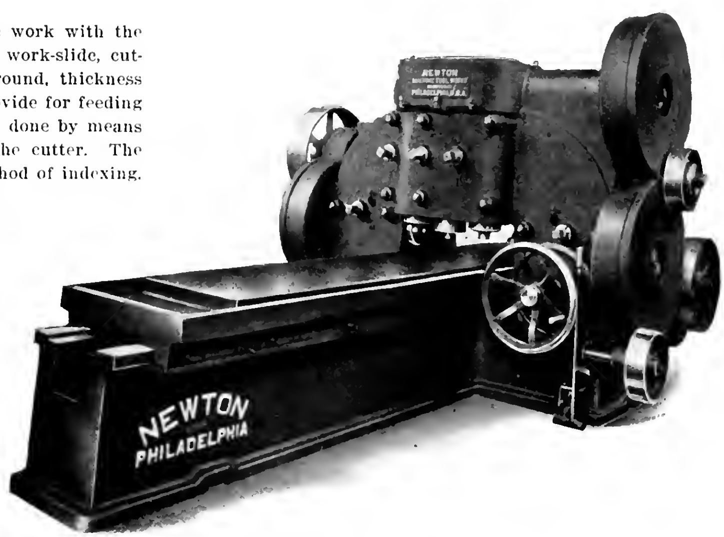


Fig. 2. Rear View of Cincinnati Gear Cutter Grinder

capacity is for cutters up to 10 inches in diameter and 1 diametral pitch.

NEWTON FIVE-SPINDLE MILLING MACHINE

The illustration shows a five-spindle milling machine which has been added to the line of the Newton Machine Tool



Newton Five-spindle Milling Machine

Works, Inc., Philadelphia, Pa. The machine is of simple design and has a powerful drive for the spindles which insures a high rate of output at a low maintenance cost. The drive for all of the spindles is taken from a single pulley

which is mounted on a shaft extending through the machine. The right- and left-hand spindles are driven from this shaft by means of spur gears, while the three vertical spindles are driven by spiral gears. Each of the spindles has a double taper bearing in its sleeve, and hand adjustments are provided for each of these sleeves which are held in position by means of binding bolts.

The work table is provided with an angular rack and spiral gear drive. Only one change of gear feed is available at any time, but additional changes can be made by using different gears. The table is 24 inches wide and long enough to provide for milling work 12 feet in length. The machine has a capacity for handling work 24 inches in width by 4½ inches high and uses milling cutters up to 5 inches in diameter. The feed is taken from the end of the main driving shaft and motion for the quick return is taken direct from the countershaft to the pulley which drives the quick-return mechanism. Hand adjustment of the table is provided and the engagement of the feed and fast power traverse is controlled by a single lever.

The weight of the machine is 22,000 pounds. While such a powerful machine may appear unnecessary for the light work for which it is intended, experience has shown that more accurate work and heavier feeds are possible on such a machine and that this justifies the additional expenditure for heavy equipment.

ROCKFORD TWENTY-INCH DRILL

The illustrations show the right- and left-hand sides of a new 20-inch vertical drill press which has been added to the line of the Rockford Drilling Machine Co., Rockford, Ill. The distinctive features of this machine are briefly described by the following: It will be seen that a star feed handle is used in place of the lever which was previously applied to the machines of this company's manufacture. This handle consists of a central clutch member, which, when thrown into the outer position, acts directly on the cross spindle to provide a quick approach or return of the tool. When thrown into the inner position, a gear is engaged which operates with a train of four reduction gears to provide a slow movement for heavy drilling or facing operations.

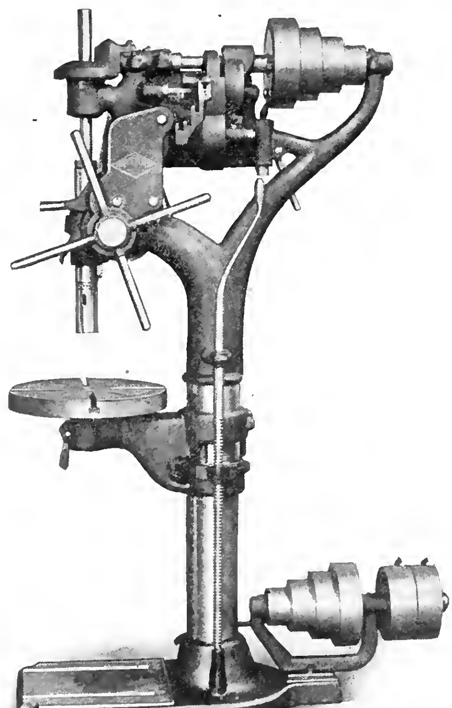


Fig. 1. Right-hand Side of Rockford Drill showing Star Feed Handle

Another distinctive feature consists of the dial which acts as a trip for the power feed. This dial is graduated to correspond with graduations on the sleeve and a small trip dog is mounted on it, which can be readily moved to any desired position, where it is secured by means of a thumbscrew. When the required depth of drilling is reached this trip engages a roll shown on the yoke casting in Fig. 2 and throws it upward, thereby disengaging the power feed. It will be seen that all gears are thoroughly incased. The worm-wheel is guarded from beneath and this guard forms a well for holding lubricating oil.

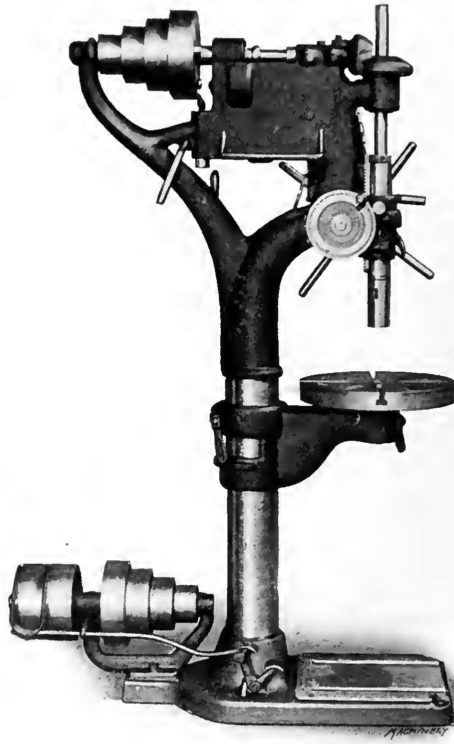


Fig. 2. Left-hand Side of Rockford Drill showing Dial Feed Trip

NEW MACHINERY AND TOOLS NOTES

Traveling Crane Trolley: Shaw Electric Crane Co., Muskegon, Mich. A traveling crane trolley particularly adapted for steel mill service. The trolley is constructed entirely of steel.

Releasing Chuck: Manufacturers' Equipment Co., Chicago, Ill. A releasing chuck designed to hold threaded pieces. This chuck eliminates the necessity of stopping or reversing the machine in chucking or removing the work.

Hand Drill: Millers Falls Mfg. Co., 28 Warren St., New York City. A two-speed hand drill with gear ratios of 1½ to 1 and 4 to 1. The change of speed is made instantaneously by means of a clutch mechanism on the drill.

Pillar Crane: Production Engineering Co., Philadelphia, Pa. A crane designed to be carried by one of the pillars in an industrial plant. The arm can be swung in a complete circle around the pillar. The crane is equipped with a chain-block hoist and is adapted for all classes of light lifting.

Center Grinder: Paul Spiegel, 234 E. 117th St., New York City. A lathe center grinder consisting of a swinging bracket attached to the front of the head. The grinder spindle is driven by a friction wheel engaging with one of the steps of the cone pulley, the speed being increased through suitable gearing.

Pneumatic Hammer: Chicago Pneumatic Tool Co., Chicago, Ill. A pneumatic riveting hammer equipped with a safety device. This device consists of a knurled nosepiece screwed over the end of the cylinder. The cup end of the rivet set projects through an opening in the nosepiece, which holds the rivet set in place.

Vertical Miller: Becker Milling Machine Co., Hyde Park, Mass. A vertical milling machine in which the movement of the head is controlled by a worm and worm-wheel, an automatic stop being provided for throwing out the feed. A quick hand return is also provided, and the depth of cut is accurately determined by means of a micrometer gage.

Boring Mill: H. Bickford & Co., Lakeport, N. H. A seven-foot motor-driven boring mill equipped with a ten-horsepower variable-speed motor. The machine is driven direct through a gear-box, which, in conjunction with the variable-speed motor, gives thirty-six table speeds. Work 84 inches in diameter by 48 inches high can be handled.

Forming Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A hydraulic press for forming articles out of sheet metal. This press has three cylinders, the middle cylinder operating the blank-holder while the cylinders at each side operate the forming platen. The press has a capacity for pressures up to 68 tons and will handle work up to 38 by 38 inches in size.

Coupler Shear and Riveter: Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic car-coupler shear and riveter in which the cylinder is an integral part of the body of the machine. The main casting is pivoted to a stand on its back face, instead of being bolted to the stand from the bottom. This permits the casting to be swung around to meet the requirements of different classes of work.

Combination Lathe and Grinder: Cincinnati Precision Lathe Co., Cincinnati, Ohio. This company has modified the design of its friction head bench lathes to adapt them for cutter grinding. When engaged on cutter grinding operations, the tooth-rest bracket is bolted to the swivel head or to the bed of the machine, according to the requirements of different classes of work. The grinding wheel is mounted on the tool-slide in the usual way.

Horizontal Miller: Becker Milling Machine Co., Hyde Park, Mass. A horizontal milling machine driven by a constant-speed pulley which adapts the machine for belting direct to the lineshaft. The gear-box is placed between the constant-speed pulley and the pulley to which the spindle is belted. Twenty-one spindle speeds are available ranging from 8 to 375 revolutions per minute. The feeds are obtained through friction disks, feeds ranging from 0.003 to 0.600 inch per revolution being available.

* * *

BROACHING HEAVY BENCH VISE BODIES

The ordinary machinists' bench vise with front sliding jaw fixed on a rectangular section bar offers, in the back jaw, a first-class broaching job. A common practice has been to cast the back jaws with the rectangular opening cored as closely as possible to the required size and to fit the sliding jaw bar to it by filing. The result, of course, is considerable hand labor and more or less unsatisfactory work in many cases. The application of the broaching machine enables the vise manufacturer to cast the back jaws with smaller openings and to remove metal all around the inside of the hole with the broach. This insures perfect bearing and working surfaces free from hard scale.

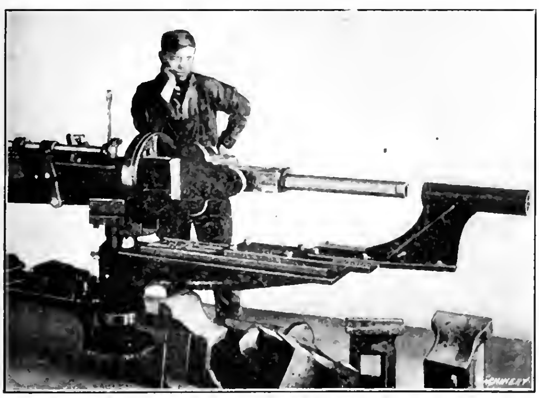


Fig. 1. J. N. Lapointe Machine broaching Heavy Vise Body

The accompanying illustration Fig. 1 shows an equipment recently furnished by the J. N. Lapointe Co., New London, Conn., to a vise manufacturer for broaching the holes in heavy vises. The chief feature of interest, aside from the general operation, is the means provided for supporting the heavy broach. The broach weighs 275 pounds and is, therefore, entirely too heavy and dangerous a tool to be lifted by hand. The necessity of handling the broach at each operation is neatly avoided. The broach is provided with a round shank at the rear, which telescopes into a supporting bracket. The bracket holds it up in line with the pulling shaft and thus eliminates the necessity of the operator's handling it. The round shank enables the broach to be turned readily to clean off the chips.

The jaw of the vise shown in the illustration weighs about 150 pounds. It is mounted for broaching with the broach in the position shown in Fig. 2, and the broach is then slipped up over the pulling shaft which projects out of the machine and is connected with the key shown lying on top. As soon as the machine begins to pull the broach through the vise jaw, the teeth come in contact with the metal all around and by the time the support shank of the broach leaves the support bracket at the rear the pressure developed is sufficient to hold the broach and vise jaw up in position. The bracket for supporting the broach is pivoted on the round column beneath the end of the machine bed, and can be swung around beside the bed out of the way when the machine is being used on lighter broaching work.

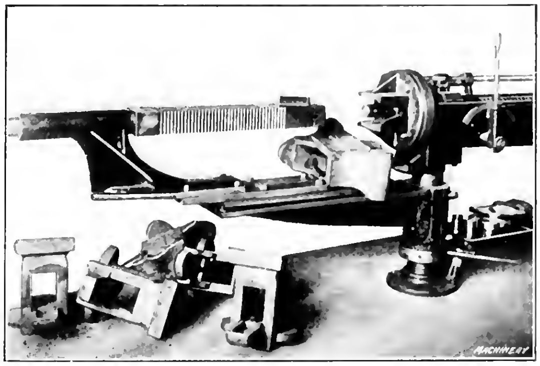


Fig. 2. Showing Heavy Broach supported on Bracket ready for placing Work in Position

This broach is believed by the makers to be the heaviest ever made and used. The time required for broaching a jaw depends, of course, on the activity of the operator, being perhaps from four to five minutes apiece.

* * *

EIGHTH ANNUAL CONVENTION OF TRADE PRESS ASSOCIATION

The eighth annual convention of the Federation of Trade Press Associations was held at the Hotel Astor, New York City, September 18-20. The program included a large number of short papers and addresses on advertising, editorial policy, circulation, publishing, etc. The object of the Federation is to bring about better business methods and a higher conception of ideals in trade paper publishing, to increase the efficiency of trade papers as advertising mediums and to raise the standards of the business generally. Friday evening, September 19, was given over to the annual banquet at the Hotel Astor which was attended by several hundred men, many of whom are prominently connected with trade paper publication.

* * *

The report of the Interstate Commerce Commission for the year ending June 30, 1912, states that the aggregate mileage of railway tracks of all kinds was 360,714.24 miles. This mileage was classified: Single track, 240,238.81; second track, 21,929.51; third track, 2511.76; fourth, fifth and sixth tracks, 1783.97; odd tracks and sidings, 91,250.19 miles. The number of locomotives in service was 61,250 of which 14,206 were classified as passenger, 36,600 as freight, 9475 as switching and 969 were unclassified.

MACHINE FOR MAKING "WELDED SEAMLESS" TUBING

Mr. Marshall B. Lloyd of the Lloyd Mfg. Co., Menominee, Mich., is the inventor of a new process for manufacturing "seamless welded" metal tubing. Front and rear views of the machine used for this purpose are shown in the accompanying illustrations; the machine is of a very compact design, only occupying a floor space of 3 by 20 feet. Double machines for producing two tubes simultaneously are also built, such machines requiring the attention of two operators.

The method by which stock is fed to the machine is clearly illustrated in Fig. 1. Either hot- or cold-rolled steel is used; the material is fed into one end of the machine and the finished tubing comes out at the other end. The operation of the machine is entirely automatic, the operations of forming, welding, straightening, sizing, polishing and cutting off being performed without any attention from the operator. The capacity of a single machine is for 4000 feet of tubing per day, regardless of the size of the tubing which is produced.

The machine is very economical in the use of stock, the only waste consisting of about 1/16 of an inch of material at

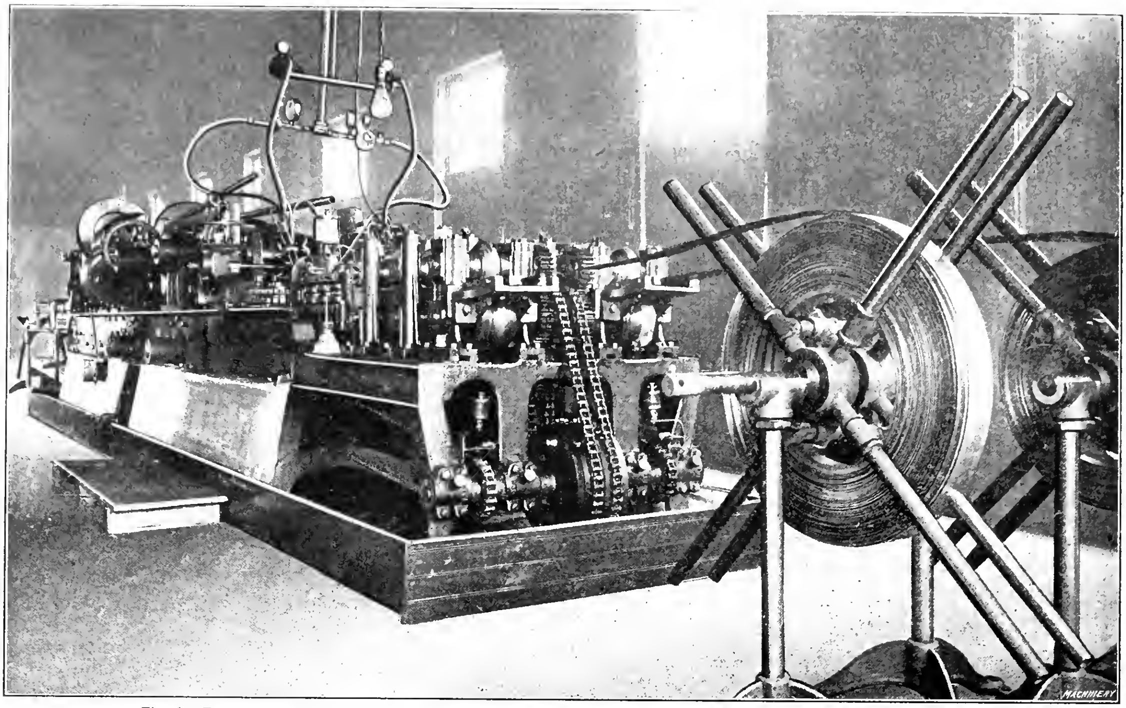


Fig. 1. Front View of Lloyd Machine for making "Welded Seamless" Tubing showing Delivery of Stock to the Machine

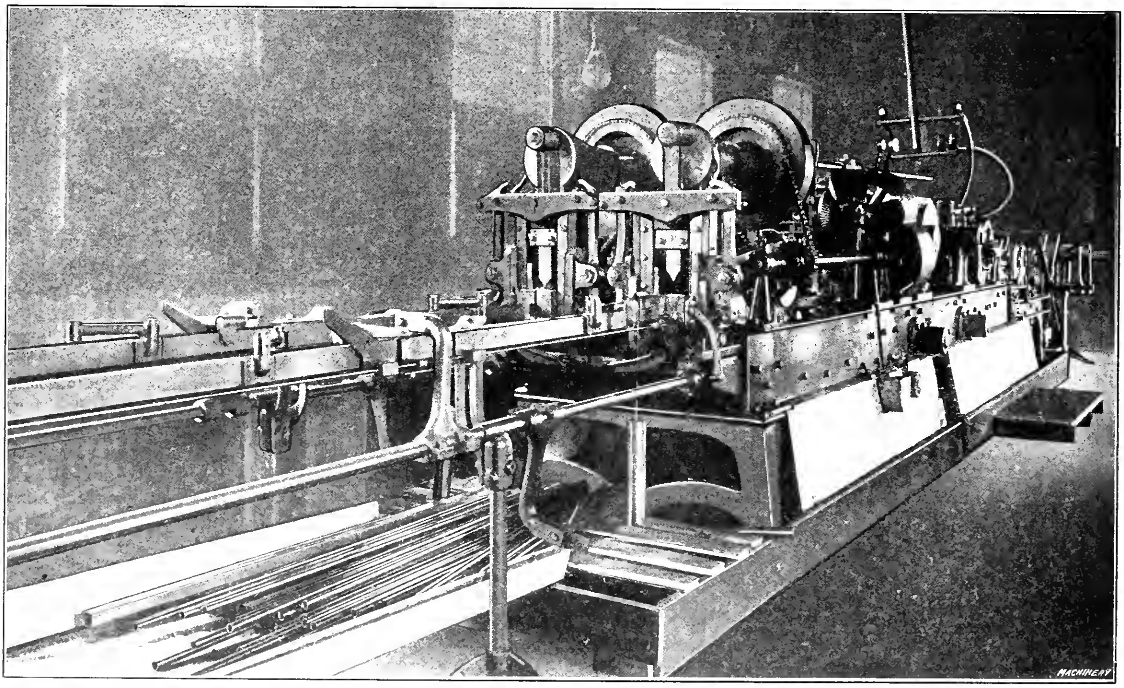


Fig. 2. Rear View of Machine for making "Welded Seamless" Tubing, showing Finished Tubes made in the Machine

each point where a finished tube is cut off. Anyone familiar with the process of manufacturing tubing will appreciate the fact that this is far more economical than other methods which are in common use. In producing drawn tubing, the thinner that the walls of the tube are required to be, the greater the expense of production, owing to the increased amount of power that is necessary during the drawing operation. With the Lloyd process, walls of a given thickness are obtained by using the proper gage of metal so that the cost of production is not affected. Practically any desired shape of tube can be made, among which may be mentioned such standard forms as oval, round, square or hexagonal. No additional expense is involved in the production of irregular shapes.

The machine has a capacity for producing tubing from one to seven inches in diameter and special machines could be built for producing larger sizes. The method of operating the machine is quite simple and consequently no extended experience in tube making is necessary in order to produce satisfactory work. The method of threading the ends of tubing produced on this machine is to build them onto the ends of the tube rather than to cut threads in the walls of the tubing. By this means, the threaded section can be made of any desired strength.

The operation of the machine may be briefly outlined as follows: The flat metal strip is drawn through a series of small rolls which form it to the required shape around a suitable mandrel of special construction. After passing through this process, the edges of the tube are close together ready for the welding operation. An autogenous welding torch is used for this purpose which joins the seam of the tube by the familiar process of fusion welding. A thin burr shows on the metal at the point where the weld was made but this defect is removed by a knife on the machine. The tube is next smoothed down with a fine emery wheel.

After these operations have been completed, the tube passes on to a powerful vise equipped with semicircular jaws. This vise has a reciprocating movement through a distance of two feet and draws the tubing through the machine at each forward movement. When the tube leaves the vise, it is sized and polished by a process of cold rolling with water. After this operation has been completed, the tube goes through the straightening device and is then cut off and dropped into a receptacle at the end of the machine. This end of the machine is clearly illustrated in Fig. 2. It is stated that the tubing produced in this way is so smooth and bright that it has the appearance of having been electroplated.

* * *

LARGEST PRECISION TESTING MACHINE

The U. S. Bureau of Standards, Washington, D. C., lately installed a testing machine for testing columns, blocks, beams, girders and other shapes of steel, iron, wood, concrete, reinforced concrete, etc. The machine measures the breaking strength, spring under load, etc. It has a capacity for specimens of any length up to 34 feet and is capable of exerting a pull of 1,150,000 pounds and a compression of 2,300,000 pounds. Although of such great capacity, the claim is made that the mechanism is so delicate that the pressure of a finger on the ram will be registered.

* * *

PERSONALS

Forrest R. Jones, formerly head of the department of machine design at the University of Wisconsin and later with Cornell University, has taken charge of the editing of data sheets known as "Lefax" published by the Standard Corporation, Philadelphia.

Otto E. Kleinert, for the past twenty-five years general foreman of the automatic and tool departments of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has resigned to become superintendent of the King Machine Co.'s works in Bridgeport, Conn.

Col. George W. Goethals, chairman of the Isthmian Canal Commission and chief engineer of the Panama Canal, has accepted the honorary presidency of the International Engineering Congress, and will preside in person over the general sessions to be held in San Francisco September 20-25, 1915.

Lawrence W. Cady, formerly electrical engineer for the Browning Engineering Co., of Cleveland, Ohio, is now engaged in consulting and designing work. Mr. Cady is a specialist on the design and application of electrically-operated machines. His address is 1557 Robinwood Ave., Lakewood, Ohio.

George L. Colburn, for the past three years assistant to Frank Burgess, proprietor and general manager of the Boston Gear Works, Norfolk Downs, Mass., is now mechanical engineer with the Holmes & Blanchard Co., builders and dealers in crushing, grinding, sifting and mixing machinery. Mr. Colburn is also associated with George Vincent Rogers, president of the company, who conducts a large factory appraisal business, established in 1893.

Axel F. Backlin, mechanical engineer with the American Steel & Wire Co., Worcester, Mass., and assistant to the late Fred H. Daniels, was tendered a farewell dinner by the Swedish Engineers' Society of which he is president, at the Bancroft Hotel, Worcester, September 26. Mr. Backlin has been transferred to the Pittsburg office of the American Steel & Wire Co., as assistant superintendent. He will act, in a sense, as master mechanic for the company.

D. De Vries, a well-known machine tool specialist, employed by R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, will visit the United States in October in the interest of his concern, which is actively engaged in selling American machine tools. Mr. De Vries has just returned from a trip to the far East, where he spent four months in Java, establishing agencies for the sale of American machine tools, and making demonstrations, etc. His work attracted favorable attention from government and railway officials. Mr. De Vries will visit the United States especially in the interest of his firm's Eastern machine tool business.

Prof. A. Riebe, director of the Riebe Kugellager und Werkzeug Fabrik, Berlin, Germany, arrived in New York, September 18, on the steamer *Imperator* to visit his American agents, Olin, Giberson & Lowy, 30 Church St. Prof. Riebe, who in conjunction with Prof. Stribeck made many original investigations into the design of radial ball bearings, will deliver several illustrated lectures while in America before the various sections of the Society of Automobile Engineers. The lecture before the metropolitan section was given on September 25, the subject being "A Review of the Inception of the Ball Bearing and Roller Bearing and their Application in the Automobile Industry."

* * *

OBITUARIES

Thurston M. Phetteplace, professor of mechanical engineering of Brown University, Providence, died at the Maine General Hospital September 7, aged thirty-six years, following an operation for carbuncle. Prof. Phetteplace was a member of the A. S. M. E. and had contributed valuable papers to its proceedings. His untimely death will be mourned by all knowing his abilities.

Howard F. Martin, general sales manager of the Eveland Engineering & Mfg. Co., Philadelphia, Pa., was killed in a railroad accident near North Haven, Conn., September 2. Mr. Martin was returning with his wife, from a vacation in Maine and she, too, was killed. Mr. Martin was forty-five years old and had been connected with the Pennsylvania Steel Co., for about fifteen years as purchasing agent and sales manager. After resigning his position as sales manager with the Pennsylvania Steel Co., which he had held for about ten years, he went with the Eveland Engineering & Mfg. Co. in a similar capacity. He was a member of several leading clubs and other organizations of Philadelphia, and was also a member of a number of steel trade organizations.

George W. Bennett, vice-president and general manager of the Willys-Overland Co., Toledo, Ohio, died September 19, aged forty-nine years. He was born in Worthing, England, and came to America at an early age. He was assistant manager of Gormully & Jeffrey Mfg. Co., of Chicago, from 1885 to 1892. In 1892 he became branch manager of the company at Washington, D. C., remaining there until 1895. From Washington he went to Brooklyn, N. Y., for the same company, leaving in 1899 to become Eastern representative of the American Bicycle Co. of New York. From 1900 to 1906 he was sales manager for the Thomas B. Jeffrey Co. of Kenosha, Wis., and in 1906 manager of the Knox Automobile Co. of Springfield, Mass. He then became Eastern representative of the White Co., remaining in this position until 1910, when he went to Toledo to join the Overland forces. Mr. Bennett was a member of many national and international organizations connected with the automobile trade, including the Automobile Board of Trade. He is survived by a widow and two sons.

Fred H. Daniels, chief engineer of the American Steel & Wire Co., Worcester, Mass., died at his home in Worcester August 31, aged sixty years. Mr. Daniels was a well-known mechanical engineer and was chairman of the board of engi-

FOR HEAVY SERVICE

What do you expect in any machine designed for heavy manufacturing service?

Above all, ample power and a consistently rigid design.

Note how well these points have been taken care of in the No. 5-B Heavy Plain Milling Machine.

Large diameter constant speed drive pulley running at high speed carries an extra wide belt. The overhead pulley is also of large diameter giving wide belt contact and powerful driving leverage. The variable feed, by means of hardened spur gears, is driven by chain direct, mounted on large diameter hardened steel shafts, firmly supported. Result—elimination of vibration, and maximum efficiency.

The knee slide extends to the top of the frame, stiffening the column and forming a massive housing for the spindle. Notice the long bearing of the knee on the column. Stout transverse ribs give rigidity for heavy service.

The table is heavy and has a vertical depth that gives the necessary stiffness to prevent springing under deep cuts. The depth of the saddle and extra long bearings in proportion to the length of the table are clearly shown.

Stout, easily adjustable braces serve to firmly lock the knee and overhanging arm together, resisting the stresses that tend to produce vibration.

If you have heavy milling, these features should interest you.

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FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a/M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I

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neers of the United States Steel Corporation. He was a graduate of Worcester Polytechnic Institute, and entered the employ of the Washburn & Moen Co. immediately after graduation as a draftsman. His skill and ability as a draftsman and designer soon won recognition and he was sent abroad several times to obtain plans and data for the development of the plant. When Charles H. Morgan retired from the company in 1887, Mr. Philip W. Moen was made superintendent and Mr. Daniels, assistant superintendent. Mr. Daniels became general superintendent after a year's service as assistant general superintendent. When the thirty big steel and wire manufacturing plants of the country were consolidated by John W. Gates in 1896 under the name of the American Steel & Wire Co., he was given the responsibility of putting a number of run-down plants in first-class condition. Mr. Daniels was the inventor of about 150 improvements in wire drawing machinery, etc.

Frank B. Rutter, second vice-president and sales manager of the Scranton Bolt & Nut Co., Scranton, Pa., was killed in a railroad wreck near North Haven, Conn., September 2, while a passenger on the Bar Harbor express which was telescoped by the White Mountain express. Mr. Rutter was forty-one years old. He was born in Lykens, Dauphin Co., Pa., and was educated in the public schools of Lebanon, Pa., from which he entered the employ of the Pennsylvania Bolt & Nut Co., now the American Iron & Steel Mfg. Co. He started as an office boy and served for a time as clerk in the rolling mills and from there was transferred to the estimating department of the general offices of the company. After working several years in that department he was chosen teller of the First National Bank of Lebanon, in which capacity he served for four years with marked ability. He left this position in 1903 to take a position as chief clerk of the accounting department of the Scranton Bolt & Nut Co., and in 1905 was promoted to president in the sales department. In 1906 he was made sales manager and in 1910 was chosen a director of the company, which position he filled with ability until his death. Mr. Rutter was a man of unusual character and ideals. He was a member of the Manufacturers' Club of New York City, the Pennsylvania Society of New York, Engineers' Society of Northeastern Pennsylvania, the Scranton Club and the Country Club of Scranton. In 1908 he married Miss Grace B. Law, daughter of A. F. Law, president of the Temple Iron Co. Mrs. Rutter also lost her life in the wreck.

SOCIETIES, SCHOOLS AND COLLEGES

University of Manchester, Manchester, England. Prospectus of University courses, session 1913-14; also illustrations of the school, laboratories, workshops, and departments for bleaching, dyeing, printing and finishing textile goods and manufacturing paper.

American Museum of Safety, 29 W. 39th St., New York City, has made a special report on lead poisoning and the report is considered of so much value by Dr. C. F. Stokes, surgeon-general of the U. S. Navy, that a lengthy abstract with illustrations will be published in the "U. S. Medical Bulletin."

Pratt Institute, Brooklyn, N. Y., will begin evening courses in mechanical drawing and machine design, October 1. Other courses offered are technical chemistry, industrial electricity, practical electricity, steam engines, strength of materials, practical mathematics, trade teaching, machine work, toolmaking, carpentry and building, patternmaking, and sheet metal work.

COMING EVENTS

October 7-10.—Convention of American Society of Municipal Improvements in Wilmington, Del. George H. McGovern, secretary, Chambers of Commerce, Wilmington, Del.

October 10-17.—Eighth annual foundry and machine exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y., last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 13-17.—Annual convention of the American Institute of Metals at Chicago, Ill. W. M. Corse, secretary, Lumen Bearing Co., Buffalo, N. Y.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 19-25.—Seventh annual convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

October 20-26.—Convention of the American Mining Congress in Horticultural Hall, Philadelphia, Pa. James F. Callbreath, secretary, Munsey Bldg., Washington, D. C.

October 22-24.—Twelfth annual convention of the National Machine Tool Builders' Association, New York City. Hotel Astor, headquarters. James H. Herron, general manager, Cleveland, Ohio.

October 28-30.—Pennsylvania Industrial Welfare and Efficiency conference in the Capitol Bldg., Harrisburg, Pa., under the auspices of the Engineers' Society of Pennsylvania, Harrisburg, Pa. In connection with the convention an engineering exhibit will be held October 27-31 in the concrete building of the Harrisburg Railway Co. containing 26,000 square feet floor space. Paul Gendell, director of exhibits, Harrisburg, Pa.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers. Headquarters Engineers Bldg., 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty one museums of safety in Europe, and all these will contribute to the American Exposition.

NEW BOOKS AND PAMPHLETS

Metallographic Testing. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 42 of the Bureau of Standards.

Standard Analyzed Samples—General Information. 12 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 25 of the Bureau of Standards.

Analyzed Irons and Steels—Methods of Analysis. 15 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 14.

Analyzed Iron and Manganese Ores—Methods of Analysis. 27 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 26.

United States Government Specification for Portland Cement. 28 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 33.

Dehydration of Clays. By G. H. Brown and E. T. Montgomery. 23 pages, 7 by 10 inches. Diagrams. Published by Department of Commerce, Bureau of Standards, Washington, D. C., as Technologic Paper No. 21.

Vitrified Brick as a Paving Material for Country Roads. By Vernon M. Peirce and Charles H. Moorefield. 34 pages, 6 by 9 inches. Illustrated. Published by the U. S. Department of Agriculture, Washington, D. C., as Bulletin No. 23.

Determination of Sulphur in Illuminating Gas. By R. S. McBride and E. R. Weaver. 46 pages, 7 by 10 inches. Illustrated. Published by Department of Commerce, Bureau of Standards, Washington, D. C., as Technologic Paper No. 20.

Typical Specifications for the Fabrication and Erection of Steel Highway Bridges. By the Office of Public Roads. 25 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Office of Public Roads, Washington, D. C., as Circular No. 100.

New Calorimetric Resistance Thermometers. By H. C. Dickinson and E. F. Mueller. 12 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as reprint No. 200 from the Bulletin of the Bureau of Standards, Vol. 9.

Note on Cold-Junction Corrections for Thermocouples. By Paul D. Foote. 13 pages, 7 by 10 inches. Diagrams. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as reprint No. 202 from the Bulletin of the Bureau of Standards, Vol. 9.

Proceedings of the First Cooperative Safety Congress. 336 pages, 6 by 9 inches. Published by the National Congress for Industrial Safety, 2135 Green St., Harrisburg, Pa. The first Safety Congress was held under the auspices of the Association of Iron and Steel Electrical Engineers in Milwaukee, Wis., September 30-October 5, 1912.

Boiler Construction. By Frank B. Kleinhans. 462 pages, 5½ by 7¾ inches. 334 illustrations and five folding plates. Published by Norman W. Henley & Son, New York City. Price $3.

The first edition of this work was published several years ago; the second revised and enlarged edition has just been published. It undoubtedly is one of the best books of the kind in print, starting with the laying out of the sheets and concluding with the completed boiler. The contents comprise laying out work, flanging and forging, punching, shearing, plate planing, bending, machining parts, boiler details, assembling and calking, finishing parts, boiler shop machinery, general tables, plates showing types of modern locomotive boilers, locomotive boiler inspection and questions and answers on boiler inspection.

The Polytechnic Engineer. Vol. XIII. 138 pages, 6 by 9 inches. Published annually by the students of the Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

The 1913 volume of this interesting annual contains the following articles: An Historical Sketch of the Early Development of Bridge Building, by Clarence W. Hudson; Thickness of Films of Silver Upon Glass, by Irving W. Fay and Arthur C. Rauchfuss; Lattice Bars, by George W. Oxley and Edward J. Squire; The Vector Diagrams of Electric Discharges, by Monroe George Woolfson; Senior Inspection Trip, by John H. Hnsing; The Diffusion of Light by Mechanical Means, by Louis A. Rosett; The Pitot Tube, by H. P. Hammond; Chinese Wood Oil, by Everitt J. Cole; Engineering Education Today in America and the Place of the Polytechnic among Colleges of Engineering, by William D. Ennis; A Resume of the Lectures of Sir William Ramsay, by Henry W. Sheff; The Predetermination of the Voltage—Regulation of Alternators, by Sampson K. Barrett.

Shop Mathematics. Part II. By Earle B. Norris and Ralph T. Craigo. 214 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., New York City. Price $1.50 net.

This work on advanced shop mathematics is a second half of the instruction papers developed and used in the University of Wisconsin. It presents the principles of algebra, geometry, trigonometry and logarithms with the intention of making them of practical value in shop work. The contents by chapter heads are: Formulas; Explanation of Terms—Algebraic Addition; Algebraic Subtraction; Transformation of Formulas; Algebraic Multiplication and Division; Solution of Simple Equations; Simultaneous Equations—Quadratic Equations; Tables and Curves; Equations of Curves; Geometric Constructions; Construction and Properties of Geometric Figures; Areas of Geometric Figures; Volumes and Surfaces of Solids; Trigonometry—the Tangent and Cotangent; Some Uses of the Tangent and Cotangent; the Sine, Cosine, Secant and Cosecant; Screw Threads and Spirals; Solution of Triangles; Logarithms; Logarithms of Decimals, Powers and Roots. The work is gotten up in excellent typographical style. The principles and problems are illustrated with good drawings, and the work as a whole is one that can be recommended to ambitious practical men generally, bent on improving their condition by home study.

Dyke's Automobile Encyclopedia. By A. L. Dyke. 557 pages, 6½ by 10 inches. Illustrated. Published by A. L. Dyke, St. Louis, Mo. Price $3.

This work is in forty parts and contains 239 charts with a dictionary and index. It treats of the construction, operation and repair of automobiles and gasoline engines in a very thorough and effective manner, covering the subjects more thoroughly probably than any other published work at the price. The titles of the subjects treated are: The Car Complete; Drives; Steering, Springs, Brakes; Axles, Differential; Clutches; Transmissions or Change Speed Gears; Gasoline Engine; Engine Parts; Valve Timing; Engine Balance, How Cylinders Fire; Explanation of the Two "Cycle" Principle; Carburetion; Self Starters; Electric Ignition—Low Tension Coil; High Tension Coil Systems; Wiring and Connections; Ignition Timing; Various Ignition Systems; Low Tension Magnetos; High Tension Magnetos; Principle and Construction of Magnetos; Magneto Wiring Diagrams; Magneto Setting and Troubles; Storage Batteries and Power Lighting; Cooling; Lubrication; Car Operation; Rules of the Road; Care of Cars; Tires; Vulcanizing; Garages and Repair Shops; Equipment, Tools and Use of Tools; Repairs and Adjustments; Digest of Troubles, Diagnosis and Remedy; Insurance, Laws; Horsepower, Tables, Measurements; Steam Cars, Air Craft; Pointers for Automobile Salesmen; Dictionary, Index.

Rules of Management. By William Lodge. 130 pages, 5 by 7½ inches. Published by McGraw-Hill Book Co., New York City. Price $2 net.

The principles of management laid down in this book are exemplified in the management of the Lodge & Shipley Machine Tool Co., of Cincinnati, Ohio, of which Mr. Lodge is president. The book is unique, being virtually a compilation of the rules and practice of the company, which is a well-known manufacturer of lathes. The contents by chapter heads are: The Exceptional Employe, The General Manager, Chief Engineer and Designer, Drawing-room, Purchasing Agent, Incoming Material and Stores Department, Superintendent of Manufacture, Routing Department, Chief Clerk, Cost and Time-keeping Department, Operation of Premium Plan, Superintendent of Assembly, Handling Complaints, Pattern Shop, Tool-making Room, Forge Department, Lathe Department, Grinding Department, Drilling Department, Planer Department, Milling Department, Gear Cutting Department, Special Manufacturing Department, Inspecting Department, Specific Instructions for Painting Lathes, Sales Manager, Shipping Clerk, Boss Laborer and Express Truckman, Millwright and Belt Man, Engineer, Electrician and Oiler, Janitors and Watchman, A Proposed Pension Plan and Basis on which a Fund can be Started. The work is one that should interest and instruct all concerned in any way with the superintendence or management of manufacturing plants and especially those connected with the building of machine tools.

NEW CATALOGUES AND CIRCULARS

Standard Tool Co., Cleveland, Ohio. Catalogue No. 21 on drill chucks.

S. E. Parker, Chicago, Ill. Catalogue No. 26 on hoisting machinery.

Yale & Towne Mfg. Co., 9 E. 40th St., New York City. Leaflet on the Yale all-steel triplex block.

Asbestos Protected Metal Co., Beaver Falls, Pa. Bulletin No. 53 on asbestos steel for roofs and walls.

Whitman & Barnes Mfg. Co., Akron, Ohio. Folder on "W. & B" screw and drop-forged wrenches.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 148 on hand drills and portable air compressors.

Cling Surface Co., 1018 Niagara St. Buffalo, N. Y. Report of comparative tests of belts with and without "Cling Surface."

Brown Instrument Co., Philadelphia, Pa. Bulletin containing a large number of testimonial letters received from users of Brown electric pyrometers.

George G. Dana, 2311 Washington Ave., Racine, Wis. Circular of the Dana duplex spring clips for holding drawings, tracings, blueprints and similar materials.

American Museum of Safety, 29 W. 39th St., New York City. Pamphlet on safety including the conditions of competition for the E. H. Harriman memorial gold medal, etc.

Millers Falls Co., 28 Warren St., New York City and Millers Falls, Mass. Circulars of "Star" hacksaw frames, sill borer or joist tools, hand and breast drills, chain drills, etc.

Kennicott Co., Chicago Heights, Ill. Little Journey to the Kennicott Co., by Elbert Hubbard, describing the ideals, aims and business of the concern, and written in characteristic Hubbard style.

Green, Tweed & Co., 109 Duane St., New York City. Booklet illustrating a number of large, well-known buildings in New York City whose engine rooms are fitted with "Rochester" automatic lubricators.

Quigley Furnace & Foundry Co., 25 Church St., New York City. Bulletin No. 2 on the continuous revolving shelf or reel type core ovens, burning coal, coke, oil or gas fuel, for baking small and medium size cores.

C. G. Garrigus Machine Co., Bristol, Conn. Circular of No. 2 Bristol hand milling machines, a machine especially adapted for keyseating, hobbing worm gears, profiling, cam cutting, and other characteristic hand milling machine work.

F. W. King Optical Co., Cleveland, Ohio. Circular on the King "I-Safe" goggle for workmen in shops, mills and factories. Special forms with colored glass are offered for open-hearth steel workers, oxy-acetylene welders, etc.

Skinner Chuck Co., New Britain, Conn. Catalogue and price list of independent, universal and combination lathe chucks, drill chucks, planer chucks, faceplate jaws, drill press vises, reamer stands, precision drawing-in chucks, etc.

Edge Moor Iron Co., Edge Moor, Del. Bulletin 51, entitled "Tests of a Steam Boiler at High Rates of Evaporation," describing tests made at the Westport generating station of the Consolidated Gas Electric Light & Power Co., of Baltimore.

Fosdick Machine Tool Co., Cincinnati, Ohio. Circular illustrating and describing heavy-duty type of round column radial drill, being the first of a complete line of round column radial drills which will be added to the company's regular line of box column radials.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin D-9 and DA-10, superseding D-8 and D-9, respectively on "Standard" high-power direct-current portable electric drills and "Standard" high-power two- and three-phase alternating-current portable electric drills.

Diamond Machine Co., Providence, R. I. Catalogue of the "Diamond" heavy face and guide bar grinding machine, illustrating details of construction fully. The machine embodies some interesting features of design, especially in table tripping and reversing mechanism.

Oneida National Chuck Co., Oneida, N. Y. Circular on the "National" safety lathe dog having no projections, driving arms or exposed set-screws to injure workmen or tear clothing. This safety lathe dog is offered in response to the demand for a greater safety in engine lathe operations.

De Laval Steam Turbine Co., Trenton, N. J. Booklet entitled "Improved Methods of Connecting Small Turbines in Steam Power Plants and Exhaust Heating and Drying Systems," describing several methods of connecting small turbines for driving auxiliaries in large steam power plants, etc.

Racine Electric Co., corner Prospect and Superior Sts., Racine, Wis. Catalogue A of "Racine" universal motor specialties, including high-speed electric grinders, driving grinding wheels at 14,000 R. P. M., high-speed lathe center grinders, universal electric portable grinder, desk and table fans, etc.

Rice Gasoline Rock Drill Co., 1510 Land Title Bldg., Philadelphia, Pa. Bulletin on the Rice gasoline rock drill, which is said to be the only free piston gasoline rock drill. The machine is entirely self-contained, consisting of gasoline drill, tripod, fuel and lubricant container, ignition battery and water tank.

Welles Caliper Co. (associated with A. J. Machek & Co.), 305 Twenty-fourth St., Milwaukee, Wis. Catalogue of Welles calipers and machinists' tools, comprising firm joint calipers, hermaphrodite calipers, adjustable calipers, hermaphrodite calipers and dividers with inserted points, steel rules, precision bench shears, tubular micrometer frames, etc.

Ingersoll Milling Machine Co., Rockford, Ill. Bulletin No. 34 R. F. on fixed-rail milling machines for manufacturing purposes. The bulletin illustrates a variety of designs of fixed-rail milling machines built by the company for various manufacturing establishments; it also shows illustrations of work in process of being machined.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Rail Reports Bulletin No. 2 on rails made of open-hearth steel, giving physical tests and chemical analysis of standard open-hearth rails and titanium open-hearth rails, photographs of sections, sulphur prints, etc. These rail reports contain valuable data for railway officials and all concerned with maintenance-of-way.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City. Bulletin No. 850 on industrial ozonators for ventilation and air purification and water purification. The effect of the industrial ozonators on industries such as fertilizer work, slaughter houses, etc., probably will be revolutionary. Such industries apparently can be made as innoxious as any other enterprise.

Skinner Chuck Co., New Britain, Conn. Circular of the Jarvis precision draw-in chuck for straight, concentric and eccentric work. The chuck is made in three sizes ranging in capacity up to 1½ inch. When used as an eccentric chuck it can be thrown 0.250 inch off center. Any degree of eccentricity between 0 and 0.250 inch can be obtained without measurement by using the dial adjustment.

Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, Ohio. Bulletins Nos. 13 and 14 on electric welder data and electric butt welders. These bulletins illustrate a variety of electric welding machines and examples of electric welding. They give elementary welding information, instructions for operating welding data and other useful data for users of welding machines.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of Canton alligator shears, illustrating five sizes having capacity from 1½ inch square in machinery steel or iron to 3 inches square, inclusive. These alligator shears are built with either motor or belt drive. Besides the regular styles, the company builds high-knife and stop motion alligator shears of various sizes; also portable motor driven shears in the No. 1 size only.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheets on adjustable mounting for automobile bevel driving pinion and gear and ball bearing on vertical spindle of matching machine. These data sheets illustrate the recommended mounting practice for Hess-Bright annular ball bearings in the designs mentioned and are uniform in style and size with data sheets previously published, illustrating a great variety of ball bearing designs.

Philadelphia Steel & Forge Co., 50 Church St., New York City. Circular on the products manufactured, including automobile steel, alloy steel, axe and hatchet steel, ball bearing steel, bit and jar steel, bevel shapes, car axles, cutlery steel, connecting rods, clover brand tool steel, crankshafts, die blocks, drill steel, forged bars and shapes, file and rasp steel, gear blanks, locomotive forgings, magnet steel, nickel steel, rings, spring steel, spindles, shafts, etc.

Superior Tap Co., Charlestown, N. H. Catalogue of taps, dies and screw plates, including machinists' screw plates, machine screw taps, machinists' hand taps, machine or nut taps, pulley taps, tapper taps, patch bolt taps, blacksmiths' taper taps, straight and taper boiler taps, Beaman & Smith taps, stove bolt taps, long hobs or master taps, short hob taps, Sellers' hob taps, staybolt taps, pipe taps, hobs and reamers, combined pipe tap and drill, mud plug taps, round and adjustable dies, machine or solid bolt dies, solid square pipe dies, "Superior" screw plates, blacksmiths' stocks and dies, etc.

Engrenages Citroen Societe Anonyme, 31 Quai de Grenelle, Paris, France. Catalogue of Citroen gears, containing a history of the development of the system, illustrations of large spur and bevel types, rolling mill pinions, etc. The Citroen gear is of the herringbone form but the right- and left-hand helical teeth are integral, being cut on one solid rim; the junctures between the right- and left-hand helices are effected in curves of short radii. In wide-face large gears there is a double reversal of helix, making in substance, two herringbone gears in one. The result is very smooth tooth action. Also pamphlet of testimonial letters from users of Citroen gears illustrated with notable examples of gears furnished.

Baldwin Locomotive Works, Philadelphia, Pa. Baldwin booklet issued in commemoration of the completion of the forty thousandth locomotive built by the company. The Baldwin Locomotive Works has been in continuous operation for eighty-two years. The first locomotive was completed in 1832. The forty thousandth locomotive is one of thirty similar engines built for the Pennsylvania Lines West of Pittsburg and designated as class K-3-S. It is of the "Pacific" type, having three pairs of driving wheels, a four-wheeled leading truck, and a two-wheeled trailing truck. The cylinders are 26 by 26 inches; steam pressure, 205 pounds per square inch; grate area, 55.4 square feet; water-heating surface 3680 square feet; weight on driving wheels, 189,500 pounds; total weight of locomotive, 293,200 pounds; tractive force, 38,300 pounds. The booklet contains a number of illustrations showing the development of American locomotives.

National-Acme Mfg. Co., Cleveland, Ohio. Catalogue of the "Acme" automatic multiple-spindle screw machines. This catalogue, which is of the standard letter size, 8½ by 11 inches, is the most comprehensive and complete that has ever been issued by this company, and is a beautiful example of typographical work. The catalogue is divided into several sections, such as construction and operation of the machine, different sizes and styles of machines, attachments for saving time or doing extraordinary operations, chucks, cams, tools and product. It is replete with halftone illustrations and contains a large number of small line illustrations showing the operating mechanism in detail. The supplementary text describes the chief mechanical features. Superintendents, foremen and operators interested in screw machines and screw machine practice generally should possess a copy of this latest catalogue, as it contains the very latest developments in this type of multiple-spindle screw machine.

TRADE NOTES

King Machine Tool Co., Cincinnati, Ohio, manufacturer of boring mills, has just completed a large addition to its plant. The company reports a rapidly increasing business.

Hoefer Mfg. Co., Freeport, Ill., has appointed the J. R. Stone Tool & Supply Co., 24 Goebel Bldg., Detroit, Mich., agent for the Hoefer line of auxiliary heads in Michigan territory.

Bury Compressor Co., Erie, Pa., has begun the erection of an addition to its plant extending the main building 100 feet. The addition is necessary to take care of the company's increasing business.

Metal Treating and Equipment Co., Inc., 1784 Broadway, New York City, has opened a plant at 834 Humboldt St., Brooklyn, N. Y., to do job galvanizing work by an improved process of electro-galvanizing.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, has opened a new office and warehouse in Galveston, Tex. The company now has three offices in the state of Texas, at Houston, Dallas and Galveston.

Ready Tool Co., 654 Main St. Bridgeport, Conn., has appointed the J. R. Stone Tool & Supply Co., direct manufacturers, representative of "Red-E" tools and "Red-E Hill" line of machine dogs for the state of Michigan and the northwestern part of Ohio.

Philadelphia Steel & Forge Co., Tacony, Philadelphia, Pa., has installed a new power plant in its rolling mill department which will increase its tonnage of finished bars 2000 tons per month. The company has also installed a heat-treating plant, and is specializing on high-grade steels for automobiles, locomotives, machine tools, etc.

Beaudry & Co., Inc., Boston, Mass., has perfected a direct-connected motor drive for the "Beaudry Champion" and "Peerless" power hammers, and descriptive circular matter will soon be ready for distribution. The company has arranged to carry a complete stock of motor-driven hammers in addition to the belt-driven hammers which they have marketed for years.

W. H. Leland & Co., Worcester, Mass., has appointed Mr. Stanley B. Dowd, formerly manager of the machinery and supply department of the Fairbanks Co., Boston, as its exclusive selling

MACHINERY

NOVEMBER, 1913

MAKING THE PHILIPS PRESSED STEEL PULLEY

OUT-OF-THE-ORDINARY SHEET-METAL FORMING OPERATIONS USED IN STEEL PULLEY MANUFACTURE

BY CHESTER L. LUCAS*

THE advance that has been made in producing good pressed steel pulleys has been largely responsible for their popularity. The earlier types were crude, but the modern pulley is light, strong and has excellent gripping qualities. Through the courtesy of Mr. J. J. Monday, president of the Philips Pressed Steel Pulley Works, Philadelphia, Pa., we are enabled to present the principal steps in the making of a modern pressed steel pulley. There are several types of steel pulleys but the Philips pulley is the only one in which the cross-section of the entire rim and supporting flange is made from a single sheet of metal. This pulley is illustrated in Fig. 1 and the steps in the formation of the rim and flange are indicated in the line illustration Fig. 2. From this it will be seen that the rim is one continuous surface of metal, properly crowned and integral with the inner part of the flange which is attached to the spider. This point should be firmly borne in mind throughout the article, as the manufacture of a pulley of this character presents unusual difficulties on account of this feature.

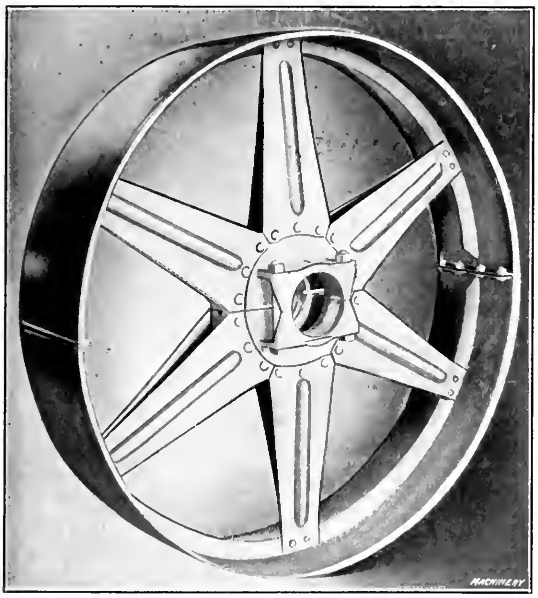

Fig. 1. Philips Pressed Steel Pulley—60-inch Size

These pulleys are made in diameters ranging from 12 inches to 60 inches, and with faces from 2 inches to 16 inches wide. For these varying sizes, different thicknesses of stock are employed, the thinnest being 17 gage and the thickest 12 gage. The first step in making the rim, aside from the shearing of the strips of steel, is the notching of the four corners as shown at *A* in Fig. 3. The purpose of this notching is to clear the metal from the section where the right angle bend must be made at each end to provide flanges for joining the two halves of the rim. This notching is a simple punch press operation and needs no further description. Next, the edges of the sheet are folded at right angles, as shown at *B*, so that they may later become the section which may be seen projecting from the center of the rim at *D*. Fig. 3, forming means for attaching to the spider. Two operations are required in doing this, the results being indicated at *C* and *D*. The folding over of these edges, as well as the subsequent bending of the rim-strip to the forms shown at *C* and *D*, requires a special type of machine, for to be successful as a manufacturing proposition it is essential that a quick and easily performed method of bending be employed.

Rolling the Rim Sections

For doing this work the rolling method has been found to be the most satisfactory, and Fig. 4 illustrates the details of the working parts of one of these machines. The principal parts of this type of machine are the long body *A* upon which a carriage *B* is traversed by a rack and pinion drive. The sheet of stock is laid upon this table and a plate *C* is clamped upon it by two clamps *D*. When locating the strip upon the table of the rolling machine, the edges overhang at each side just enough to make the two folded edges. Thus the blank is supported from above and below at the center section, leaving the edges unsupported so that they may be readily bent. As the clamping plate is a heavy casting to handle, a lifting toggle *J* is provided to assist in adjusting the strip before the rolling operation commences, and it also serves to return the plate after the strip has been removed at the end of the rolling stroke. While firmly clamped upon the table, the table, stock and plate traverse between the uprights *E*, the top of the clamping plate passing under the rolls *F*, which insures a continuous pressure

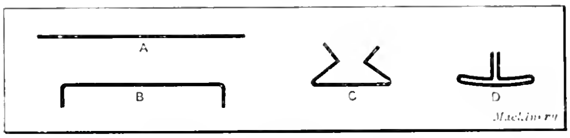

Fig. 2. Sectional Development of the Rim

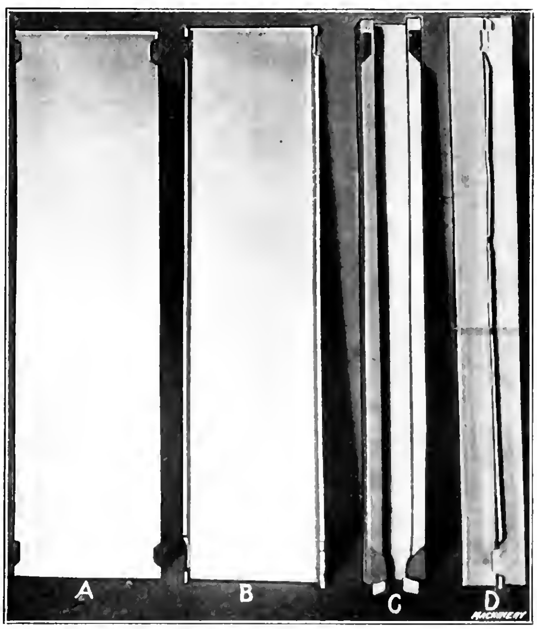

Fig. 3. The First Four Steps—accomplished in the Machines shown in Figs. 4 and 5

* Associate Editor of MACHINERY.

being placed downward upon the sheet. While this downward pressure is being applied the edges are passing by two cam-strips *G*, only one of which may be seen in Fig. 4. These cam-strips are so bent that the edge of the metal is gradually twisted from the horizontal plane down to the vertical plane by reason of its contact with the cam-strip. At the end it passes under a roller *H* which "sets" it against the edge of the carriage, leaving it in a perfectly square

Fig. 4. Rolling Machine for turning the Edges

bent condition, as shown at *I*. This operation leaves the rim-strip in the condition shown at *B* in Fig. 3. Subsequent bending operations which bring the rim-strip into the condition shown at *C* and *D* in Fig. 3 are performed upon another machine. This machine is illustrated in Fig. 5 and it works upon the same principle as that previously described in bringing the strip from the state shown at *B* to that shown at *D*, Figs. 2 and 3. For this purpose the strip in the condition at *B* is placed upon the carriage *A* of the rolling machine illustrated in Fig. 5, and a plate *B* is clamped upon it.

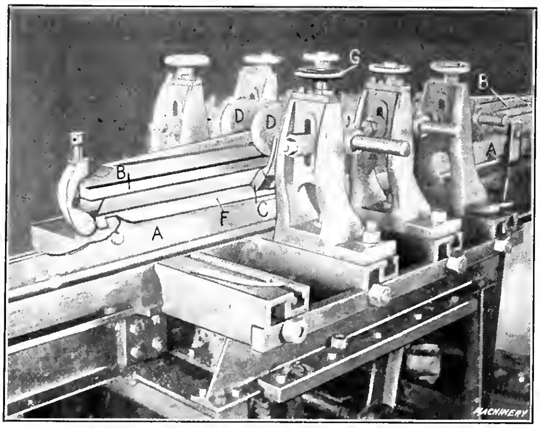

Fig. 5. The Second Bend—Reversing the Strip

It should be noted that in locating the strip, the turned edges are placed upward. As in the machine previously described there is a pair of cam-plates, one of which is shown at *C*, and as the carriage and clamping strip pass under rolls *D*, of which there are six, the edge of the strip comes in contact with the beginning of the cam-strips. At the start these strips simply bear on the top of the rim blank, and as the work follows the cam-piece down, it gradually takes on the finished shape, so that when it emerges at the end of the cam-strip, as shown at section *F*, that part of the work is completed. The cam-strips are adjustable, and the rolls which bear upon the clamping plate may be adjusted through hand screws *G*. The machine in Fig. 5 is used for rolling the strips to the condition shown at *C* in Figs. 2 and 3, and by inserting a new pair of cam-strips and holding block this piece is brought to the condition shown at *D*, Figs. 2 and 3, leaving it ready to be curved into the final rim shape.

Curving the Rim

One of the most important operations in the making of the Philips pulley is the curving of the rim-strips to form the two sections of the pulley. This operation presents difficulties in that it is very important that the central rib formed by the two edges of the strip be kept perfectly straight and free from buckling. This rolling is performed in the machine shown in Fig. 6 which at the same time crowns the rim face and leaves it curved properly for assembling. By referring to Fig. 7, the details of the working parts of this machine may be more clearly seen. The roll over which the strip is formed must, of course, be the exact diameter of the finished pulley. This means that sets of rolls must be provided for the different diameters of pulleys. As the pulleys are made in various widths of face as well as diameters it will be seen that the number of rolls required for rolling a complete line of pulleys would be very great

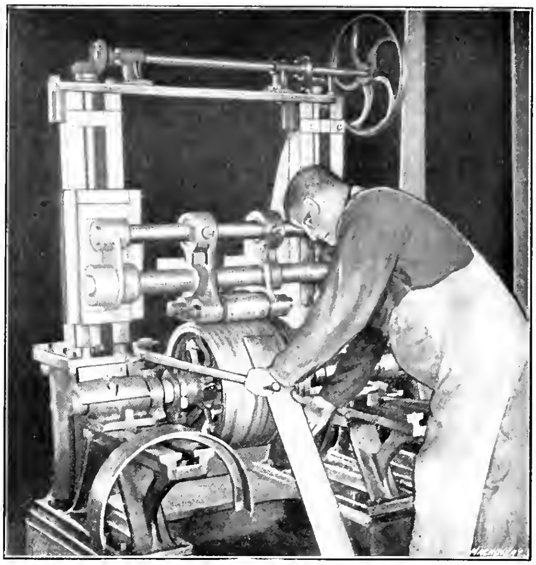

Fig. 6. Starting the Rim-forming Operation

were it not for the fact that each size of roll is arranged so that the various widths of pulleys may be formed upon it, although the upper rolls which support the face of the rim-strip must be changed to suit every width of face. Before the straight rim-strips come to this machine, iron stiffening rods are slid into the outer edges of the bends so that they may be rolled in place and thus reinforce the edges of the rim. To accommodate the various widths of pulley faces, the forming rolls over which the strips are curved are cut

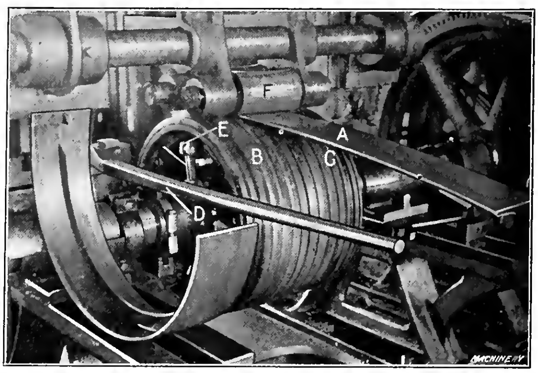

Fig. 7. Details of the Rim-forming Operation

with depressions corresponding with each width of pulley face which that diameter of roll will be called upon to form. These depressions are to allow the reinforced edges of the rim to drop beneath the surface while being rolled. One of the completely rolled strips is shown at the left-hand side of the machine in Fig. 7, and from this it will be seen that the central rim is preserved very straight and smooth, being in fact, in better condition than it was in the straight form.

This is accomplished by having the lower forming roll in two sections *B* and *C*, of which *C* is stationary and *B* capable of being set up against *C* by means of lever *D* and toggles *E*. It has already been stated that the object of cutting out notches at the corners of the sheet shown at *A* in Fig. 3 was to provide clearance for the right-angle bending of the end to secure flanges for bolting the two halves of the rim

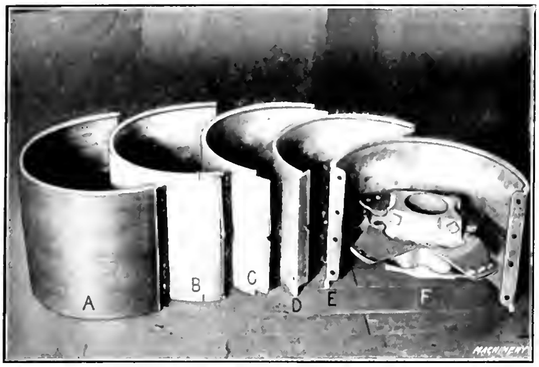

Fig. 8. The Evolution of the Rim Lug

together. The purpose of the short section of tongue remaining beyond the notch was not stated, however, and the object of this is to secure a gripping surface for starting the rolling operation. As shown in Fig. 6, the operator starts the piece by separating the two halves *B* and *C* of the roll and inserting the extreme end of the tongue in the gripping section of the rolls where the inner faces are knurled. Clamping the knurled section against the tongue he starts the rolling operation, allowing the strip to feed in under the pressure rolls *F* which press the strip into shape against the forming rolls *B* and *C*, at the same time squeezing the flanges down between the rolls. After running under the pressure rolls for two revolutions the piece is formed and ready to be taken from the machine. The point that should not be overlooked in this rolling operation is that the central

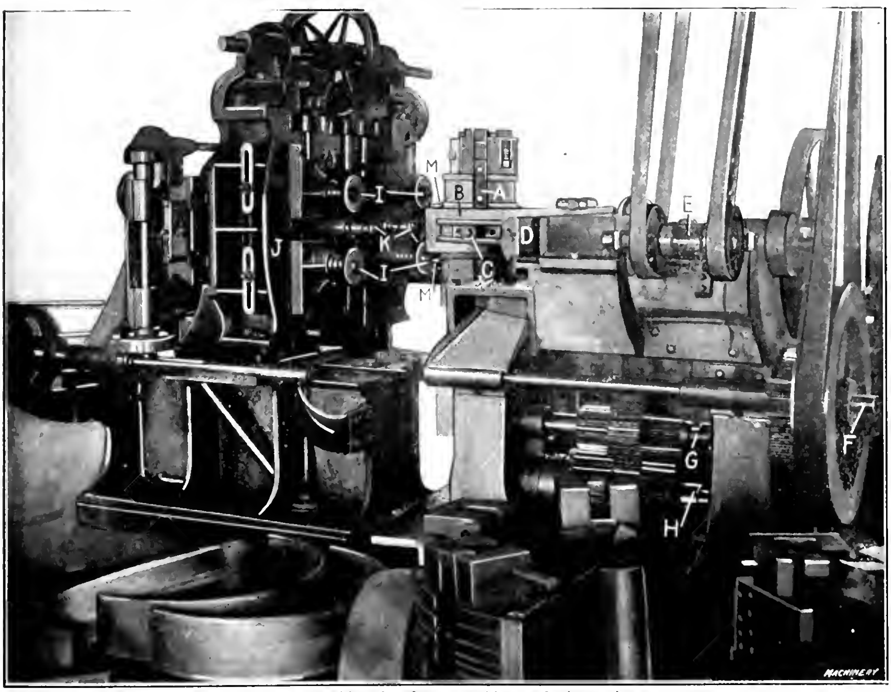

Fig. 9. Machine for flange-punching and rim-sawing

rib or flange is kept from buckling by reason of the side pressure exerted between halves *B* and *C* of the forming rolls, so that when the upper rolls *F* force this web between the two halves it is confined so that it cannot buckle or distort in any way.

Operations on the Rolled Rim-strip

The operations performed on the rolled rim-strip are four in number and the rim-strip and the four operations are shown at *A*, *B*, *C*, *D* and *E* in Fig. 8. The first of these operations consists of sawing the edges of the rim, thus sizing them to the semicircular dimension, and at the same time punching the holes in the flange to provide for the riveting of the spider in place. The function of these rivet holes is more clearly illustrated by observing the spider shown at *F* in connection with the rib or flange of rim *E*.

This combined shearing and sawing machine is interesting in its operation, and is shown as a whole in Fig. 9. Referring to this illustration the machine may properly be said to consist of two working members on opposite sides of a stationary arbor *A*. The rim is placed upon this arbor as

Fig. 10. Punching the Rivet Holes in the Arms

indicated at *B* and is firmly clamped in position by clamping strap *C* which is semicircular in form and held against the rim face, pressing it to the arbor by means of a traveling carriage *D*, which is advanced by power from driving shaft *E*. Through another driving shaft *F* at this end of the machine power is transmitted by means of a small pinion to an intermediate shaft *G* and thence to a pinion sleeve *H*, rotating upon a shaft, on the end of which there is a large eccentric. Now, by referring to Fig. 11, which shows the arbor and part of the eccentric on a larger scale, the method of punching the holes in the rim flange may be followed. Here again we have the central arbor and the clamping strap shown at *C*, and lower down may be seen the intermediate shaft *G* and the pinion sleeve *H* on the eccentric shaft. It will be noticed that in the center of the form where the rim is held, is a deep depression *B*. This is for the reception of the central rib of the rim through which the holes must be punched. For the purpose of punching these holes, a pair of punches is located at *P*, and the dies are, of course, directly beneath, allowing the punchings to drop out through the recess *Q*. These punches are held in a slide *R* which is reciprocated by a lever *S*, pivoted at *T* near the top of the arbor. The opposite end of the pivoted lever is held in the vertical shaft *U* and reciprocated by the eccentric motion previously referred to in connection with

Fig. 9. Some of the punchings from the central ribs may be seen in this illustration and even more clearly in Fig. 12 where they have dropped out from the dies. In Fig. 12, however, the work is shown in place; therefore the punches and dies are concealed.

This feature of the machine takes care of the punching only, the sawing being performed at the opposite side of the arbor. Referring back to Fig. 9, the arrangement of the sawing mechanism is adequately shown. There are four sawing spindles *I*, each fitted with circular saws and rotating at correct cutting speeds for steel. These are all mounted upon the traveling head *J* which is advanced by a hand

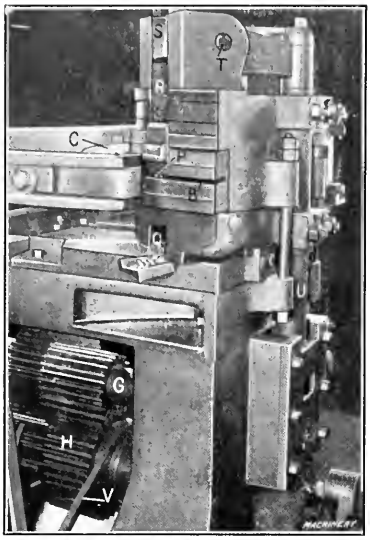

Fig. 11. Close View of the Arbor and Punches

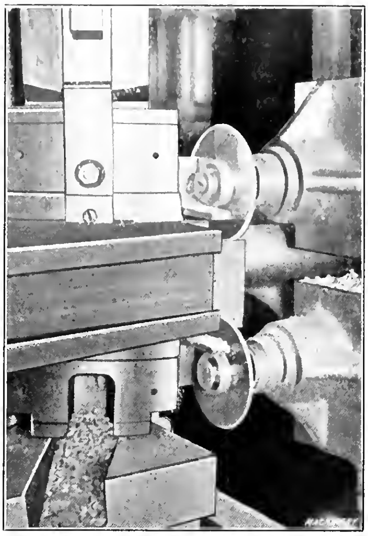

Fig. 12. The Sawing Operation

Fig. 13. Assembling the Pulleys

lever on the opposite side of the machine until stop *K* strikes against the work-arbor *A*. The feeding forward of the head brings the saws into the cutting position, but in order to take up any little differences in the saw locations or end play of the spindles, the saws are flexibly mounted. They are held in forward positions on the arbors by stiff spiral springs. The feeding forward of the head causes the sides of the saws to bear against gages *M* and any differences in position are taken up by the spring pressure. Gages *M* are, of course, set so that the sawing will be done at

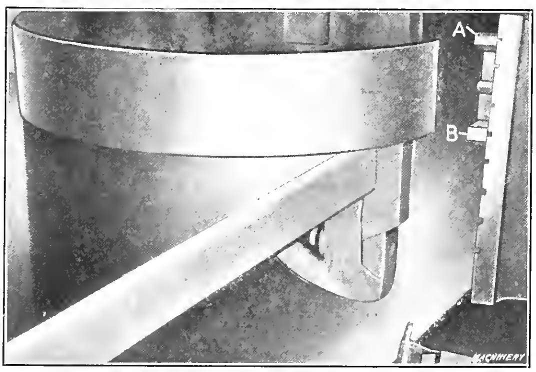

Fig. 14. Rough-trimming the Ends of the Rim

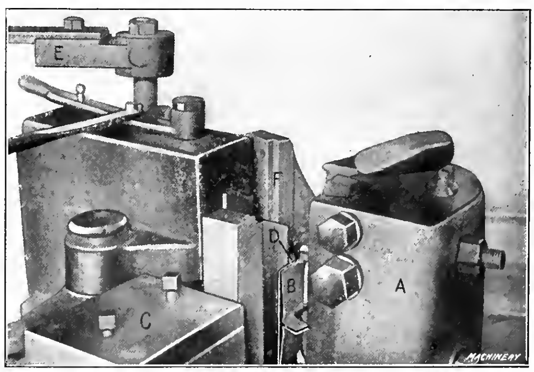

Fig. 15. Bending the Rim-lug

exactly opposite points on the rim. At this point the saws are above and below the edges of the pulley rim, and by throwing in the vertical feed the operator causes the two lower saws to come up and the two upper saws to feed down into the rim, sawing until the feed is automatically tripped. This, of course, takes place after the rims have been sawed to the required depth. Sawing rather than slotting is necessary for this operation on account of the heavy steel wire reinforcement which is within the rim on each edge. The result of this operation leaves the rim in the condition shown at *B* in Fig. 8. In operation, the rim is clamped around the arbor by running carriage *D* up to the arbor so as to bring clamping strip *C* into action. Shaft *F* is transmitting rotation continuously to auxiliary shaft *G*, and thus to the pinion sleeve *H* on the eccentric shaft. This sleeve rotates loosely upon the shaft except when keyed to it by a clutch that is controlled by lever *V* shown in Fig. 11. Throwing over this lever, therefore, causes the eccentric to operate the set of punches, pushing them downward through the rim flange. The smaller rim halves have four punched holes, while the larger ones have six holes. The rim punching is followed closely by the sawing operation on the same machine as has been described.

Preparing the Rim Halves for Joining

A series of three punching and forming operations follow the sawing and they are all done on similar machines, *viz.*, a type of horizontal punch. The first of these operations consists of cutting out the square section that has been sawed and rough-trimming the end of the rim section to approximately the finished length, leaving it in the condition shown at *C* in Fig. 8. The rough-trimming operation appears in Fig. 14. An adjustable table is provided upon which the rim is supported, its end being inserted between the punch and die of the horizontal punching machine. The work is located by means of the previously made saw cuts, and adjustable punches *A* and *B* cut out the two sections beyond the saw cuts, the punches being in line with the dies on the opposite side of the work. The object of having these punches and dies adjustable is to provide for trimming the different widths of rims which must be handled in the machine. Tongues on the punches fit into corresponding grooves in the punch-holder and make the changing over of the machine for another size of pulley a comparatively simple matter.

Following this operation comes the bending of the flanges to the condition shown at *D*, Fig. 8, on a machine similar to that illustrated in Fig. 15. While the machine on which this bending operation is done is similar to the horizontal punch, the movements of the tools are more interesting and may be best understood by the line illustration Fig. 16. In order to bend this end of the rim properly it must be supported while the right-angle bend is made, and then an additional "setting" bend from the front is necessary to give it the proper angle to make a good tight joint when bolted to the mating-rim half. Referring to the line engraving which shows a plan view of the working parts of the horizontal punch, the anvil is shown at *A* and the work encircling it at *B*. The ram or head of the punch appears at *C* and the side bending punch at *D*. After the work has been placed in position the operator swings hand lever *E* over, causing rocker arm *F* to bear against the work thus holding it firmly for the bending. Tripping the clutch of

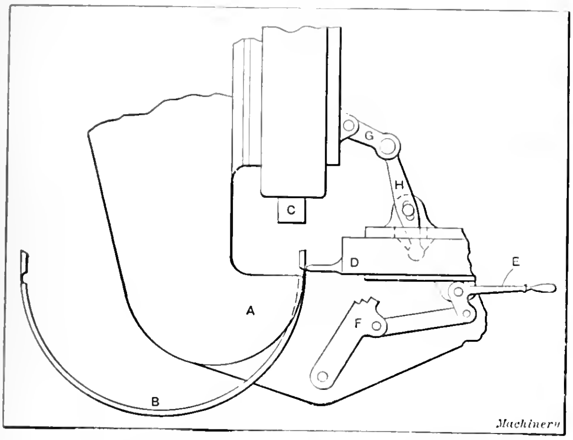

Fig. 16. The Mechanism of the Rim-lug Bending Machine

the punch the ram advances and through link *G* and toggle *H* the side bending slide *D* is caused to advance and make the first part of the bend, producing the approximate shape. As the ram continues to advance, the side bending slide draws back, after which the heading punch strikes the partly bent work and "sets" it against the form on the anvil. The operation of the cross bending slide by means of the heading punch is quite novel.

The third rim-finishing operation is along the same general lines, and comprises the final punching of the joining flange, trimming the lug to its finished shape and punching the

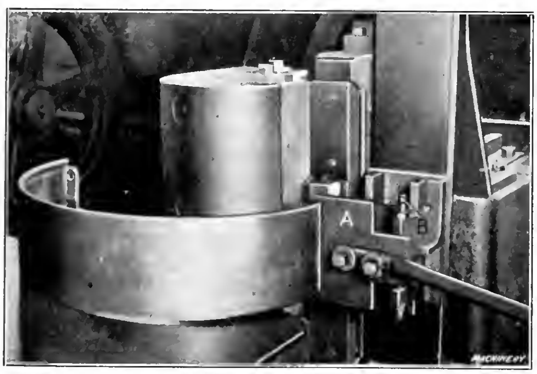

Fig. 17. The Final trimming of the Rim-lug

rivet holes for the attaching bolts. This operation is shown in Fig. 17, and with the exception of gate *A* which is hinged at *B* and serves to hold the work firmly while being punched this comparatively simple operation has no unusual features. This operation leaves the rim section in the finished condition shown at *E* in Fig. 8.

Making and Assembling the Spider

The spider or central structure from which the rim is supported is built up around a split cast-iron bushing. The two halves are bolted together and sheet metal arms riveted on each side to form connections with the central flange of the pulley rim. After these arms have been riveted in place, the ends are punched for assembling with the rim. It is very necessary that these rivet holes be equidistantly spaced from the hub of the spider so that the rim will be riveted

Fig. 18. Riveting the Arms to the Rim-flange

true with the bore in the hub, and thus produce a true running pulley. The punching fixture is shown in Fig. 10. This fixture has a pivot over which the spider may be slipped, and provision is made for indexing the spider for four or six arms, as the case may be. There is a certain amount of spring to the arms of the assembled spider, and in order to punch the holes accurately they must be held close together, while the punches are passing through the stock. For this purpose a stripper *A* is fitted over the die, being hinged at *B*, and extending out around the punches. Before punching,

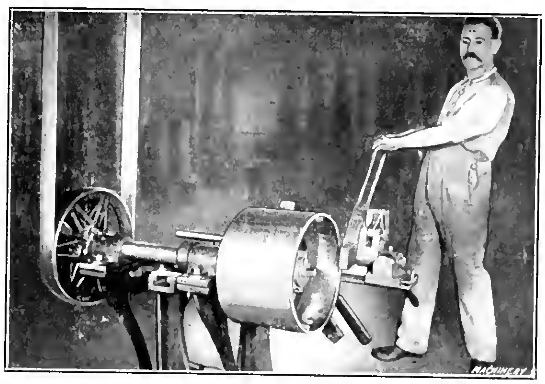

Fig. 19. Truing the Edge of the Pulley Rim

hand lever *C* is depressed, causing the stripper to be pressed against the stock, and while the two spiders are thus held close together, they are punched clean and accurate.

Two of the pulley assemblers are shown in Fig. 13. Their part of the work is to assemble the two halves of the rim about the spider and to insert the rivets ready for riveting. The spider is first mounted on a pivot stud and the two halves of the rim bolted over it. These operators handle S-wrenches continuously, and the speed which they develop in manipulating them while putting the bolts through the rim-lugs is remarkable, considering that the bolt locations are not very accessible.

In Fig. 18 may be seen one of the hydraulic riveters for upsetting the rivets when attaching the spiders to the rims. The riveter is fitted with a stationary anvil and a hydraulically operated punch directly over it. A traveling carriage is mounted on the frame of the machine, on which is supported a pivot stud which may be moved in or out according to the diameter of the pulley being riveted. The riveting operation is simplicity itself, for after the work is located, it is only

necessary to pull over the operating lever which hydraulically applies pressure to the riveting punch.

Truing the Pulleys

The final operation, exclusive of painting, on the Philips pressed steel pulley, is truing. This is an operation which requires considerable skill and no little manual strength. The pulley is mounted on the truing stand as shown in Fig. 19, and the operator revolves it by power and observes the way the rim runs, locating the high points by holding a piece of chalk stationary against the revolving rim. His first operation consists in throwing the edges of the rim into their respective vertical planes. This is done by pressing in the high points with a wooden lever applied as shown in Fig. 19. Two or three pulls by an experienced operator will usually put the edges into alignment. This part of the work being done, the face receives attention, and with the two

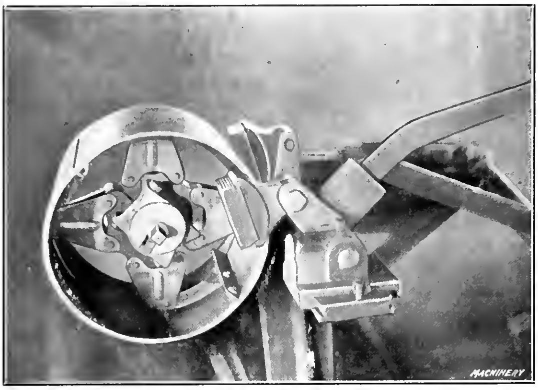

Fig. 20. Method of truing the Pulley Face

levers with which the truing stand is equipped, shown on a larger scale in Fig. 20, the rim may be trued. This is done by pressing down the high points by pulling up on the levers when their wooden faces are against the outside of the rim or by depressing the levers with the edge of the block caught inside the rim as shown by the forward lever in Fig. 20. It will be seen that four different combinations of the two levers may be secured; both inside, both outside, one inside and one outside in both directions, thus providing for restoring any distorted rim. Care has to be taken not to throw the edge out of true when working on the face and *vice versa*. In spite of the seeming difficulties of the pulley truing operation an experienced operator will true 200 finished pulleys in a day of 10 hours.

* * *

The cartoonists' idea of illustrating motor car troubles still seems to be to show the driver underneath, lying on his back or stomach, with his feet sticking out, working himself into a frenzy under the mysterious and diabolical mechanism. The cartoonists are not up to date. They have not found out, apparently, that very little of modern motor car machinery needs tinkering from beneath. It is true that the first cars were so built that the prostrate position of the luckless driver was necessary to effect many repairs, but the modern car is quite a different sort of machine. With the engine in front, the gear-box and clutch beneath the floor in front of the front seat, and the differential in the rear axle, there is very little indeed to call for taking a mud or dust bath underneath. But we suppose that comic pictures of automobile troubles will be shown in the conventional way for another ten years at least.

* * *

Wireless telephony continues to make progress. Wireless communications have been established between Berlin and Vienna, a distance of 355 miles. A Japanese telephone official is credited with having invented a wireless telephone apparatus different from those used in Europe, which has been successfully tested between Yokohama and steamships 60 miles at sea.

DON'TS FOR DRILLING MACHINE OPERATORS*

BY JAMES E. COOLEY†

Don't use a loose feed belt.
Don't use the shank of a file for a drift.
Don't spot holes in the table with the drill.
Don't use a wrench or a file to throw off a belt.
Don't use a wrench or a collet to drive a drift with.
Don't forget to use oil when drilling malleable iron.
Don't drum on the table with the ball-end of a hammer.
Don't forget to fasten the spindle-head and table-slide.
Don't leave chips in the drilled hole; empty them out.
Don't try to drill tough steel with oil; use turpentine.
Don't run a twist drill in a cored hole; use a butt-mill.
Don't use a jack having a top as large or larger than its base.
Don't run a body-counterbore down too far in a tap size hole.
Don't use a reamed stud-hole in a knee to drill work through.
Don't put drills or reamers in collets having different tapers.

Don't let the lip of the drill strike on the edge of the bushing.

Don't let the drift and wrench get lost each time after using it.

Don't get in the habit of slapping a belt each time you adjust it.

Don't try to get along by using one jack; use two if necessary.

Don't leave the machine with a drill running idly in a bushing.

Don't slide a jig across the table and bang it against the drill.

Don't try to grind a reamer if it does not cut; take it to the foreman.

Don't forget the value of a long leverage as a stop when drilling.

Don't forget that a piece of hard wood is handy to drill sheet metal on.

Don't fail to clean and oil the threads in the clamp screws occasionally.

Don't have a foot on a jig extend over the edge of a hole in the table.

Don't be afraid to own up that you have broken a drill or counterbore.

Don't throw or toss drilled work in a box; lay it down carefully.

Don't be above sweeping the dirt around your machine into a neat pile.

Don't fail to lower the spindle-head as close to the work as possible.

Don't bear down too hard when drilling a hole through the rim of a pulley.

Don't forget to chalk over the spot you are laying out on a rough casting.

Don't think that it is necessary to sit down for every drilling operation.

Don't let oil drip off the table onto your overalls, shoes, or the floor.

Don't let the drill cut on the edge of the holes or slots in the table.

Don't fail to look and see if every hole has been drilled in the piece.

Don't drive a drill out of a sleeve collet by striking the end on the table.

Don't be too slow in putting in and taking out a quick-change drill collet.

Don't use your fist to drive a heavy casting under the drill; use a babbitt hammer.

Don't use machine oil to drill with; use lard oil or a drilling compound.

Don't forget to fasten every screw in the jig and lock the work in securely

Don't place the fingers under the work to feel if the drill is coming through.

* For "Don'ts" previously published in MACHINERY, see "Don'ts for Drill Grinders," July, 1913, engineering edition, and "Don'ts" there referred to.
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Don't put a jack directly under the point where the drill comes through the work.

Don't put on the feed until the point of the drill is down against the work.

Don't forget to have another piece ready to put in the jig when one is taken out.

Don't kill time by letting the drill run deeper in the work than is necessary.

Don't use too much oil when tapping holes in cast iron with the tapping fixture.

Don't forget to take out the scratches and dents in the table with a smooth file.

Don't throw clamps and bolts around on the floor and jam the threads in the screws.

Don't drill aluminum without using kerosene oil; it makes a very smooth hole.

Don't forget that brass, aluminum and wood should be drilled at a high speed.

Don't forget to use the try-square against the spindle to see if the work is true.

Don't forget to spot a hole with a full-size drill, before using a tap size drill.

Don't use a center-punch made out of a round file; it is too brittle and dangerous.

Don't forget to fasten the tap securely in the tapping fixture before tapping a hole.

Don't keep the jacks where you have to stretch over to reach them; have them near you.

Don't fail to rub oil on the pilot of counterbores each time they are placed in a hole.

Don't use extension collets to lengthen the spindle unless absolutely necessary.

Don't use a large drill press to drill a small hole, when a smaller one can be used.

Don't start to drill a hole unless you are sure you are using the right size drill.

Don't let the spindle-sleeve get gummed up; wipe it clean and oil the entire length.

Don't forget to put a piece of sheet brass between the end of the clamp screw and the work.

Don't stand on the table or belt-shipper to adjust a belt while the machine is running.

Don't forget to clean off all taper shank tools before "socking" them up in the spindle hole.

Don't think a piece of work will hold itself while it is being drilled, but fasten it down.

Don't yank the belt-shipper forward to start the machine, but draw it over carefully.

Don't take a drill out of a spindle by clamping a monkey wrench across the flute and twisting it.

Don't forget to look at the outer end of the work that is being drilled to see if it tips up.

Don't push a drill down in a bushing without first oiling the drill or inside of the bushing.

Don't put the spanner wrench in your pocket or in a place where someone will have to hunt for it.

Don't strap work on the outside of a knee or angle plate when it can be placed on the inside.

Don't drive out an Almond chuck from the spindle by hitting it on the back end; use a drift.

Don't forget that a dull tap in a tapping fixture breaks the fixture quicker than the tap.

Don't forget that a reamer should be drawn up from a hole, nearly as slowly as it was run down.

Don't forget to wipe the oil and chips from the table each time before laying the jig down under the drill.

Don't forget that a box is a handy thing for holding a pulley to drill an oil-hole in it on an angle.

Don't run a head counterbore into cast iron scale, but gouge out the hole first with an old drill.

Don't brush chips toward the column, as they will get in on the ways of the table slide.

Don't set a screw too tight against the piece in the jig; it will spring the piece or spread the jig.

Don't push a tap against a hole when it is running in the reverse direction in the tapping fixture; raise it up first.

Don't forget when drilling pin holes to try a pin in the hole occasionally to see if it will drive.

Don't forget to try the reamer in a hole after the drill is ground to see if the drill cuts small enough.

Don't try to hold work with the hand while drilling because it is too much trouble to rise and get a wrench.

Don't leave drills and reamers lying around after you are through with them; return them to the tool-room.

Don't use waste to wipe the chips off the tap while it is running in the tapping fixture; use a stiff brush.

Don't waste time by running a nut too far on the thread of a bolt when bolting down work; use plenty of washers.

Don't hasten the spindle stoppage after the machine is shut off by trying to insert the drift in the spindle broach.

Don't, when the drill runs off the center of a scribed circle use a center-punch to draw it back; use a draw-chisel.

Don't forget that the very first rudiment in running a drilling machine is to have the work square with the spindle.

Don't force out a collet from the spindle by placing the drift through the broach in the collet and twisting it.

Don't put the spout of the oil can down in a jig-bushing while the drill is in motion; the end will be chewed off.

Don't drill a heavy casting on a sensitive drilling machine as the weight of it will spring the table out of true.

Don't leave an Almond chuck with a drill in it lying lengthwise on the table; it will roll off and break the drill.

Don't forget when drilling a deep hole in cast iron that a little oil rubbed on the drill will prevent it from squealing.

Don't use a collet for a stop by driving the taper end down in a hole in the table, but bolt down a knee for this purpose.

Don't forget that if a small drill is run down into the mark made with a center punch, it will guide a large drill central.

Don't let a tap strike the bottom of a hole when using a tapping fixture, but be sure to set the stop to limit the depth

Don't drive out a stud from an angle plate when it is strapped down; the hammering is likely to break or spring the plate.

Don't lay anything on the table too near a jig; in case it gets caught and whirls around it will sweep everything in range.

Don't forget when fastening a clamp over the table to have the head of the screw point downward; it is then out of the way.

Don't tighten the table slide or spindle head by hitting on the wrench with a babbitt block or hammer; the hand pressure is sufficient.

Don't, when the jig has been raised or tipped up, put it down again and continue drilling, because chips are likely to be under it.

Don't forget that the bottom end of a hole is smaller than the top and a hole should always be reamed from the drilled side.

Don't twist a drill with a wrench when it gets stuck in a jig; squirt a little turpentine in the bushing and it will come out easily.

Don't fail to examine the point of the drill after it has had a fit of sputtering in the hole; it has struck hard sand and needs grinding.

Don't have washers, nuts or clamps, etc., scattered around you; keep them in a box or, better still, drive nails in a bench and hang them up.

Don't forget that if you drill a hole in a separate piece and then strap it down over the piece you want to drill, you will get a true hole.

Don't leave the machine while it is running and think it will take care of itself; something is likely to get stuck and it is best to shut it off.

Don't fail to listen for the noise made by the drill when it is coming through the work, as it requires less pressure if there is backlash in the spindle.

Don't try to tighten up the drill chuck while it is running with the hand. When the drill slips stop the machine and use the spanner wrench.

Don't under any circumstances draw up a drill from a jig too quickly, as it will bind in the bushing and whirl the jig around.

DRAWING AND FORMING AN AUTOMOBILE CLUTCH CONE*

A GOOD EXAMPLE OF HEAVY SHEET-METAL FORMING IN THE PUNCH PRESS

BY DOUGLAS T. HAMILTON†

The automobile clutch cone shown in Fig. 1 illustrates one of the many interesting examples of sheet-metal work turned out by the Acklin Stamping Co., 1645-1653 Dorr St., Toledo, Ohio. This clutch cone is made from 1/8 inch cold-rolled sheet steel and is completed in the punch press, with the exception of a light cut taken from the bearing of the cone in

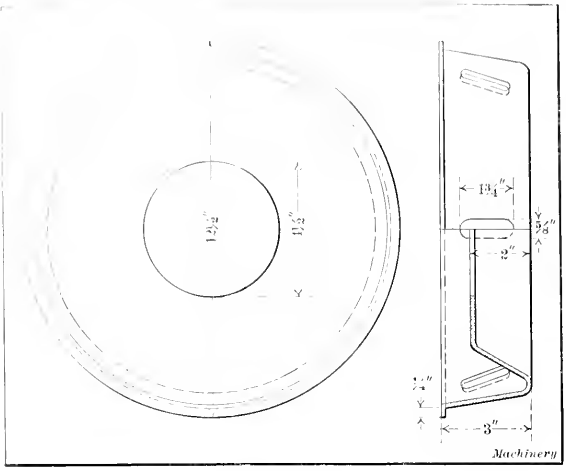

Fig. 1. Automobile Clutch Cone completed in the Punch Press in Six Operations

a grinding machine. The grinding is done in order to obtain a perfect frictional bearing surface. Some of the most important punch press operations on this clutch cone are illustrated in Fig. 2, where the nature of the work accomplished is evident. The cone is completed in the punch press in six operations, the completed part being shown at *D*.

Blanking and Drawing the Clutch Cone

In the half-tone Fig. 3 is shown the first drawing die and the result of the operation performed by it, the latter being indicated at *B* in the illustration. The blank *A*, which is 17

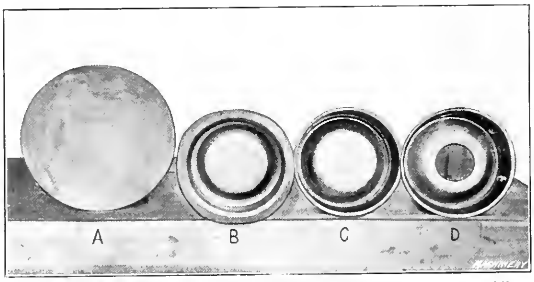

Fig. 2. Sequence of Important Operations performed on the Automobile Clutch Cone shown in Fig. 1

inches diameter by 1/8 inch thick, is cut out by a simple blanking die. Punch *H* is fastened to the base *I*, which is attached in the usual way to the bolster of a No. 78½ Bliss press shown in Fig. 4; draw ring *C* moves freely around punch *H*. The holder *D*, carrying the inserted die ring *E* and reversing pad *F* is held to the ram of the press. These dies are used in a single-action press and are given the double-action movement by means of a rubber compression pad under the bolster which operates the draw ring *C* through the medium of the six pins *G*. The pressure exerted by the rubber pad prevents the blank from buckling when being

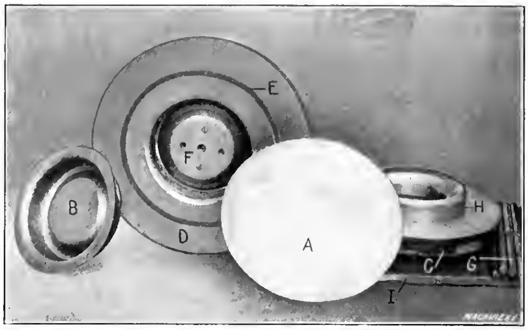

Fig. 3. Combination Blanking and Forming Dies for making an Automobile Clutch Cone

drawn. The reversing and drawing of the cup is accomplished by the punch *H* in combination with the reversing pad *F*. The result of this operation is shown at *B* in Figs. 2 and 3.

Redrawing and Tapering Dies

The dies used for redrawing the cup and bringing it to practically its final shape are shown in Fig. 5. These are held in the same manner as those shown in Fig. 3 and are

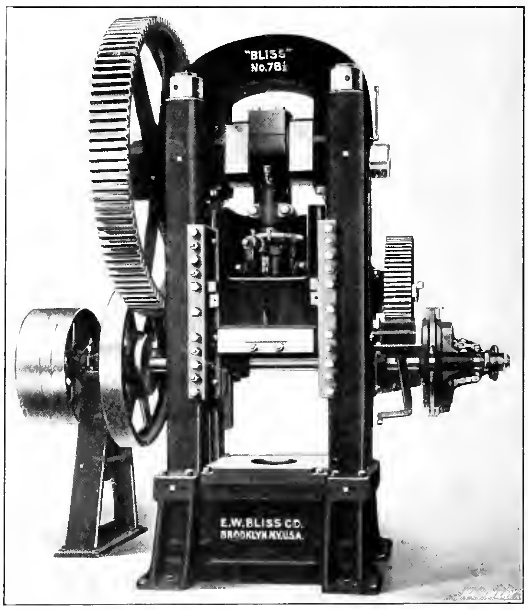

Fig. 4. Bliss No. 78½ Press used in making Automobile Clutch Cone

somewhat similar in design, with the exception that the exterior drawing surface of the punch *C* is tapered instead of straight like the punch used for the previous operation. These dies are also held in a single-action No. 78½ Bliss press. The pins *D* operate on the drawing ring *E* and prevent the blank from buckling when being drawn down into the die *F* by punch *C*. The condition of the cup before and after this operation is shown at *A* and *B* in the illustration, and at *B* and *C* in Fig. 2. The finishing operation requires a

* For additional information on punch and die work, see the following articles previously published in MACHINERY: "Blanking, Forming and Cutting Die," September, 1913; "Sectional Punch and Die Construction," July, 1913; "Blanking and Drawing a Large Steel Cup in One Operation," "A Problem in Press Work," July, 1913; "Blanking, Forming and Piercing Die," June, 1913; "Combination Punching, Cutting and Forming Die," "Punch and Die for Forming Electric Terminals," May, 1913; "Punch and Die made in Sections," "Punch and Die for Bending past the Vertical Line," March, 1913; "Standards in Die Work," "Locating Punches in Tandem Dies," "Tools for Multiple Plunger Presses, (engineering edition), February, 1913; "Some Interesting Drawing and Curling Dies," "A Bending Die," January, 1913; "Modern Methods of a Press Working Plant" (engineering edition), December, 1912; "Producing Drawn Steel Rollers in a Gang Die," "Drawing a Small Shell from Thick Brass," "Punch and Die for Forming Electric Terminals," "Combination Folding and Curling Die," November, 1912; "Method of Making Watch Case Pendants" (engineering edition), October, 1912; "Prevention of Wrinkles in Drawn Work," "Closing and Curling Die," September, 1912; "Tools for Perforating Lamp Burner Parts," "Watch Case Manufacture—," "Sub-press Die for Making a Cleat," August, 1912; "The Drawing of an Odd Shaped Cup," "A Piercing and Cutting Off Punch and Die," April, 1912; "Drawing a Flange and Tapered Cylindrical Shell," March, 1912; and other articles there referred to.

† Associate Editor of MACHINERY.

pressure of approximately 500 tons. After the redrawing and tapering operation the flange is trimmed and finished to size. Following this, the center hole is cut out.

Cutting the Elongated Slots in the Rim

Undoubtedly the most interesting operation in connection with the manufacture of this clutch cone is the cutting of the elongated slots in the rim. From an inspection of Fig. 1, it will be seen that the cutting of these slots presents a difficult problem, owing to the "returned" shape of the lower portion of the cone. This not only makes it hard to get at, but also makes it a difficult matter to get rid of the scrap if the punches are presented from the sides. The gang method of punching would be impossible owing to the slender construction of the dies which would be required for the space allowed. The tools used to accomplish this interesting operation are shown in Figs. 6, 7 and 8. Fig. 6 shows the work in position in the slotting die, while Fig. 7 shows the work removed and the die opened up and thrown back.

The manner in which this slotting die is used is as follows: The base *A*, Fig. 8, is held in the usual manner to the bolster of the punch press, while the two studs *B* are held by nuts

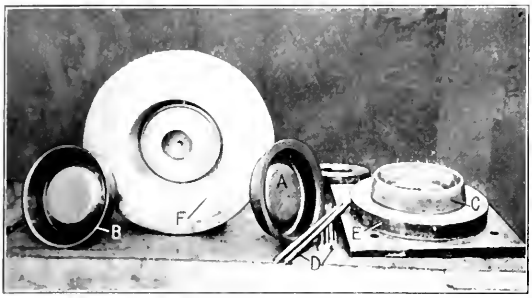

Fig. 5. Redrawing and Finish-forming Dies for Automobile Clutch Cone

in lugs cast integral with the ram of the press, and are used to return the punch-block *C* after the punch *E*, Fig. 7, has passed through the work. This, of course, is accomplished on the return stroke of the ram. The cutting die *D*, as shown in Fig. 7, is inserted in the base *A*, whereas the punch *E* is held in the block *C*, which is acted upon to punch the slot by a punch-holder *F*, held in the ram of the press.

In operation, the clutch cone is clamped to the circular holder *G* which is attached to the arm *H* by a block *I*, acted upon by a cap-screw *J*. This circular holder is revolved by hand and carries an indexing plate *K*, as shown in Fig. 8. This index plate is made of steel and is located for the different indexings by a hardened tool-steel dog controlled by the handle *L*. At the beginning of each indexing the moving

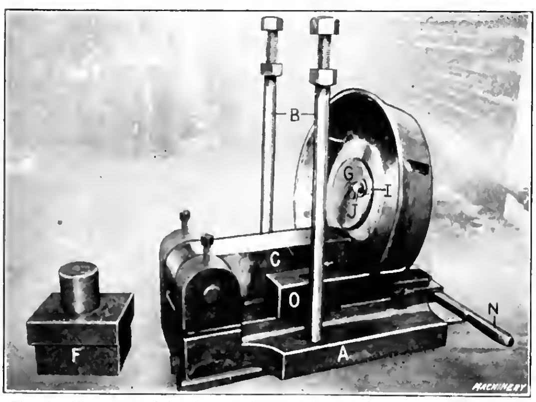

Fig. 6. Fixture used in the Punch Press for cutting the Six Elongated Slots in the Rim of the Clutch Cone

parts are securely clamped by means of the wedge *M* operated by handle *N* and the adjustable blocks *O* against which the rim of the cone is held. While these three members are not essential parts of the apparatus, they serve to render the gaging much more accurate. Handle *P* is attached to these blocks and is located in a recess provided in the base of the die shoe.

The ingenuity displayed in the solving of this difficult slotting problem speaks well for the ability of the Acklin Stamping Co. to handle sheet-metal stampings of unusual and complicated shapes.

* * *

FOOL-PROOF AUTOMOBILES

Some time ago a local paper published an item stating that a Norwich, N. Y., man drove his automobile ten miles with the emergency brake set, and humorously added, "It is

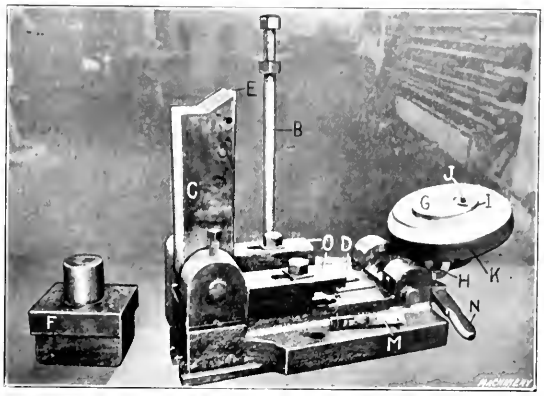

Fig. 7. Fixture shown in Fig. 6 with Work removed and opened up to show Construction

a pretty good car yet." This and other accidents that often happen indicate the need of better control apparatus on motor cars. Gears are often stripped by putting on the emergency brake with the clutch engaged, and other interferences contribute not a little to the rapid deterioration of the motive mechanism and tires.

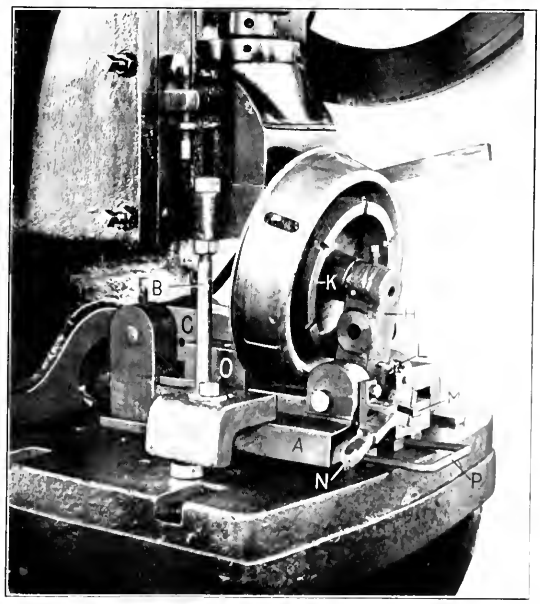

Fig. 8. Slotting Fixture shown in Fig. 6 set up in a Punch Press ready for Action

Automobiles, motor trucks and other power-driven vehicles should be provided with strictly interlocking gears which would prevent interferences of this character, and until that sort of control apparatus is achieved the motor car will not be a strictly practicable vehicle for all sorts of users. The tendency in all modern design is to simplify and make operation easy. Such improvements popularize machinery and materially reduce the cost of operation, to say nothing of making it safer for the average user. Safety is a prime requirement for all automobile driving, but so long as the driver can make serious blunders while driving they will continue to be made.

EXAMPLES OF SCREW MACHINE "SET-UPS"*

VARIOUS "SET-UPS" USED IN MAKING PARTS ON THE "ACME" MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

As one of the first considerations in laying out a job on the Acme multiple-spindle screw machine is to determine the best method of applying the tools, etc., a few examples of representative "set-ups" will be given. Of course many jobs could be handled in several different ways; but as a rule there is

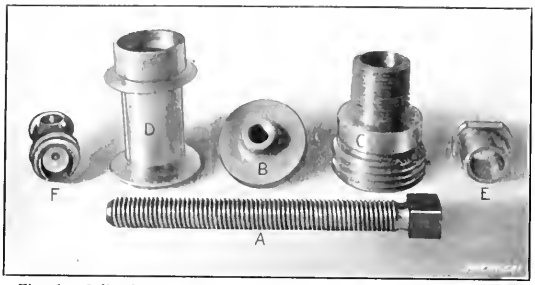

Fig. 1. Collection of Pieces economically produced on the "Acme" Multiple-spindle Automatic Screw Machine

always some governing feature that makes it possible to produce the part much more quickly and accurately in some specific way. Fig. 1 shows a number of parts produced on the "Acme" automatic by methods which are commendable, and in the following a description will be given of the tool equipments and "set-ups" used. The examples shown in Fig. 1 have been chosen because they represent several of the most common tooling methods employed in producing the general run of work.

"Set-up" in which the Longest Operation is performed from the End-working Tool-slide

The long set-screw shown at A in Fig. 1, and also in Figs. 2 and 4, is a common piece of work produced on the "Acme"

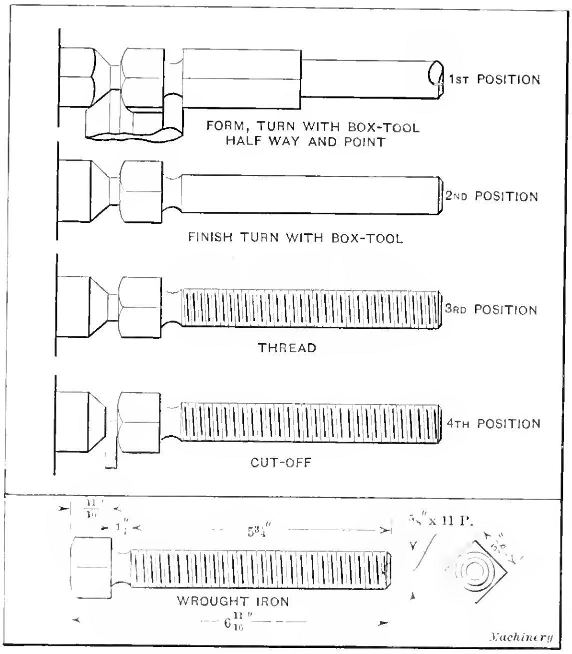

Fig. 2. Order of Operations used in making a Long Square-headed Set-screw

multiple-spindle automatic. By referring to the lower section of Fig. 2, it will be seen that this set-screw is made from a square wrought-iron bar, and that the threaded portion is 5¾ inches long, the length over all being 6 11/16 inches. The longest single operation, as can be seen at a glance, consists in turning down the body diameter to the required size. We first decide on the machine to use for this piece, endeavoring where possible to use the size of machine that will handle

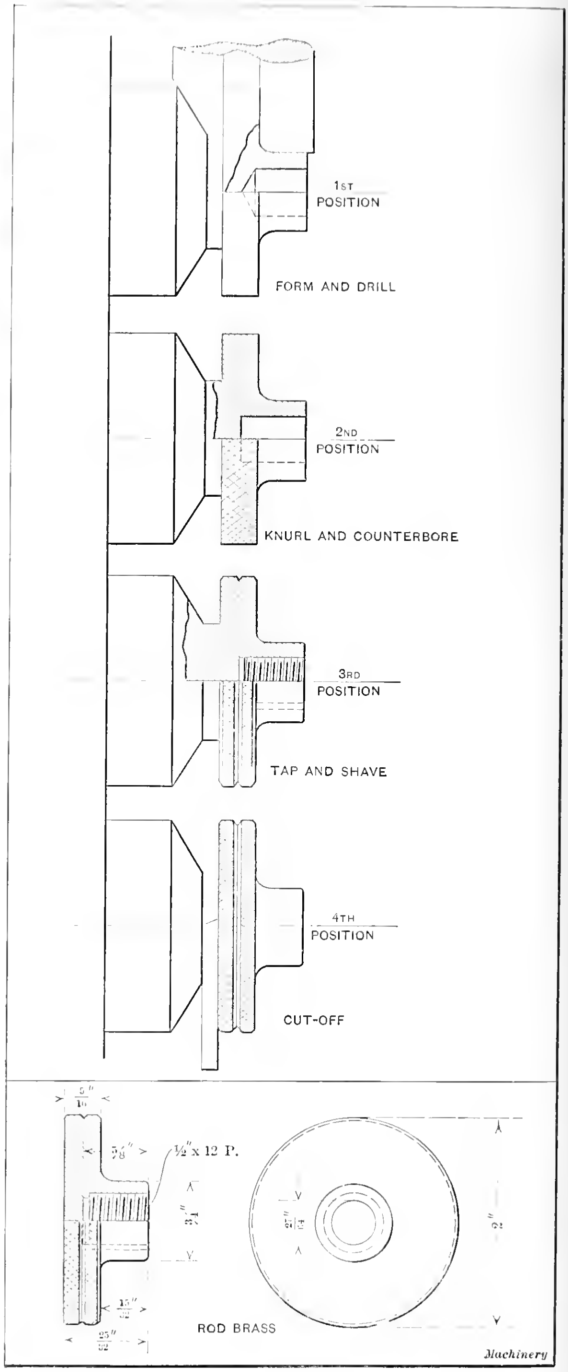

Fig. 3. Order of Operations used in producing a Brass Thumb-nut

the work most economically. Of course where only a few sizes are in use it is not always possible to select the machine best suited to every job. It is advisable, however, to have the work approach, as closely as possible, the rated capacity of the machine that is to produce it.

The distance across the corners of this set-screw is 0.880

* For material previously published on the "Acme" multiple-spindle screw machine, see "Setting Up and Operating Screw Machines" and articles there referred to in the October, 1913, number of MACHINERY.
†Associate Editor of MACHINERY.

inch, so we will select a No. 53 machine—this being the nearest size. The next step is to determine the spindle speed at which to rotate the work. Taking the diameter of the stock across the flats as the basis of our calculations and deciding on a surface speed of 100 feet per minute, we find that the desired spindle speed would be 611 R.P.M. Upon referring to Table VIII in the January, 1913, number of MACHINERY, we find that the nearest spindle speed is 635 R.P.M.; this gives a surface

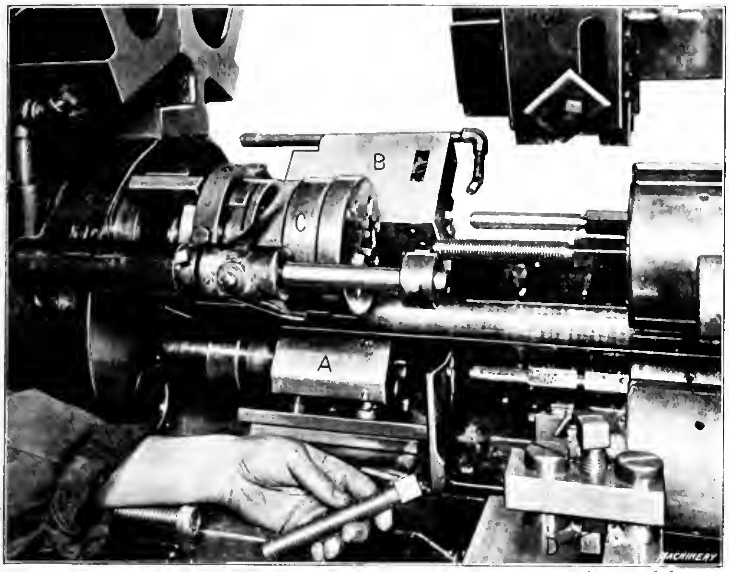

Fig. 4. Tooling "Set-up" used in producing the Set-screw shown in Figs. 1 and 2

speed of about 104 surface feet per minute, which will not be too high.

The next step is to determine the number of revolutions necessary for the box-tool to travel up half the length of the screw—$2\frac{7}{8}$ inches. Deciding on a feed of 0.0045 inch per revolution of the work, the number of revolutions required to make this cut is found to be 640. As the spindle makes 635 revolutions per minute, the time, in seconds, to turn half the body is $\frac{60}{635} \times \frac{640}{1} = 60.47$ seconds. Adding to this the time for the idle movements of the machine we get $60.47 + 2.4 = 62.87$, or approximately 63 seconds. This gives us a product of 57 pieces per hour, but upon referring to the table of change gears we find that gears to give this product are not obtainable. Therefore it is necessary to do either one of two things—increase the product to 59 and increase the feed of the tools accordingly, or else decrease the product to 51 pieces per hour with a corresponding decrease in feed.

The "set-up" used in making this set-screw is illustrated in Fig. 4. The operations start in the "first" position, where the first box-tool *A* comes into position, turns up half the length of the body—$2\frac{7}{8}$ inches—and points the end of the screw. At the same time that the box-tool is in operation on the work, the form tool comes in from the side and turns down the neck—also rough-forming the top of the head. As the cylinder is indexed into the "second" position, the second box-tool *B* comes into operation and finish-turns the body. The cylinder is again indexed into the "third" position, where a self-opening die *C* cuts the thread. For a clear description of the operation and application of this die, reference should be made to the article which appeared in the February, 1913, number of MACHINERY. After threading, the cylinder is again indexed and the piece cut off with a straight-blade cut-off tool *D*. These various operations have been described separately, but in actual performance all tools are at work on different bars at the same time.

"Set-up" in which Forming Operation is the Time to Complete One Piece

The knurled head nut shown at *B* in Fig. 1, and in Figs. 3 and 5, represents an example in which the forming is the longest single operation, and is the time to make one piece. This is evident from a glance at Fig. 3 where the dimensions of the piece are given. This knurled nut is made from a 2-inch bar of round brass rod in a No. 56 "Acme" multiple-spindle automatic screw machine.

The first step in determining the time to make this piece is to obtain the correct speed at which to rotate the work. Rod brass can be worked at 150 to 200 surface feet per minute, and by calculation we find that a spindle speed of 290 R.P.M. will give 150 feet surface speed. The next step is to determine the proper feed at which to operate the form tool. Now the conditions under which this thumb-nut is made are ideal as far as a heavy feed is concerned, so the form tool can easily be operated at 0.005 inch per revolution. By dividing this into the travel of the form tool, which is 0.635 inch (allowing 0.010 inch to approach the work) we find that it will require 127 revolutions of the spindle to complete the forming operation.

As this is a case where the longest single operation is performed from the form tool-slide, it will be necessary to calculate the time required in seconds to complete the idle movements of the machine. We find, however, by referring to Fig. 10, in the October number of MACHINERY, that the form cam occupies exactly the same circumferential space as the lead cam; thus we can utilize the same time as that given in the article previously mentioned, which is 4.6 seconds. Then

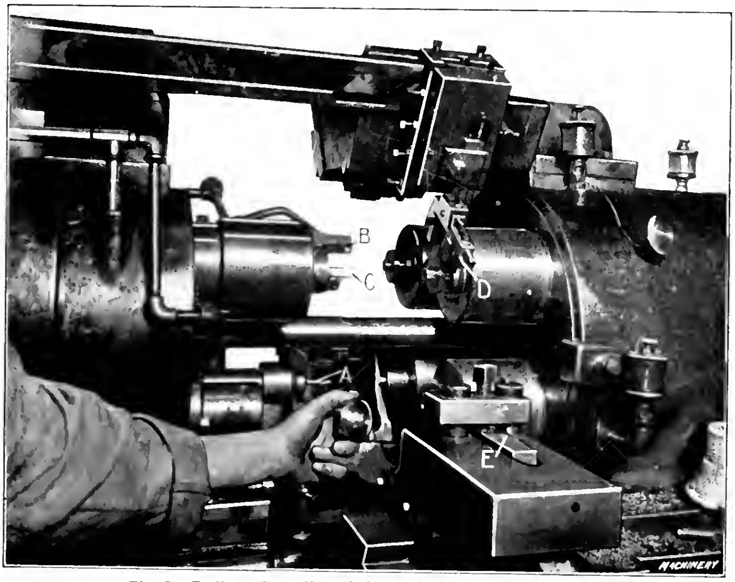

Fig. 5. Tooling "Set-up" used for producing a Brass Thumb-nut

the time in seconds to complete the forming operation equals 26.27 seconds. Adding the time for the idle movements we get $26.27 + 4.6 = 30.87$ seconds. Say that it takes 30 seconds to make one piece, then we get a product of 120 per hour. The nearest production to this for which change gears are obtainable is 122 pieces, and by using the change gears to get this production, we increase the feed of the tools slightly, which in this case could be done with satisfactory results.

In making this thumb-nut, the rough-forming is accom-

plished in the "first" position and the hole drilled to the proper depth with drill *A*, see Fig. 5. In the "second" position the head of the nut is knurled with knurl *B*, and the hole counterbored to a square bottom, both operations being handled by tools held in the end-working tool-slide. The hole is tapped with tap *C* and the head beveled and notched in the "third" position, the latter operation being accomplished with a shaving tool *D*. In the "fourth" position the completed nut is cut off from the bar with cut-off tool *E*.

An example of work whose operation is difficult to determine at a glance is shown in Figs. 6 and 8. This piece, which is also shown at *C* in Fig. 1, is made from cold-rolled steel bar, 2 3/16 inches diameter, and is 2¾ inches long. The forming cut is rather heavy, so the production on this piece can be considerably increased by dividing the forming cut between two forming tools. The first forming tool is used for breaking down only, as indicated at *A* in Fig. 6, while the second forming tool is used to bring the piece to the desired shape, as at *B*. The greatest reduction in diameter on this piece is 15/16 inch, making a rough-forming travel of 0.440 inch necessary. Now the finish-forming tool has to travel practically the same distance as the rough-forming tool, but while it does not remove as much material, it is operated by the same slide as the roughing tool; hence both roughing and finishing cuts consume the same amount of time and are the longest operations.

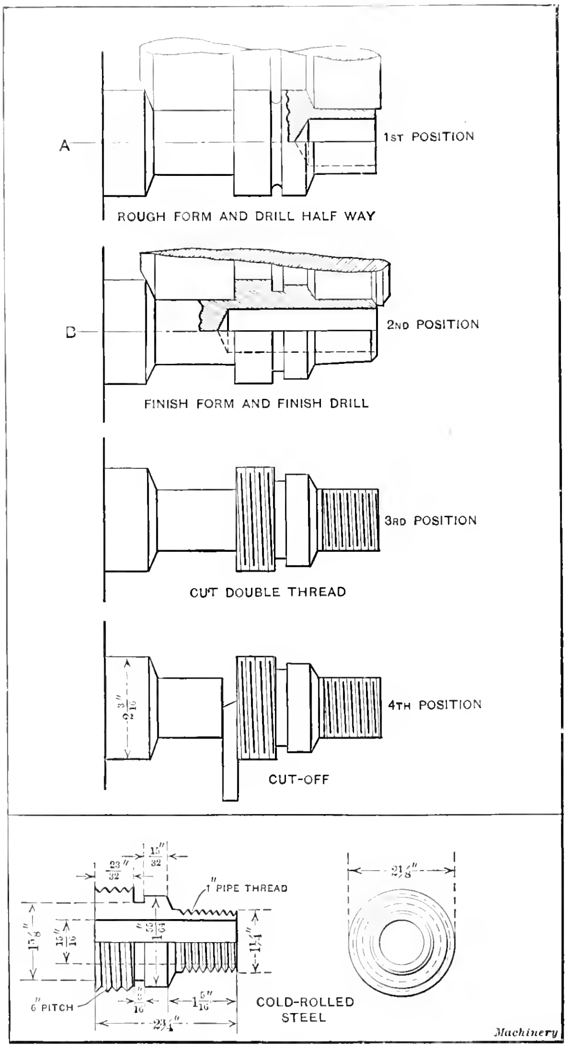

Fig. 6. An Example of Work on which it is Difficult to figure the Longest Single Operation

Turning our attention now to the drilling operation, we find that a hole 15/16 inch in diameter and 2¾ inches deep has to be produced. This can be divided between two drills, as indicated at *A* and *B* in Fig. 6, so that the travel of the main tool-slide for drilling will be 1⅜ + 1/32 inch, or a total of 1.406 inch. The drills can be operated successfully in this material at a feed of 0.010 inch per revolution. This will give 140 revolutions to complete the drilling operation. Figuring on a feed of 0.0015 inch for the rough-forming operation, and a rise of 0.445 inch (0.005 inch being allowed to approach the work), we find that it requires 296 revolutions of the spindle. As the method of calculating the time required to complete a piece of work when the forming cut is the longest single operation has been previously described, it will not be necessary to go into detail here.

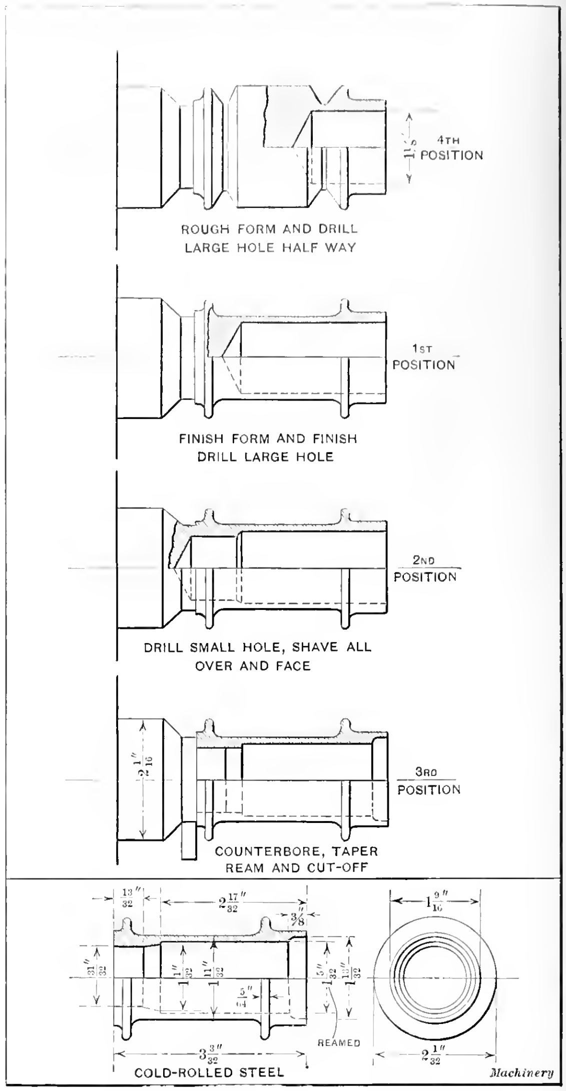

Fig. 7. Order of Operations on the Motorcycle Hub shown in Fig. 9

The tool "set-up" used for making the piece shown in Fig. 6 is shown in Fig. 8. It will be noticed by referring to this illustration that two circular forming tools *A* and *B* are used. The first forming tool *A* is held in the regular tool-holder, working in the "first" position, while the second or finish-forming tool *B* is held in a special holder, attached to the top face of the forming slide. This holder is provided with an overhanging arm in which a set-screw *C* is located, to enable the forming tool to be held rigidly in place. In making a double tool-holder of the type illustrated, it is essential that it be rigidly clamped to the tool-slide and have as much bearing surface as is consistent with the space available. As a general rule, it is advisable when a holder is of the built-up type, to have the stock rotating toward the form tool instead of away from

it. This enables a much heavier cut to be taken without chatter, as the thrust is directed against the tool-slide instead of from it, the latter action tending to lift the tool up. In this case, however, the holder is supported by the top bracket, thus overcoming the tendency of the tool to rise. This job also presents another interesting feature in the double or telescopic die-holder *D*. This die-holder, which was described in the February, 1913, number of MACHINERY, can be used for cutting two diameters of threads of unequal pitches, owing to its construction and operation. The outer member of the die-holder is spring controlled in its action, so that it can lead out in advance of the other part of the holder, thus enabling threads of different pitches to be cut.

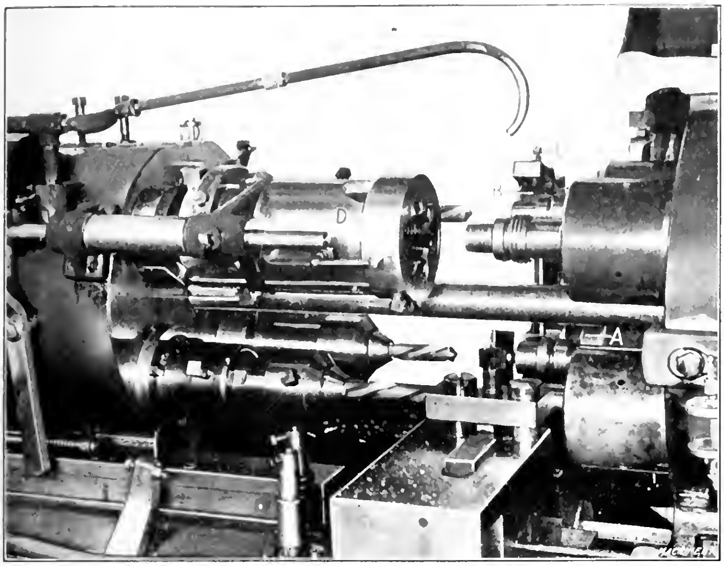

Fig. 8. Tooling "Set-up" used in producing the Steel Part shown in Fig. 6

The motorcycle hub shown in Figs. 7 and 9, and at *D* in Fig. 1, presents a good example of how production can be greatly increased by using the most efficient tooling method. It will be seen by referring to Fig. 7 that this motorcycle hub is made from a cold-rolled steel bar $2\frac{1}{16}$ inches in diameter and $3\frac{3}{16}$ inches long. Considering the length of form and the large amount of material to be removed in this manner, the work can be handled much more expeditiously by dividing the forming cuts between two or more tools. Both forming tools are required to take long, heavy cuts, so that rigidity is absolutely necessary.

In order to keep the feed up to a point where a good production is possible, the arrangement shown in Fig. 9 is adopted. This, as can be seen, consists in placing the first forming tool in the "fourth" position instead of in the "first," as is the usual manner, and cutting off the completed piece in the "third" position. It is evident that the cut-off tool does not need to be held nearly so rigidly as a form tool, and hence can be successfully handled on an extension bracket, as illustrated. This arrangement allows the rough-forming to be done in the "fourth" position (where the stock is fed out) and the finish-forming to be accomplished in the "first" position. Suppose, for instance, that the stock were fed out in the "first" position —the rough-forming would have to start at this point. This would hardly be advisable, as the wide amount of form necessary could not be handled with an extension tool. It is therefore evident that the tool "set-up" shown in Fig. 9 is commendable, in that it obviates all flimsy construction, and enables the work to be produced much more rapidly.

The operations handled in this "set-up" are as follows: In the "fourth" position the diameter is rough-formed, and the large hole drilled part way with drill *A*; in the "first" position the forming cut is finished, and the large hole drilled to the required depth with drill *B*; then in the "second" position the small hole is drilled with drill *C* and the diameter finished all over by a shaving tool *D*, the end also being faced with a cutter held in the holder *E* which is attached to the holder *G* carrying the smallest drill *F*. In the "third" position the hole is counterbored and taper-reamed, and the work cut off. Inasmuch as this job is handled in a manner out of the ordinary, it may be advisable to go through the calculations and see what product can be obtained by applying the "set-up" illustrated in Fig. 9.

Cold-rolled steel, as a rule, can be worked at from 90 to 110 surface feet per minute. We find by calculation that a spindle speed of 100 revolutions will be about the desired speed at which to rotate the work. The rough-forming tool will stand a very much heavier feed than the finish-forming tool, and as both tools have to travel the same distance, it is evident that the finish-forming operation will be the one on which it will be necessary to base our calculations. The width of the form tool is made up of two sections about $1\frac{1}{4}$ inch long, does not bear in the center, and the smallest diameter formed is $1\frac{11}{32}$ inch. Considering this, it would be inadvisable to use a feed exceeding 0.0015 inch per revolution of the work. Figuring on a travel of 0.350 inch for the finish-forming tool, at the rate of 0.0015 inch feed per revolution, we get 233 revolutions to complete this operation. As the forming cut is the longest single operation, we find from this the time to make one piece. The spindle speed used is 100 R.P.M. and the revolutions required for forming are 233, which is equivalent to 2 minutes and 18 seconds; adding the time required for the idle movements—4.6 seconds—we get a total of 2 minutes and 23 seconds, approximately, to complete one piece, or 26 pieces per hour.

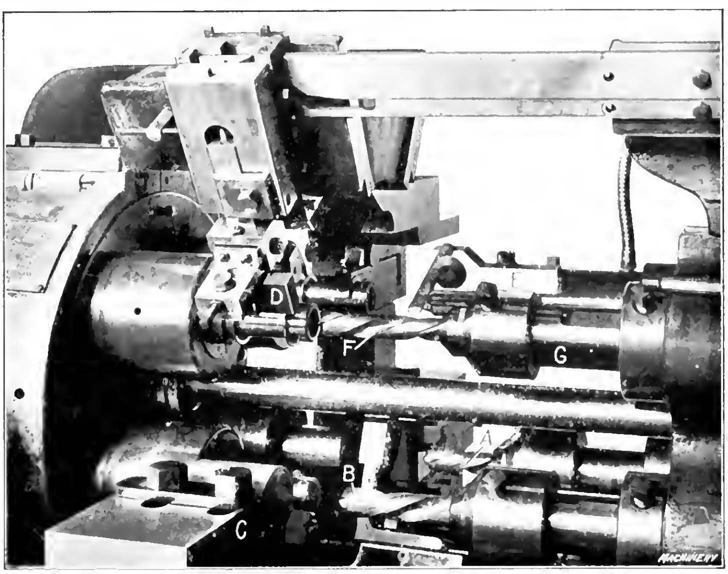

Fig. 9. A Motorcycle Hub which is produced economically on the "Acme" Multiple-spindle Machine by means of a Commendable Tooling "Set-up"

"Set-up" in which Longest Operation is performed from Cut-off Tool-slide

A sample of work which differs considerably from those previously described is shown in Figs. 10 and 12, and at *E* in Fig. 1. This piece is a cold-rolled steel bushing, which is slab milled on its largest diameter. The slab milling opera-

tion, in this case, can be most conveniently handled from the cut-off tool-slide, a fixture of the type shown in Fig. 11 in the April, 1913, number of MACHINERY being used and carrying two cutters. These end milling cutters are brought in at the same time as the cut-off tool and work in the "third" position, the cut-off tool severing the completed piece from the bar in the "fourth" position. Now it is evident from a close study of this piece that the longest single cut lies between the milling and forming operations. Taking the forming cut first, we find that the distance the forming tool must travel is 3/16 inch. No allowance need be made for the tool to approach the work, as the diameter is finished by a shaving tool. The length of the form tool is about 1 1/4 inch, and the smallest diameter 1 inch, so that the feed should not exceed 0.002 inch. Working the form tool at this rate of feed will require 93 revolutions. As the slab milling attachment is carried on the top face of the cut-off tool-slide, it can easily be seen that the feed given to the milling cutters will be governed by the feed used for cutting off. Now as the distance that the milling cutters must travel is greatly in excess of the travel of the cut-off tool, an accelerating device is used on the milling attachment. This increases the travel of the milling slide over the travel of the cut-off slide in a ratio of 1¾ to 1. Deciding on a feed for the cut-off tool of 0.0025 inch per revolution, the feed or rate of advance of the milling cutters in relation to the revolutions

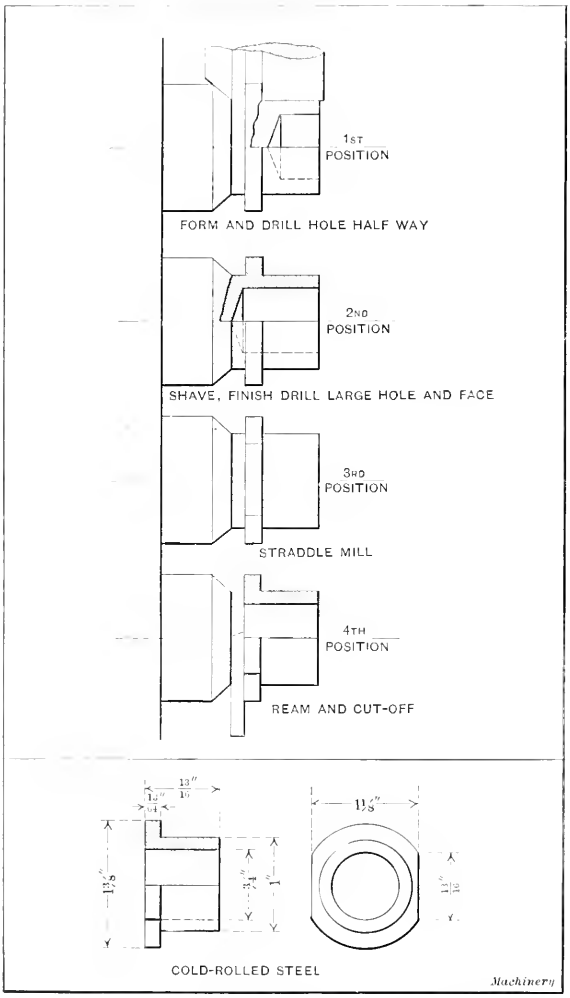

Fig. 10. Order of Operations on a Steel Job that is slab-milled

of the spindle will be $0.0025 \times 1.75 = 0.00438$ inch. Then dividing this into the travel of the slide—13/16 plus radius of the milling cutters, which are 1/2 inch diameter, plus 0.020 inch for clearance—gives us 1.082 inch travel. This is equivalent to 247 revolutions of the spindle.

This piece can be most economically produced on a No. 54 machine, and deciding on a surface speed of about 95 feet per minute, we get a spindle speed of 260 R.P.M. The time required to complete the milling operation was found to be equivalent to 247 revolutions of the spindle or 57 seconds.

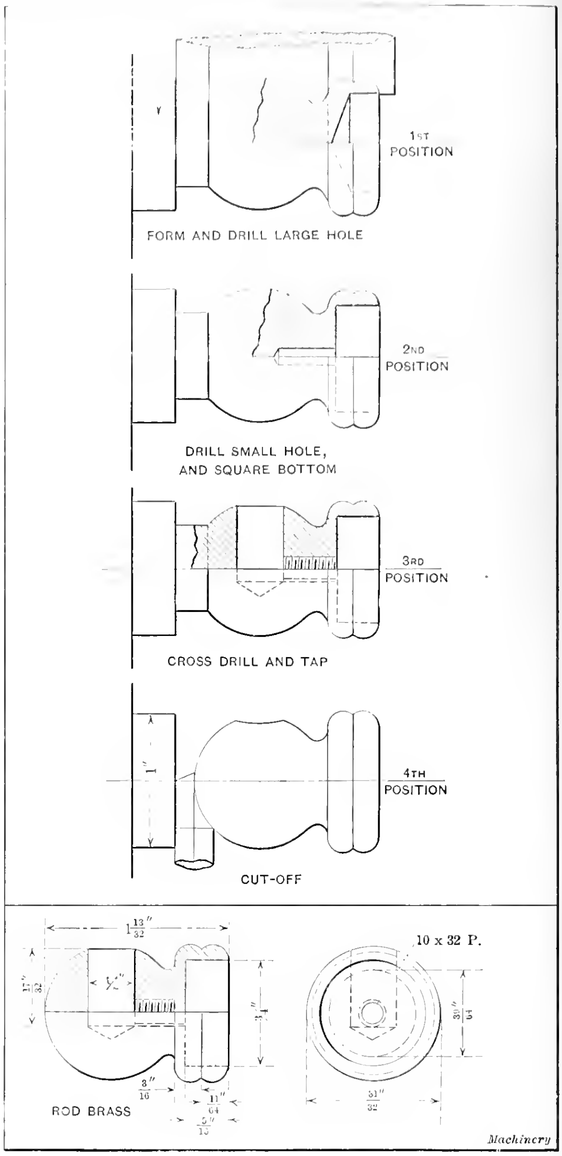

Fig. 11. Order of Operations for producing a Cross-drilled Brass Knob

Adding the time for the idle movements—1.88—(see Table IV in the October number of MACHINERY) gives us 58.88 or approximately 59 seconds to complete one piece, which is equivalent to a product of 61 pieces per hour. The nearest gears to the product required are those for 58.5 pieces, so we will drop down to this product.

The brass knob shown at *F* in Fig. 1, and in Figs. 11 and 13, is a difficult piece on which to determine the longest operation at a glance. It is evident, however, that the drilling of the large hole in the end will not require much time, so that the longest operation lies between the forming and cross-drilling cuts. Referring to Fig. 11, we find that the depth of form cut is 0.195 inch. Then deciding on a feed of 0.002 inch per revolution, we find that it will require 98 revolutions of the spindle to complete this operation.

The cross-drilling attachment is held on the cut-off tool-slide, and as was previously stated is governed in its travel by the feed given to the cut-off tool. As the cross-hole is deeper than half the diameter of the stock to be severed by the cut-off tool, it is necessary to use an accelerating cross-drilling

attachment. This will increase the rate of travel of the attachment in relation to the cut-off tool-slide in a ratio of 1¾ to 1. The travel of the cross-drill is equal to the depth of the hole—$\frac{15}{32}$ inch—plus the length of point on the drill and the height of the arc removed from the ball by drilling a hole in it. This we find is equal to 0.750 inch.

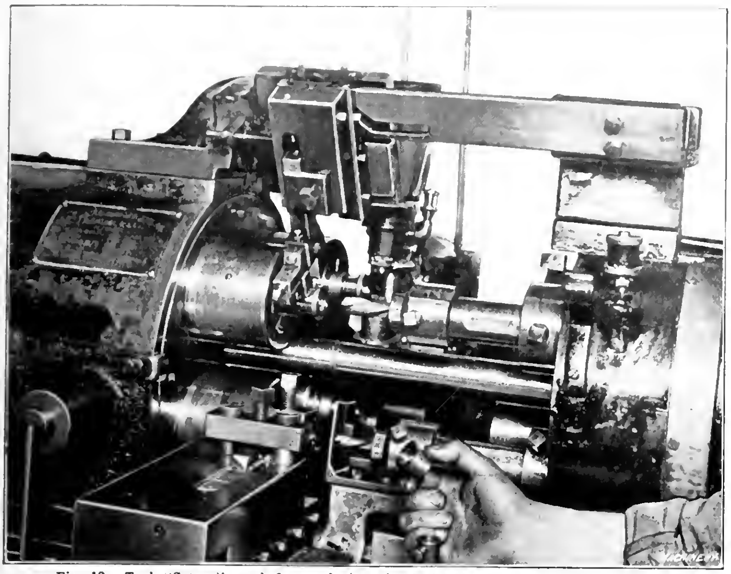

Fig. 12. Tool "Set-up" used for producing the Slab-milled Piece shown in Fig. 10

Deciding on a feed for the cut-off tool of 0.003 inch per revolution, the feed of the drill in relation to the rotation of the spindle is $0.003 \times 1.75 = 0.00525$ inch. Then the number of revolutions of the spindle equivalent to the time required to drill the cross-hole is 143. Putting this job on a No. 54 machine and using a speed of 520 R.P.M., it will require 16.5 seconds to drill the cross-hole. Adding the time for the idle movements—1.88—gives us a product of one piece in 18.38 seconds or 195 pieces per hour. We find upon referring to the product that the nearest production to this for which gears are provided is 199.5 pieces.

* * *

CAPITALIZING CHARACTER IN ITALY

Wherever one travels through the north of Italy he sees large or small groups of workingmen, skilled or unskilled, with no padrone to drive them, making roads, carting the gravel from beds of torrents, constructing steam railways for the government, erecting big apartment-houses for the working people to live in, extending their operations to every sort of trade by organizing themselves into cooperative societies to undertake big contracts. Binding themselves together to work for themselves and for one another, paying their own wages, carrying the responsibility of properly fulfilling their contract, and depositing a fund to guarantee its completion, they eliminate the intervening contractors entirely, saving the middleman's profit to divide among themselves in proportion to the amount of work which each man has contributed and to the existing wage scale for his trade. Having now become their own employers, they have in their own work eliminated the strike. The labor cooperative society is the latest and farthest advance of collectivism today, and some forms of it in Italy are unique. Ask these laborers about their work, how they are holding together, how they secured the contract and the necessary guarantee to obtain it, how they have been able to purchase all the machinery required to carry it out, and they will tell you that there is a cooperative bank in the neighboring city to which they belong, with which their contract is deposited, and which advances them from month to month the necessary funds for equipment, supplies and wages. Based on assets which have previously been of negligible value to the laborer in the securing of credit namely, character, thrift, the ambition of every man to get on, his normal impulse to produce the greatest within him, mere numbers which, joined together with their small mites of money, are no more to be despised than a Rothschild singly—there have arisen in Italy a host of Banks of the People—*Banche Poplari*—a veritable army of cooperative savings and loan societies which have given to individual members a credit service previously inaccessible if not impossible, and which now are extending their operations to reliable cooperative groups of workmen. Owned and operated by the people themselves on the most democratic lines, the power is diffused by the single vote which each member wields, irrespective of the number of shares he holds.—*Harper's Magazine.*

* * *

Electro-chemistry is likely to work a marvelous change in certain industries that are now generally regarded as nuisances by their neighbors if not actually detrimental to general health. Soap works, glue works, slaughter houses, fertilizer plants, tanneries and similar factories are the pariahs of industry condemned to locate in out-of-the-way and desolate parts where no one cares to live. Their odors advertise but do not recommend them. All this is likely to be changed by the ozonator, an electrical device that liberates free ozone, by electric discharge. Ozone has wonderful power to destroy bacteria and disagreeable smells. One part of free ozone in a million parts of air will dispel odors that resist all ordinary cleansing agents. Warehouses that reek with the smell of smoked fish can be made fit for storing meat, coffee or dress fabrics in a few hours Ozonators connected to the stacks of a meat packing-house completely eliminate the bad smells. To change thus the character of many disagreeable industries will mean an uplift in the state of employes, and other improvements in social and physical ways that can hardly be overestimated

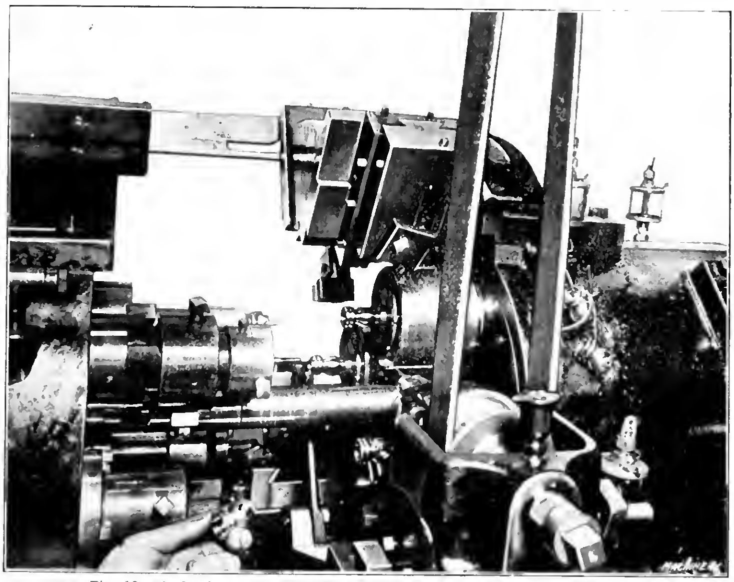

Fig. 13. A Good Example of Cross-drilling on the "Acme" Multiple-spindle Automatic Screw Machine

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

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NOVEMBER, 1913

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REMOVAL OF MACHINERY'S OFFICES

The offices of MACHINERY will be removed this month to 140-148 Lafayette St., corner of Howard, five blocks north of the present location, where a twenty-one year lease has been taken of the four upper floors of the Bradstreet building, comprising about 40,000 square feet. The business offices will occupy the top floor, and the mechanical departments two other floors, the remaining floor being reserved for future requirements.

* * *

DESIGNING SPECIAL MACHINERY

The draftsman or mechanic who wishes to design special machinery, develop inventions or produce any mechanism out of the general run has few precedents to guide him. There are no schools nor textbooks that teach invention; the way to learn to design new combinations of mechanical elements is to go ahead and do it. This paradox has parallels in other walks of life. The way to accomplish the apparently impossible is simply to try.

However, the would-be designer can get much help from books and a general training in mechanical engineering. Books that illustrate many mechanical movements are useful. Treatises which explain the principles of mechanics, the laws of friction, motion, inertia, falling bodies, velocity ratio, and related subjects are indispensable. The aim should be to design machinery that is efficient—that is, having low frictional resistance. Also due attention should be given to the elimination of noise. Friction means wear, and excessive friction will cause rapid wear and reduce the working life. Noise is generally evidence of mechanical inefficiency. The clash of moving parts and consequent vibration tends to rack the machine and to distract the operator. But these refinements should be studied after the main features of design have tentatively been chosen.

Many machine designers work in a haphazard way, beginning, perhaps, by laying out the main center lines, outlining the bed casting, or designing the spindle and headstock of the machine. There is too little logic, system and order about machine design, and yet it is possible to introduce a systematic method of procedure that greatly reduces the time that would otherwise be required. A very successful machine designer outlines the following method as being one which could be followed to advantage in most cases of machine tool design, particularly of special machinery.

First draw in the piece that is to be made. If a number of sizes of work are to be handled, draw in the largest and smallest; then design, without considering the remainder of the machine, the best means for holding the work to be operated upon. When the chuck or faceplate for holding the work has been designed, lay out in the proper positions the kind of tools that would be employed under ideal conditions; next design the tool-holder for holding the tools, and then lay out the slide or carriage for holding this tool-holder to provide the required movements. Lay out the spindle that is to support and drive the chuck, making its dimensions just what they should be under the ideal condition; then provide the bearings for the spindle and a head for holding the bearings. The design of the drive for the spindle, comprising gears, cones or other parts, follows. If the machine is automatic, it requires a camshaft. Place the camshaft in the air in the most desirable position and locate cams on it just where they ought to be without reference to the rest of the machine; then build up a frame or bed with bearings as required for the various shafts, and provide the necessary clearance.

When a machine is designed in this way, it will be possible in nearly every case to select for each detail the most satisfactory design and to use such dimensions as are most appropriate for each part. There will be no difficulty in finding room for this or that part, because the whole machine has been built from the center outward instead of having been built in a predetermined space as in the usual procedure. In the latter case, it is often difficult to get parts to clear one another and to find room for all the mechanism. The design has to be stunted and warped and parts placed in improper positions. By following the method of building out from the center in all directions, the machine will be made just as long, wide and high as is actually necessary to admit the parts required to perform the work satisfactorily.

* * *

ECONOMY IN AUTOMOBILE MANUFACTURE

The recently published announcement to the effect that the builders of the most costly automobile in America would discontinue its manufacture and sale because of losses sustained, has awakened wide interest in the problems of building high-priced and low-priced cars. The announcement came shortly after the division of a $10,000,000 surplus by a concern building an automobile costing about one-tenth as much as the other. Why is the latter concern so prosperous when the first one has found the building of $6000 automobiles unprofitable?

While an answer cannot be given in a single sentence, the gist of it is that the large market for the low-priced automobile warrants the most advanced and economical means of production, whereas the demand for the high-priced automobile is so limited that expensive methods of manufacture are necessary. Poor management could not succeed with this handicap.

The prosperity of the automobile concern building the low-priced automobile whose name is almost a household word throughout America, and which is well known abroad, is a triumph for interchangeable manufacture and specialized machinery. It is a triumph for a plant organized in considerable part on the twenty-four hour production basis where the means of production are thus kept in constant use. The ordinary plant runs nine or ten hours a day except when the pressure is greatest, and then it runs a few hours overtime each day, at a high cost for labor. The inequality in cost of production under the two systems is startling. The disparity in weight and character of material entering the two cars cannot be offered as an adequate reason for the great difference in cost. But there is a great difference in the selling cost, for the low-priced car virtually sells itself, while the high-priced car requires high-priced salesmen and an expensive selling organization generally. The fact that the plant was not in the geographical center of the automobile trade was also of some importance. Another disadvantage was the heavy overhead charges due to injudicious investments of capital; but the principal cause of failure was the lack of demand and the consequent high-cost methods.

FIRES IN FACTORIES

One of the serious hazards of manufacturing is fire. Many prosperous concerns have been ruined by fires even when their actual loss on buildings, machinery and material was covered by insurance. Their insurance, however, did not cover the loss caused by stopping the output, by the demoralization of the working force, the loss of records, diversion of trade to competing concerns and destruction of means of production that could not be immediately replaced.

Many factories are built of wood and are poorly designed to resist a destructive fire when it has once gained headway. It may be impracticable to replace the buildings with stone, brick or concrete, but that does not mean that adequate fire protection cannot be provided. The way to prevent fires is to provide automatic means for quenching them at the start, and the sprinkler system does just that. No concern having inflammable buildings or product, or both, can afford to take the risk of having its business ruined, with loss of life perhaps, when the expenditure of a few thousand dollars will reduce the risk to a minimum. In some industries the reduction of insurance rates will effect a saving amounting to more than enough to pay the interest on the investment. A fire-resisting roof to protect from outside fires and the sprinkler system to quench small interior blazes will give to the proprietors peace of mind and permanancy of plant—two conditions necessary for success.

* * *

THE SPECIALIZING MANUFACTURER

Specialization in the manufacture of engine and transmission parts has become one of the many noteworthy developments connected with the growth of the automobile industry. Nowadays one concern produces the gears, another is equipped exclusively with automatic machinery for turning out small parts, and so on. Finally the various members all come to the central plant and are assembled. While this method of manufacturing is not new, it is an interesting development and is conducted on a much larger scale in the building of automobiles than in any other line of machine construction. Of course a machine or tool is rarely built entirely under one roof, or in one plant; usually some small parts, such as screws, lubricating devices, etc., are purchased from another concern which specializes in that particular line. But the automobile manufacturers have gone a step further, and not only buy accessories, but many important parts, so that at the present time some of them have ceased to become builders and are simply assemblers.

If the advantages of this method are as great as the extent of the practice in automobile manufacture indicates, it is reasonable to suppose that it may become more general in other lines of work. The continual introduction of new machines and methods doubtless has had much to do with this system of manufacture. While the variety of machine tools now being built enables work to be done more economically, the variety also makes the proper selection of tools more complex. Take turning, for instance; it might be possible to turn a given part that is required in large quantities, in a half-dozen "automatics" of different design, all of which are capable of handling the job. But which type will be the most efficient? The automobile manufacturer leaves the solution of this problem to the screw-machine products man. He is equipped with automatic screw machines of all kinds, and knows from experience which type is best adapted for turning various classes of work. And so it is with many other machining operations that are highly specialized. Just how far this practice could be profitably applied to machine construction in general, it would be difficult to predict. We have seen large concerns making small parts by obsolete methods so costly that money would be saved by buying from a manufacturing specialist even at prices yielding fancy profits.

* * *

"Non-productive" labor may be a necessary evil; yet the manager who tries to dispense with the product of the non-productive labor will soon find that he has no other product to dispose of.

SYSTEM CARRIED TO EXTREMES

BY M. T.

The story of Benjamin Lawrence and cost-keeping which appeared in the August number of MACHINERY reminds me of some of my own experiences while in the employ of a big automobile concern. The firm in question is enjoying a well deserved national and even international reputation for the quality and reliability of its product. It knows no dull seasons and it furnishes steady employment to thousands of men; its financial standing and reputation are an object of envy to all its competitors. It has a rigid system which is a model of thoroughness and waste.

High standard of workmanship is a part of this system. Every bushing used in the construction of the product must be reamed within prescribed limits, the most liberal margin being 0.0005 inch above and below the standard. Likewise, all the pins fitting in these bushings must be ground within the same limits and no deviation from this rule is permitted. A glaring example of waste resulting from such inflexible rules is to be found in the construction of the propelling mechanism of the car, where four bronze bushings and four steel pins are being used. On account of the twisting action of the frame resulting from unevenness of the road, it has been found advantageous to give the pins about 1/64 inch clearance in their bushings and thereby secure a sort of universal action. The arrangement proved a success and was promptly adopted, but the usual limits for reaming and grinding were retained. The bushings are drilled and then reamed to within 0.0005 inch, and the pins are ground to within 0.0005 of 63/64 inch.

The folly of such fine workmanship is only too apparent. I had a friend in the cost-keeping department who furnished me with some figures pertaining to the cost of extra machining, inspection and shop charges on these bushings and pins, and with the aid of simple arithmetic I calculated that if someone in authority cared to give a jolt to this iron-clad rule he could effect a yearly saving amounting to the cost of two complete cars, which, by the way, sell for a snug sum each. But, as long as the firm is enjoying good business and its stockholders get their regular and occasionally extra dividends, who dares to pick faults with the system?

Another curious feature of this system was the filling out of time cards by the employes of the drafting-room. The latter, while being on the monthly salary basis, were required to fill out a time card for every drawing made. While such a system may be desirable and even essential for a jobbing concern, it is entirely out of place in a big firm turning out a staple product and disposing of it in the market through an organized sales force. I had a chance to observe some of the effects of this regulation. A spends three days in an effort to improve a certain oil pump fitting which was causing a good deal of trouble. At last he succeeds and produces a very neat and simple article that overcomes every objection and meets every requirement; it takes him only one-half hour to make a complete drawing. Presently he is filling out the time card, but instead of putting down three days consumed in arriving at his goal all he dares to put down is two hours; the fitting looks so simple and the drawing consists of so very few lines that no man who has not followed A's mental process closely can account for the time actually spent in producing the drawing. The time card never did and never will record one's mental process, and for A to put down three days, as he is supposed to do, is to invite criticism. The balance of two days and six hours he charges to "miscellaneous work," "changes," or some large pattern on which he spends only two days but to which he can fearlessly charge five days' time.

The "boss" knows and admits that time cards in his department are absurd and accounts for them by the desire on the part of the management to have a uniform system throughout the plant, but he thinks it really does not make much difference one way or another. But it does. These time cards, many of which do not record the correct amount of time consumed within several hundred per cent, become a matter of record; the cost of drawings is figured separately

and with departmental charges added to the cost of the particular pattern or forging, and for all I know they might have also served as a basis for plotting efficiency curves for the individual members of the company's engineering department.

Quite a number had a vague suspicion that somewhere someone was keeping an accurate record of the work turned in; the practical results of this suspicion may be illustrated by the case of B who spends five days in making a sketch of some proposed mechanism and turns to his neighbor C for a friendly criticism. The latter discharges his duty in a very thorough and conscientious manner. B goes back to his table and while admitting that C is right—he remembers the time card, and rather than spend two additional days redesigning the mechanism, he hands it in just as it is. The "boss," the "chief" and the "governor" get their heads together and after a few hours of consultation they turn it down for the reasons fully anticipated by C and admitted by B. The drawing, however, is not destroyed; it is preserved as a matter of record. In two days' time B turns out another design of the same mechanism which after a close scrutiny is accepted by the department heads. Thus B's efficiency curve is maintained at a satisfactory height by the fact that he has two drawings instead of one to his credit, and, by the way, B and C are the only souls who know that the time card is responsible for two instead of one consultation on the part of the department heads.

The system in this plant is not unlike the proverbial Hydra of Greek mythology; it has many an ugly head. One of them was the limit placed by the management upon salaries connected with various positions both high and low, and as these limits were set some five years ago; they are considerably out of date. As a result the more capable men were constantly leaving for more lucrative positions elsewhere and the least efficient men in all departments would hang on to their jobs as long as they could. The theory and practice of placing a limit to compensation on any given position rather than on the man filling it is contrary to every known rule of common sense. Coupled with this practice, there was among the employes a general feeling—which came as a result of long observation—that it was not the policy of the company to promote its men to positions of responsibility. As a consequence, rising young men possessed of spirit and ability would leave the firm's employ to be appreciated elsewhere. I was told by old-timers of three men who never rose above subordinate positions in their engineering department and who are now occupying positions as chief engineers with various concerns. I had the good fortune of meeting one of them—Mr. D——. When asked if he knew the reason for placing a price on the position rather than on the man, he replied: "Why, yes, it is intended to prevent graft. If it were not for this limit any department head might bring in his friends to work for him and pay them anywhere from fifteen to twenty-five dollars more a month than they are worth and—in some cases—as much as they dare. Of course you understand," added he, "that this plan does not eliminate graft—it merely keeps it within certain bounds."

This method of dealing with petty graft in no way interfered with unworthy men getting into responsible positions and drawing fat salaries. D——'s own case fairly illustrates the point. He spent four years with this firm as chief designer on experimental work. At the end of that period the firm expanded, several new positions were created, and the most lucrative of them were going one by one to young men just out of college who had little or no practical experience but who had considerable "pull." D—— took the matter up with the chief engineer, pointed out his long experience in the automobile field on both sides of the Atlantic and his four years' faithful service and excellent record with the firm and wanted to know what show he stood of being promoted to a higher position. "None," frankly replied the chief engineer; "while you are an excellent man in every respect, there is one thing against you—you are a foreigner." Two weeks later D—— left the company's employ to be appreciated elsewhere.

The system in this plant was unique in that it left but small scope of action to individual departments and provided for matters both important and trivial. As an example of the latter, I may cite the stupid demand made on the engineering department that no drawing, however simple, should have less than three views on it. The result was that such simple parts as bolts, studs, nuts, washers, etc., which could be fully illustrated by two views, were invariably shown in three views, two of which were, of course, precisely alike. The boss himself could not give any plausible explanation for this state of affairs, merely stating that it was a "time-honored" custom with this particular firm. Yes, indeed, system was the keynote in this plant, but the question is was it worth while?

* * *

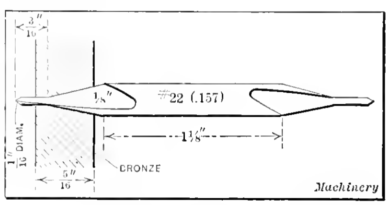
WATERPROOFING CEMENT STUCCO

It must be emphasized that with a lean mortar the permanency of the waterproofing compound is a very important point, as the stucco is exposed to beating storms. That class of compound using stearates, oleates, resinates or other soapy material as a base, gradually washes out under prolonged action of water which slowly but surely dissolves even stearate of lime. A permanently waterproof stucco is dependent on using a compound that is absolutely insoluble and unaffected by the elements. Bituminous waterproofing products belong to this class and compounds have been developed which are miscible with water yet become absolutely insoluble after the mortar has set. This result is obtained by emulsifying the bitumen, which then mixes with water as easily as milk does (milk is an emulsion). But when the mortar sets, it de-emulsifies the bitumen, which then becomes as insoluble as a milk spot. (Butter is de-emulsified milk and is not miscible with water). Bituminous materials so prepared give a very high degree of permanent waterproofing. They are absolutely unaffected by salt air, brine, running water, boiling water and ordinary chemicals. Weight for weight, they give four times the efficiency of soap compounds, yet they actually strengthen the mortar instead of weakening it, and because of the lack of all harmful action the amount of compound is not limited to 2 per cent. If desired 10 per cent or more may be incorporated in the mixture and the waterproofing effect correspondingly increased. In this way a factor of safety may be secured which is as important in waterproofing as in other branches of engineering. It then becomes possible to waterproof under guarantee a cellar fifty feet below tide level, by means of a three-fourths inch interior mortar facing. Evidently this is the kind of material which will give satisfaction also in external stuccos, where no pressure is encountered, but where on account of the lean mixture, a safety factor is desirable to cover variations in mixing and plastering.—*Architecture.*

* * *

ENDURANCE RECORD OF SLOCOMB COMBINATION CENTER DRILLS

The illustration shows one of a lot of special Slocomb combination center drills made by the J. T. Slocomb Co., Providence, R. I., for a customer of the Seattle Hardware Co., Seattle, Wash. These drills are of unusual form because of the fact that the countersink has a long taper. The Seattle Hardware Co. reported that its customer drilled and countersunk 212,000 holes in bronze cylinders 5/16 inch thick, using eighty of the special countersinks. In view of the slenderness of the drill, this seems to be a remarkable record, the average number of holes drilled and countersunk by each center drill being 2650.



Special Slocomb Combination Center Drill used on Bronze

LENGTHS OF WORMS AND HOBS

BY E. WINSLOW BAXTER[*]

The derivation of a formula for quickly finding the approximate length of a worm, to run with a worm-wheel having hobbed teeth, depends primarily upon an assumed relation between the worm and worm-wheel and also upon the pitch and size of the wheel. The relation between the length of worm and the dimensions of the worm-wheel differs with the conditions under which the gears are to run or the standards of the manufacturer.

In the accompanying illustration the hob (or worm) is shown extending from A to B, which produces a hob having

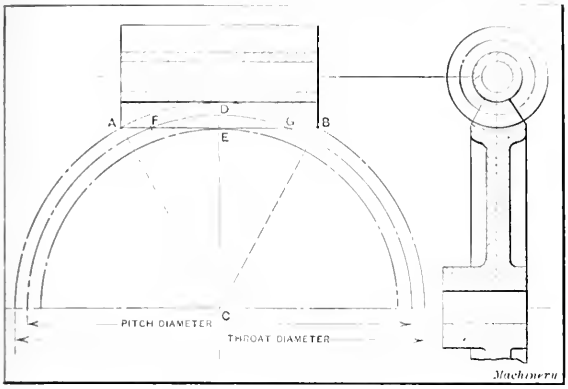


Diagram of Worm and Worm-wheel

the maximum generating action. This length also provides a safe allowance for any end adjustment which may be necessary for the worm. A hob to cut a worm-wheel without interference should be as long as the worm to be used, and neither should be less than the length of the chord between points F and G, which are both on the pitch circle of the wheel.

Let AB or length of hob $= f$;
BC or throat circle radius $= r$;
DE or whole depth of tooth $= d$;
Number of teeth in worm-wheel $= N$.
$CE = BC - DE = r - d$.

Solving the right-angle triangle enclosed by the lines BC, CE and BE or r, $r - d$ and $\frac{f}{2}$

$$(r-d)^2 + \left(\frac{f}{2}\right)^2 = r^2$$

$$r^2 - 2rd + d^2 + \frac{f^2}{4} = r^2$$

$$d^2 + \frac{f^2}{4} = 2\,rd$$

$$\frac{f^2}{4} = 2\,rd - d^2$$

$$f^2 = 4\,d\,(2\,r - d)$$

$$f = 2\sqrt{d\,(2r - d)}$$

In order to further simplify the formula, we will assume the pitch to be 1 inch circular pitch.

DE or d (whole depth of tooth) would then equal 0.6866 inch, and BC or r (throat circle radius) would be equal to $\frac{N + 2}{2 \times 3.1416}$

Substituting we get:

$$f = 2\sqrt{0.6866\left(\frac{N + 2}{3.1416} - 0.6866\right)}$$

which can be simplified as follows:

$$f = 2\sqrt{\frac{0.6866\,(N + 2)}{3.1416} - (0.6866)^2}$$

$$f = 2\sqrt{0.21855\,(N + 2) - 0.47142}$$

$$f = 2\sqrt{0.21855\,N + 0.43710 - 0.47142}$$

$$f = 2\sqrt{0.21855\,N - 0.03432}$$

Squaring both sides of the equation we get:

$$f^2 = 0.8742\,N - 0.13728$$

As the value for f need be only approximate, we can write the equation as follows:

$$f^2 = \frac{7\,N}{8} - \frac{11}{80};$$

$$f^2 - \frac{7N}{8} + \frac{11}{80} = 0;$$

$$80\,f^2 - 70\,N + 11 = 0.$$

Now, if we solve for f for different numbers of teeth, the length of hob or worm when the pitch is 1 inch circular, will be obtained.

For other pitches it will be necessary to multiply by the circular pitch to obtain the correct length.

The accompanying table gives the values of f for 1 inch circular pitch. To illustrate the use of this table, suppose we desire to find the length of a worm to suit a 3/4-inch circular pitch worm-gear, having 39 teeth. Find the value for f in the table opposite 39 teeth. This value is 5.83 and multiplied by the pitch, 3/4 inch, gives 4.37, or about 4 3/8 inches, which is the length of the worm or hob.

TABLE OF CONSTANTS FOR DETERMINING THE LENGTHS OF WORMS OR HOBS

Factor f equals length of worm when circular pitch is 1 inch. To find length for any other pitch, multiply factor f corresponding to given number of teeth in worm-wheel by the required pitch.

No. of Teeth in Worm-wheel	Factor f for 1-inch Circular Pitch	No. of Teeth in Worm-wheel	Factor f for 1-inch Circular Pitch	No of Teeth in Worm-wheel	Factor f for 1-inch Circular Pitch	No. of Teeth in Worm-wheel	Factor f for 1-inch Circular Pitch	No. of Teeth in Worm-wheel	Factor f for 1-inch Circular Pitch
10	2.93	44	6.18	78	8.25	112	9.92	146	11.28
11	3.08	45	6.25	79	8.30	113	9.96	147	11.32
12	3.22	46	6.32	80	8.35	114	10.00	148	11.36
13	3.35	47	6.39	81	8.40	115	10.04	149	11.40
14	3.48	48	6.46	82	8.45	116	10.08	150	11.44
15	3.60	49	6.53	83	8.50	117	10.12	151	11.48
16	3.72	50	6.60	84	8.55	118	10.16	152	11.52
17	3.84	51	6.67	85	8.60	119	10.20	153	11.56
18	3.95	52	6.74	86	8.65	120	10.24	154	11.60
19	4.06	53	6.80	87	8.70	121	10.28	155	11.64
20	4.17	54	6.86	88	8.75	122	10.32	156	11.68
21	4.27	55	6.92	89	8.80	123	10.36	157	11.72
22	4.37	56	6.98	90	8.85	124	10.40	158	11.755
23	4.47	57	7.04	91	8.90	125	10.44	159	11.79
24	4.57	58	7.10	92	8.95	126	10.48	160	11.825
25	4.66	59	7.16	93	9.00	127	10.52	161	11.86
26	4.75	60	7.22	94	9.05	128	10.56	162	11.895
27	4.84	61	7.28	95	9.10	129	10.60	163	11.93
28	4.93	62	7.34	96	9.15	130	10.64	164	11.965
29	5.02	63	7.40	97	9.20	131	10.68	165	12.00
30	5.11	64	7.46	98	9.25	132	10.72	166	12.035
31	5.20	65	7.52	99	9.30	133	10.76	167	12.07
32	5.28	66	7.58	100	9.35	134	10.80	168	12.105
33	5.36	67	7.64	101	9.40	135	10.84	169	12.14
34	5.44	68	7.70	102	9.45	136	10.88	170	12.175
35	5.52	69	7.76	103	9.50	137	10.92	171	12.21
36	5.60	70	7.82	104	9.55	138	10.96	172	12.245
37	5.68	71	7.88	105	9.60	139	11.00	173	12.28
38	5.76	72	7.94	106	9.65	140	11.04	174	12.315
39	5.83	73	8.00	107	9.70	141	11.08	175	12.35
40	5.90	74	8.05	108	9.75	142	11.12	176	12.385
41	5.97	75	8.10	109	9.80	143	11.16	177	12.42
42	6.01	76	8.15	110	9.84	144	11.20	178	12.455
43	6.11	77	8.20	111	9.88	145	11.24	179	12.49

Machinery

* * *

Rich cements are likely to crack if dried rapidly. To avoid hair cracks in stuccos, builders are advised to use three-to-one mixtures rather than two-to-one mixtures which are common. The rich mixtures are more nearly waterproof than the lean mixtures if they dry without cracking, but unless extraordinary precautions are taken to prolong the drying-out process they will be more permeable by water on account of many cracks.

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MAKING STEEL WIRE BELT LACING

THE CLIPPER BELT LACER CO.'S STEEL WIRE BELT LACING AND LACING TOOL

The steel wire belt lacing and method of application developed by the Clipper Belt Lacer Co., Grand Rapids, Mich., consists of wire clips which are clinched in each end of the belt to be joined, forming loops at the outer ends, and locked together by means of either a rawhide or bamboo pin. This

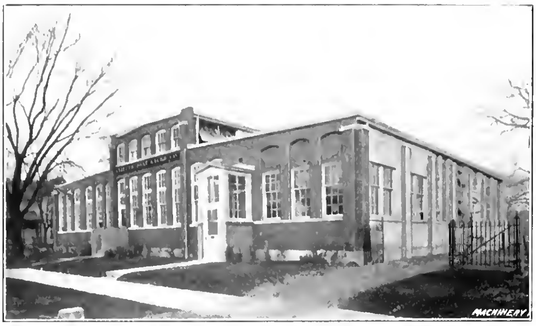

Fig. 1. Factory of the Clipper Belt Lacer Co., Grand Rapids, Mich.

method of lacing makes possible the disjoining of the belt without destroying the lace or in any way affecting the joining members, it simply being necessary to pull out the rawhide pin. Fig. 2 shows two ends of a belt joined in this manner at *A*; at *B* the pin has been removed, disjoining the belt; at *C* a section of the belt is shown with a rawhide pin in place; and at *D* is shown the shape of the hook before being clinched in the belt.

Construction and Operation of "Clipper" Belt Lacer

The "Clipper" belt lacing tool shown in Fig. 3 consists principally of a frame or base *A*, carrying a comb *B* and

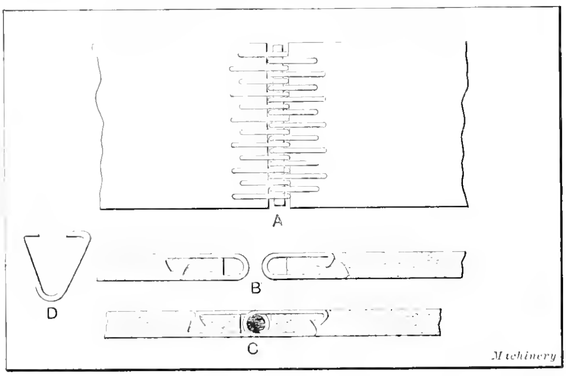

Fig. 2. The "Clipper" Method of lacing Steel Wire Belt

lacer *C* for holding and closing the steel wire hooks, respectively, and an anvil *D*, on which the hooks are closed by means of the clinching bar *E*. Bar *E*, in turn, is held in a swinging arm or bracket fulcrumed on the king pin *G*. Center head *H*, carrying the operating lever sockets *I*, is also fulcrumed on this pin and is held in the desired position when inserting the hooks by means of a dog *J*, hinged to it and located by a ratchet *K*. Power to insert and clinch the hooks in the belt is secured by means of operating levers inserted in sockets *I*, the levers being eccentrically fulcrumed and carrying the rollers *L*, which bear on the tracks *M* and operate the clinching bar.

In operation, the head is first thrown back by removing the dog from the ratchet; then the card of hooks is cut to suit the width of the belt being laced. This is accomplished with a pair of scissors supplied with the lacing tool, by cutting first one edge of the card and then the other, and then bending the card slightly back and cutting through the center. The card of hooks is now inserted in the lacer where it is held in place by the pin *N*. The center head is next brought forward and the dog and ratchet put in place, after which the belt, which has been previously cut square on the end, is placed between the hooks in the tool and on top of the belt holder *O*, care being taken to keep the end of the belt tight against the lacer. Next the levers are inserted in the socket and pressed down, forcing the hooks into the belt. As the head is forced down it is drawn slightly forward each time the levers are raised, and this operation is repeated until the hooks are flush with the surface of the belt.

For lacing a belt wider than the capacity of the lacing tool, the hooks are inserted in sections. On a belt of such a width as to require two lacings, one section is put in at one end, clinched, and brought flush with the belt, and another section of lacing is put in at the other end, thus completing the lacing of one end of the belt; the other end is handled in a similar manner. For a belt requiring three lacings, the hooks are first inserted in the center portion of the belt, after

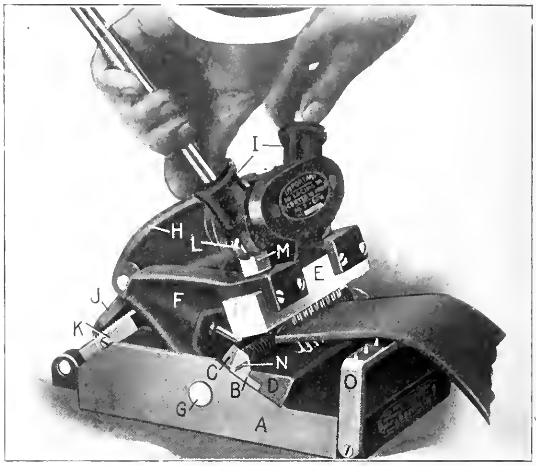

Fig. 3. Operating the "Clipper" Belt Lacing Tool

which the hooks are put in on both sides of the center portion. It is always advisable to locate the hooks as near the center of the lacing tool as possible, as this obviates any unnecessary strain on one side of the tool, insuring a much more even pressure.

Making the Steel Wire Lacing

The steel wire lacing is made from 0.054-inch specially treated steel wire, which is formed into a hook of the shape

Fig. 4. Automatic Wire Forming Machines used in making Steel Wire Belt Lacing

shown at *D*, Fig. 2, in the special wire forming machine illustrated in Fig. 4. This machine, which is known as the regular type of four-slide wire forming machine, completes the hook in one operation. The wire is held on a reel, as shown in the illustration, and pulled through a straightener by means of a feeding device actuated by a crank motion, which, in turn, receives its operation from a cam.

Carding the Lacing Hooks

After the hooks have been formed, the next operation is to place them in cards and thus facilitate their easy insertion in the lacing tools. Previous to the adoption of this method, the hooks were placed in the lacing tool by hand, which was a rather tedious operation. The hooks to be carded are held on a hook, as shown in Fig. 6, and removed from this by the operator. They are placed in the slide, the ends being reversed so as to bring them in the proper position for producing the zig-zag lacing effect in the belt. The paper in which these hooks are inserted is specially treated on the edges so that it will be stiff and at the same time brittle enough to allow them to make their own passage into it without being previously cut. This paper is held on a roll under the machine, and is brought up over a small pulley *B*. From this it passes down through a chute which gradually diverges

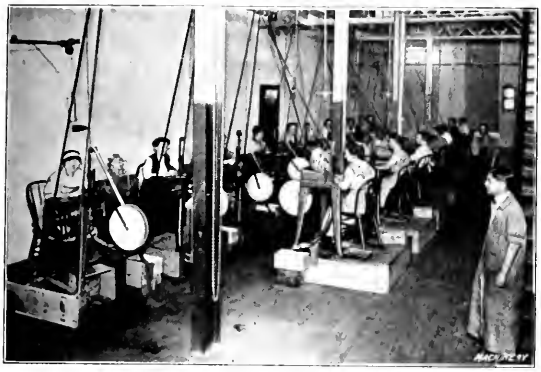

Fig. 5. View of Wire Hook Carding Department

towards the bottom so as to loop over the paper. The hooks are placed in a slide by the operator and fed in, being alternately located as previously described. The paper is forced out by a plunger and the hooks fit into slits which they form in the paper. As the strip of paper feeds down and the hooks are inserted, it is cut off to the required length (containing

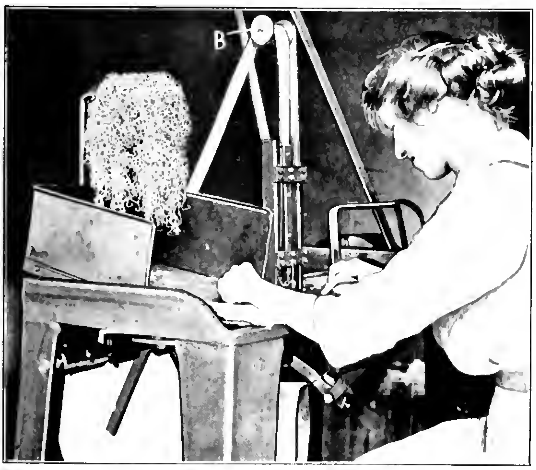

Fig. 6. Machine used for carding the Steel Wire Lacing Hooks

thirty-seven hooks) by a knife which receives its motion from a cam-operated slide. Fig. 5 shows the department in which the carding is handled.

Machining Parts and Assembling "Clipper" Belt Lacing Tool

The frame members for the "Clipper" belt lacing tool require principally milling and drilling. Fig. 7 shows a row of Leland sensitive drills which are used for performing the drilling and reaming operations on the different parts of the frame. The arrangement of these machines is worthy of special mention. Those parts requiring just one drilling and reaming operation are handled on the single-spindle machine at the far end of the line, while those requiring two drilling and reaming operations are handled on the two-spindle machine, this order being followed until the parts requiring the largest number of operations are handled on the four-spindle machine. Thus it will be seen that these machines are so arranged as to handle the work in accordance with the number of operations required on them. This eliminates

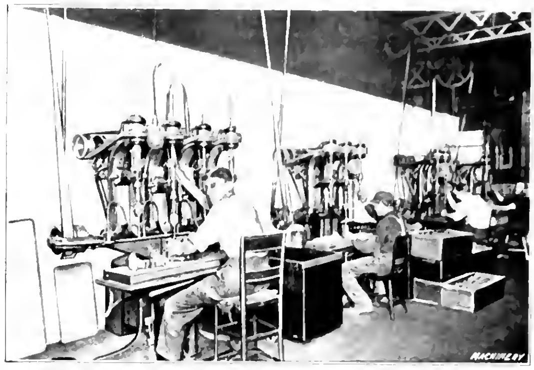

Fig. 7. Drilling Parts of "Clipper" Lacing Tool Frame

the necessity of changing the tool frequently, and increases the output.

Another interesting feature used in making parts of the "Clipper" belt lacer is shown in Fig. 8. This is a grinding device, made by the Grant Automatic Machine Co., used for grinding king pins. This fixture *A* is set at an angle with the

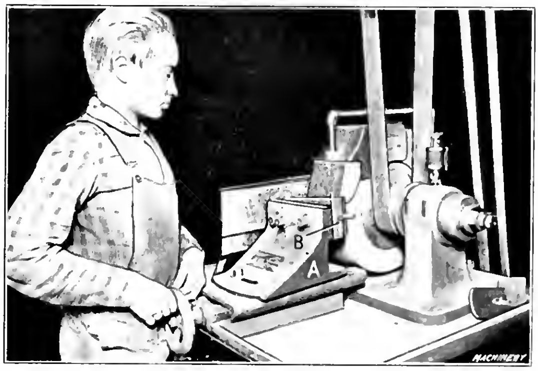

Fig. 8. Fixture used in grinding King Pin

side of the grinding wheel and is also tilted in relation to the horizontal base of the machine. The king pin to be ground is held in a V-slot in the face of block *B*, being pushed in from the right-hand side; the inclined position of the holder in both directions causes it to be fed in by the action of the grinding wheel. This continues until the pin has been ground for its entire length, after which it drops out

Fig. 9. Assembling the "Clipper" Lacing Tool

at the other end. Of course the production obtained on this fixture is much greater than that secured from a regular cylindrical grinding machine, and it also obviates the necessity of centering the ends of the work. As regards accuracy,

the results obtained are close enough for this class of work.

Upon the completion of all the parts of the lacing tool they are brought to the assemblers where the units are collected, hand reamed where necessary, and then assembled. Fig. 9 shows this step in the production of the "Clipper" belt lacer, and illustrates the final work that is done on it.

D. T. H.

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MILLING MACHINE DYNAMOMETER

BY R. POLIAKOFF*

The dynamometer shown in the accompanying illustration was designed to measure the force exerted by the teeth of a cylindrical milling cutter with straight grooves. Fig. 1 shows the dynamometer mounted on a No. 2 Cincinnati mill-

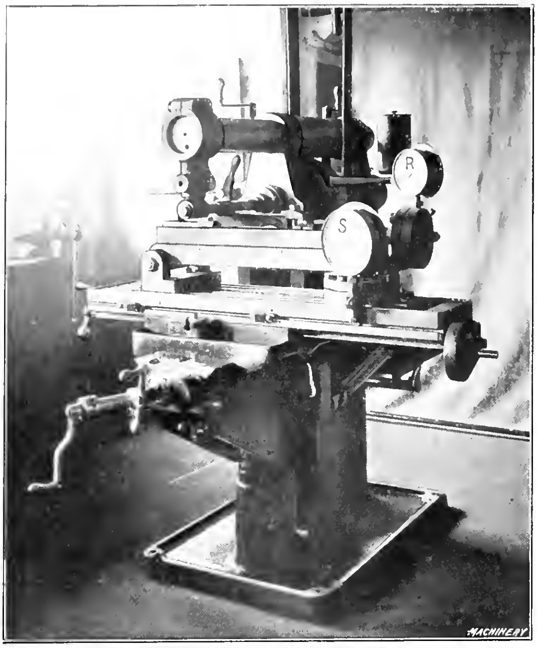

Fig. 1 Milling Machine Dynamometer mounted on No. 2 Cincinnati Miller

ing machine, and Fig. 2 gives details of the design. The work to be milled is shown at *A* in Fig. 2. The work is mounted on the slide *C* instead of being bolted to the table of the milling machine in the usual manner. The longitudinal movement of slide *C* is guided by a wing which runs in a groove in the lever *E*. This lever is fulcrumed on points *F* of screws *G* which pass through stay *H*. This stay is secured to the table *B* of the milling machine by means of two bolts *I*. Slide *C* bears against the point *K* of screw *L*; this screw presses against the thin brass diaphragm *M*, the diaphragm being filled with glycerine which transmits the pressure applied by screw *L* to the recording gage shown at *R* in Fig. 1. In a similar way lever *E* bears on the point *N* of screw *O*, which applies pressure to the diaphragm *P*. This pressure is indicated on the gage shown at *S* in Fig. 1.

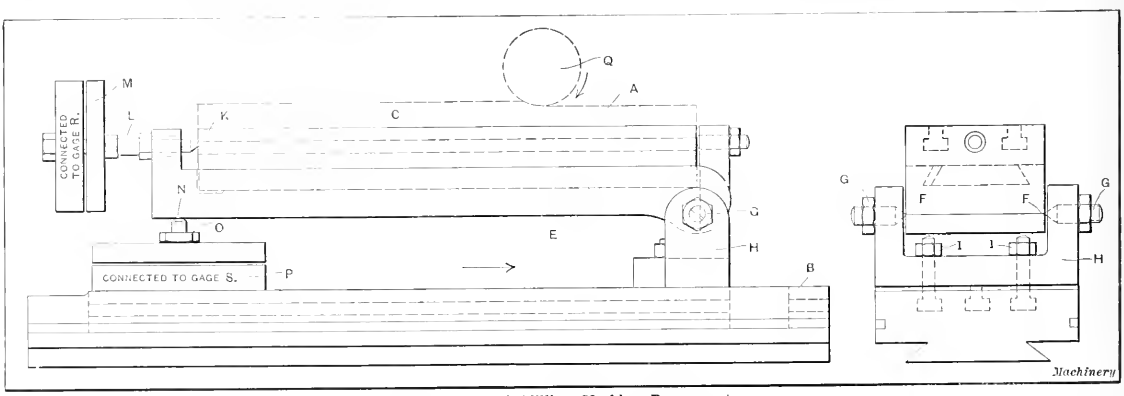

Fig. 2. Design of Milling Machine Dynamometer

When the cutter *Q* rotates in the direction indicated by the arrow, the force exerted by the teeth resolves itself into a longitudinal pressure acting parallel to the table and a downward pressure acting perpendicular to the table. The longitudinal pressure is transmitted to the gage *R* and the vertical pressure to the gage *S*, so that these pressures can be accurately determined if the gages have been calibrated before the test is started. In determining the magnitude of the longitudinal and vertical pressures the following conditions must be considered. By referring to Fig. 2 it will be evident that the lever arm of the vertical pressure changes as the table moves in relation to the fulcrum *F* about which lever *E* swings. As the feed is known, however, the lever arm of the vertical pressure is also known at any moment. The downward pressure also produces a frictional resistance which decreases the longitudinal pressure indicated by gage *R*. By determining the coefficient of friction between the two sliding surfaces *C* and *E* in the usual way before starting the test, it is possible to correct for friction and thus obtain the true value of the longitudinal pressure. This correction is made by adding to the reading of gage *R* the correction for the resistance due to friction between slide *C* and lever *E*.

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MOVING PICTURES OF FLYING BULLETS

Moving pictures have unlimited possibilities apparently for the study of rapidly moving objects. An apparatus capable of making pictures at the rate of 100,000 a second has been made. With it seventy-two pictures of a revolver bullet were taken while moving ten inches. Pictures of a bullet passing through a stick of wood showed a curious condition. The bullet passed completely through the thin stick and was well on its way beyond before the wood gave any sign of distress. Then some tiny splinters started out, following the bullet; the stick began to split, and after the bullet had proceeded some distance the stick suddenly fell to pieces. No camera shutters are fast enough to take pictures at anything like this speed, so no shutter was used. Instead, a series of electric sparks was flashed, the sparks following one another at the rate of 100,000 a second, each spark making a picture. The film was mounted on a wheel about three feet in circumference, and the wheel was revolved at the rate of 9000 revolutions a minute. When all was ready, the bullet was shot, the spark flashed and the wheel revolved, the actual exposure being limited to a fraction of a second so as not to pile up pictures one over the other.

* * *

Hardening pots for molten lead baths, etc., should preferably be made from seamless drawn steel rather than from cast iron. Experience has shown that the seamless pots will, in some cases, last for six months' continuous service, while cast-iron pots will last on an average only four days.

ON DRIVING LINESHAFTING

BY GEORGE N. VAN DERHOEF*

The question of what is the best method of driving lineshafting is one that must be considered in the case of the layout of almost every mill. The form of power to be used for driving the mill—water, steam, electric, gas or oil—generally depends upon local conditions. On account of efficiency, as well as first cost, electricity is seldom utilized as a motive power unless it can be obtained from an outside generating station, so that the maintenance of a complete power plant can be avoided. This is quite a factor where current can be obtained at a low price and the installation of large hydroelectric plants all over the country is making this possible. But in almost all cases where the mill has its own waterpower or must install its own steam, gas or oil engine, electricity becomes too expensive and inefficient a means of transmitting power to the different parts of the mill to be attractive. On account of their low first cost, flexibility and high efficiency, rope drives offer greater advantages.

In the case of mills buying outside electric power, the utilization of this current in the most advantageous way is a matter of the greatest importance. There are two methods of doing this. A separate motor may be used for driving each individual machine or the machines may be divided into groups and each group driven by a motor. A few years ago the manufacturers of electric motors advocated the use of the individual drive; today they are arguing for the group system. This is due to the actual demonstration of the superiority of the latter system in mill practice, and in the majority of cases it is only by the use of the group system that it is possible to equal the high efficiency of a well laid out mechanically driven mill. The individual motor offers a real advantage in the way of convenience. A machine may be placed in any position, without regard to the location of other machines, and the light is not obstructed by overhead belts; furthermore, each machine is a unit by itself and only consumes power when in actual operation. Unfortunately this is not the whole story. The individual motor must usually be a small one; consequently the first cost must be relatively high.

At the very outset, the mill owner is confronted by two horns of a dilemma. If the motor selected is of such a size that it will take care of the maximum requirements of the machine, it must usually be operated at a point below its full load capacity, as the overload capacity is not enough above the full load capacity to equal the difference between the maximum and normal requirements of the individual machine. Hence we have a piece of apparatus that has a high efficiency at full load, running most of the time below rating and with an actual current consumption per horsepower due to the low efficiency at small load which makes it a most expensive form of transmitter. On the other hand, if the size of the motor is kept down to the normal requirements of the machine, the reserve capacity of the machine becomes zero, and pushing the production beyond normal would be impossible.

The advantage of being able to place a machine in any position is seldom of great practical importance; certainly not enough to warrant any increase in either first cost or operating expense. The increase in shop light due to the absence of belts is more fanciful than real, as a fraction of the current wasted by individual motors would give all the illumination that is necessary. Besides, window glass is cheap. The individual control of the machine is also more imaginary than real, as the ordinary tight and loose pulley or the friction clutch pulley often affords a better control from the operating point of view. Still, there are many cases where the individual motor should be used. A machine may be so placed or the power required to run it may be so small, relatively speaking, that the question of power efficiency is purely secondary, as, for instance, the portable tools used in large machine and erecting shops or the large special tools used in a number of the industries. In all of these the actual efficiency of the motive power is purely a secondary matter.

In the group system of driving there is a chance to adjust matters with some regard to efficiency, by playing up the law of averages. The overload capacity of a motor that is large enough to drive a group of machines at normal load will almost always be found ample to take care of the maximum requirements of any machines in the group that could possibly be expected to have peak requirements at the same moment. This makes it possible to select motors of a size that is in accord with a reasonable consideration of efficiency; but it should be remembered that errors in judgment will interfere with efficiency, unless the groups can be so arranged that one or more machines can be easily shifted from one group to another. On this account and in order to get the best average load conditions, as well as to economize in motor cost per horsepower, it is well to determine how large rather than how small the group can be made. In a general way the interests of the mill owner are on the "other side of the fence" from those of the motor manufacturer and the company furnishing the current. There is one condition, however, where the interests of the mill owner and the motor manufacturer are in accord. That is when the lineshaft speed is such that it can be direct connected to a low speed motor. Low speed motors are relatively expensive, but direct connection eliminates the friction losses due to speed reduction transmissions. The ideal arrangement of a motor-driven lineshaft is with the motor situated at the middle of the line. This permits the use of shafting of the smallest possible diameter, as the load is equally distributed over it and friction losses are reduced to a minimum. If a friction clutch coupling is placed at each side of the motor, either half of the line can be run by itself.

Where direct coupling is not feasible the question of what form of reduction transmission is most suitable, and whether the reduction should be made in one or more stages will depend on local conditions and the difference in the speeds of the motor and lineshaft. With small motors and a large speed reduction, cut gears are commonly used for at least the first reduction, but this method is seldom used in driving lineshafts. In the case of medium-sized motors, some form of silent chain or leather or rubber belts are generally used. If silent chains are used, the reduction is generally made in one stage; and if belting is adopted the reduction may be made in one or two stages. The mill owner should bear in mind that a two-stage reduction sometimes shows a higher efficiency than a one-stage reduction, where the pulleys differ greatly in diameter. In the case of large motors, rope transmission will be found the most satisfactory and efficient means for reducing the speed, the freedom from slip giving as uniform rotation to the lineshaft as could be secured by direct coupling. This whole question should be carefully considered before deciding upon the type of transmission to install. The direct drive is, of course, the most efficient, but the low speed motor is expensive. In the case of the larger sizes of motors, the question of support is one that must be carefully considered, as large low speed motors are very heavy. This question of weight sometimes makes it necessary to place the motor at one end of the line near a wall or even to choose a high-speed motor and use the necessary transmission to reduce the speed to the desired point.

Countershafting should be eliminated entirely, or, at least, as far as possible. The ideal construction is high-speed shafting, small pulleys of either the tight and loose type or with attached friction clutches, and direct drive from the lineshaft to the individual machine. This plan is now in use in many of the most up-to-date mills. In mills where the load per lineshaft is light, maximum efficiency is sometimes secured by what may be called the "compound group" system, in which a single motor is used to drive several lines—usually an entire floor. The motor is direct connected or belted to one shaft and the other shafts are driven from this shaft by either belts or ropes. By using the Dodge American system of drop-off rope transmission, each shaft can be driven direct from the motor with one rope and without any intermediate losses, such as must occur where the shafts are driven, one from the other, all across the room. In the smaller mills, where the individual floor loads are light, two or more floors

* Address: Dodge Mfg. Co., Mishawaka, Ind.

can be driven from the same motor by using this form of rope drive, which works just as well vertically as it does horizontally. There is no question but that rope gives a better and more efficient drive from a motor than a belt, and it should be employed whenever possible. It is not possible, however, to use as small wheels with rope as with belting, so that the choice of which to use is frequently limited by the speed of the motor and the amount of speed reduction required. With large motors, particularly those designed to run at low speed, either form of transmission can generally be used. When rope can be used and the transmission is a plain, straight drive from the motor to the shaft, either the American continuous system or the English separate wrap system will work all right; but it will generally be found that the continuous system will be rather more satisfactory in the long run.

In selecting motors, it is well to determine whether the overload and starting torque characteristics of the motor can be fully utilized in actual service. Many motors have a very high starting torque when thrown directly on the line. This is a very valuable feature from the mill owner's point of view, but commonly the service company will not permit the use of such motors on account of line disturbance, and insist upon the use of compensating coils that completely nullify this advantage. It is usually better for the mill owner to purchase his motors direct from the manufacturer, but he should not do so until after full consultation with the company from which he expects to buy current. The question as to whether or not to use electric power is almost always a difficult one for the mill owner or his consulting engineer to decide. Except in a few cases, the actual net saving is small and this saving is only possible when the utmost care is exercised in laying out the whole proposition. Applied engineering is not an exact science and good "horse sense" is more conducive to dividends than too much efficiency figuring.

* * *

GUARDS FOR POLISHING WHEELS

At a recent visit to the small tool department of the Pratt & Whitney Co., Hartford, Conn., the writer had his attention called to an interesting and effective type of sheet steel guard for polishing wheels. Two types of these guards are shown in Figs. 1 and 2. That shown in Fig. 1 is used in connection with the polishing of the flutes of small taps, while that shown in Fig. 2 is used for larger sizes, such as staybolt taps and other tools of the same type. A particularly interesting feature of the guard shown in Fig. 1 is that it is provided with glass sides or "windows" on both sides, so that the workman always has the proper light on the work being polished. This is a very important consideration in the design of guards for polishing wheels or for other parts. Often these guards are made from solid sheet steel or cast iron in such a manner that the workman cannot see the work properly, and he naturally objects to the use of the guard. Many cases are known where the workman has taken the first opportunity to discard guards so designed. In the present instance, however, this difficulty is entirely eliminated and the guard can be carried forward to a point where it almost encases the polishing wheel without interfering with the work.

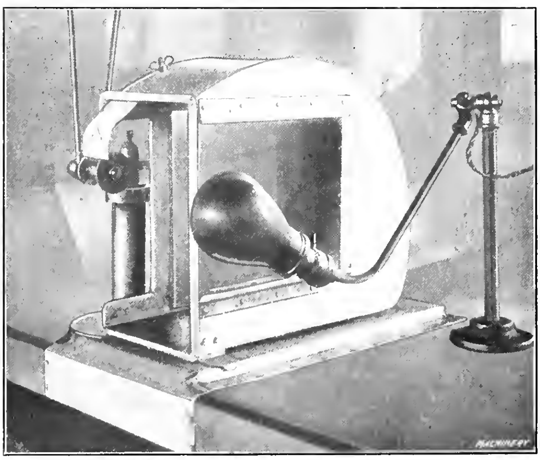

Fig. 1. Guard used for Polishing Wheels for Small Taps—Note "Windows" in Sides of Guard

It will also be noticed that an electric lamp bracket is provided in such a position that the light can be placed directly outside of the window, thus getting the full benefit of the light on the work at night. The lamp bracket is of the universally adjustable type made principally from pipe and pipe fittings. The lamp shades are of the type which should always be provided for machine tool work, as these prevent the light from being thrown into the operator's eyes, and reflect it against the work.

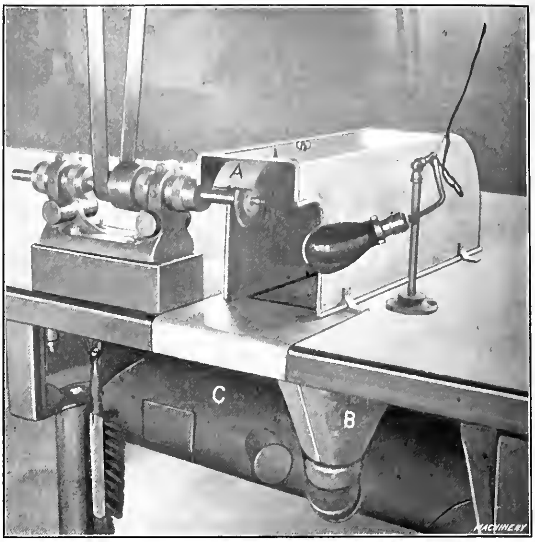

Fig. 2. Guard for Large Polishing Wheels—Sparks from Work provide the Necessary Light

The glass sides of the guard are slid into position as indicated, and can be easily removed and replaced. Immediately over the wheel a small adjustable sheet steel extension guard *A* is provided. This can be pulled out or pushed in according to the nature of the work being done, and prevents any sparks from being thrown into the operator's eyes. This guard can be bent to suit different diameters of wheels, and it is adjusted by a thumb-nut shown in the top.

All dust from the polishing operation is removed by suction through the bottom of the hood which is provided with a screen as shown in Fig. 2. From here the dust passes through duct *B* into the main pipe *C* of the suction blower. The type of guard shown in Fig. 2, which is intended for large tools, is not provided with glass sides. The reason for this is that the sparks produced when polishing large work give the operator all the light necessary inside the hood.

These guards have proved very convenient and are a safeguard to the operators' health, in that the dust is completely removed; they also prevent injuries due to wheel breakages. The sheet steel used is amply strong to resist the small fragments that would be thrown in case of breakage of the thin, small wheels. The effectiveness of these guards is proved by the fact that there is practically no dust in the polishing room, nor is there any evidence of dust settling on the benches or machine bases, as is often the case in workrooms where operations of this kind are carried on.

E. O.

* * *

Experiments carried out with compressed seamless zinc tubes are said to have proved that in point of strength and elasticity they are approximately equal to copper and brass tubes. Owing to the fact that they are not chemically affected by naphtha or petroleum, they may be found useful in the petroleum refining industry.

HOLDING DEVICES FOR FIRST-OPERATION WORK*

DESIGN OF CHUCKING FIXTURES—CONSTRUCTION OF VARIOUS TYPES FOR TURRET LATHES AND VERTICAL BORING MILLS

BY ALBERT A. DOWD†

The methods of holding and clamping rough castings for the first or "chucking" operation are so diversified that the subject must, necessarily, be treated by means of examples representing different varieties of work. Nearly all of the examples shown are more or less cylindrical in shape, for the reason that elliptical, rectangular, or odd-shaped parts require special treatment and, therefore, can only be touched upon in an article of this kind. In the general course of manufacturing, there are occasionally pieces of peculiar shape which require chucking fixtures, but as this work is of such great variety, it is difficult to give much information regarding its handling except in a general way. Any piece of work of peculiar shape requires a thorough knowledge of the conditions governing its use, in order that it may be chucked properly and located from the surfaces which are of the greatest importance.

Important Points in Design of Chucking Devices

In the design and construction of chucking devices, there are a number of points to which the most careful consideration must be given. In some cases, the work must be held by the cored interior, as, for example, an automobile piston, or, in fact, any other work in which it is necessary to have

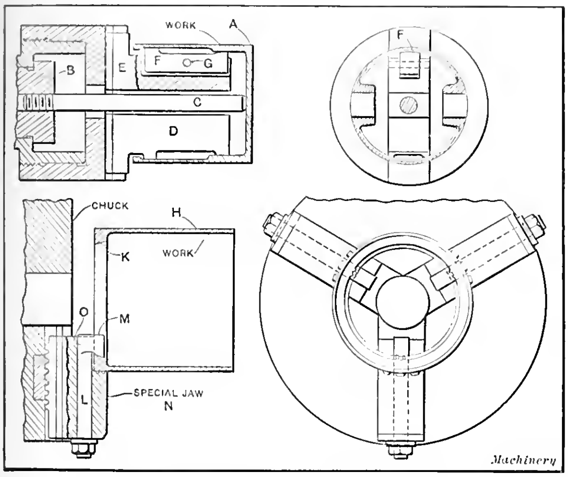

Fig. 1. (Upper View) Two-jawed Chuck for holding Piston internally; (Lower View) Chucking Fixture for Piston Ring Pot

an equal division of metal throughout the cylindrical walls. In other instances, however, some method of exterior holding may be perfectly satisfactory. The term "exterior holding" does not necessarily mean that chuck-jaws are referred to, for various devices other than jaws, will be cited during the following discussion of holding methods.

Having determined whether the work is to be held externally or internally, let us take up the important points in the design of holding devices.

First: The important locating surfaces should be carefully considered, always having in mind the future handling of the piece in its various operations. Great care should be taken that no locating points are so placed that they will come in contact with the work in places where the pattern is gated, or where numbers or letters may appear.

Second: In setting up a rough casting there should never be more than three fixed supporting points; any others which may be necessary for the proper support of the work must be made adjustable, with some approved method of clamping securely after adjustment.

Third: The work must be firmly secured so that no distortion can take place under the strain of clamping.

Fourth: When the work is of such a nature that difficulty is experienced in obtaining proper clamping surfaces, it is sometimes advisable to consult with the patternmaker in regard to the addition of clamping lugs to the pattern. In

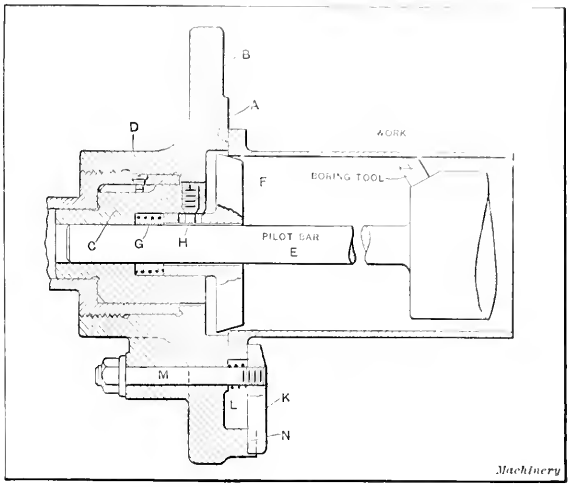

Fig. 2. Another Ring Pot Chucking Fixture

cases of this sort, these lugs should be so applied that their subsequent removal can be effected readily.

Fifth: In designing a chucking fixture the safety of the operator should be considered carefully, and by that is meant that protruding heads of screws, bolts, clamps and similar parts should be avoided as much as possible. A little forethought in this regard may be the means of saving an operator from mutilation or death.

Sixth: Convenience and accessibility in setting, locating and clamping the work, are also of primary importance.

Individual points regarding the work-holding devices shown in the illustrations will be discussed. We shall consider holding devices for the horizontal turret or chucking lathe, the vertical turret lathe, and the vertical boring mill. In describing these devices, the work and its requirements will be considered, as well as the important locating surfaces, the method

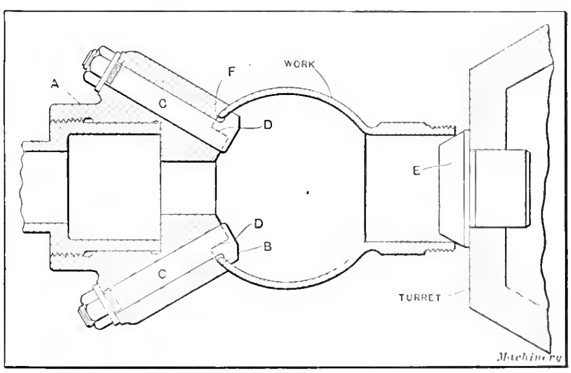

Fig. 3. Fixture for Ball-and-socket Pipe Joint

of handling the work and important points in the design of different fixtures.

Two-jaw Chuck arranged for Internal Chucking

It is essential that the cast-iron piston shown in the upper part of Fig. 1 be located from the cored interior, in order to have the outer walls concentric with the core, thus obtaining an equal distribution of metal throughout the piston walls. Due to the formation of this casting, the core is poorly supported at the closed end and, therefore, has a tendency to drop slightly when the metal is poured into the mold, thereby

* For information on this subject previously published in MACHINERY, see "Arbors for Second-Operation Work" in the October, 1913, number.
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producing a lack of concentricity between the cored portion and the exterior surfaces. It is logical then, in order to obtain uniform results, to work from the cored portion when setting up the casting. Many methods of holding have been devised for this purpose. The fixture shown in Fig. 1 is one of the simplest, an ordinary two-jaw chuck with special internal jaws being used for holding and locating the work *A*. A steel bushing *B*, fastened into the spindle, contains the stop-rod *C*, which comes against the head of the piston, thus insuring a uniform thickness of metal at this point. The chuck is supplied with the two special jaws *D* and *E*. The former is a plain jaw with two bearing points, while the other has a swivel-jaw *F*, pivoted on the pin *G*, which allows it to conform to the inequalities of the casting. This method of chucking is one of the cheapest, and the results obtained by its use are fairly satisfactory. There is a tendency toward inequality in the thickness of the piston walls in the direction of the wrist-pin bosses, due to the fact that the centering action of a chuck of this type is in two directions only; however, at least one large manufacturer in the East uses this method entirely. The chuck is employed for rough-turning only, thus securing a partially finished surface which is true with the core and which may be used to work from for subsequent operations.

The work *H*, shown in the lower view of Fig. 1, is a cast-iron piston ring pot, which must be held in such a way that it can be bored, turned eccentrically, and separated into narrow rings for a gas engine piston. As the ring pot is very thin, it must be carefully held to avoid distortion and yet be very rigidly secured, as there are several tools working at one time so that the torsion produced by the cut is excessive. The pot is made with an internal gripping ring *K*, which is slightly beveled to assist in keeping it back against the chuck jaws. The chuck is an ordinary three-jaw, geared-scroll type, having jaws as shown in section at *N*. These jaws are of steel and are drilled to receive the hook-bolts *L* which pass entirely through them and grip the ring from the inside. The heads of the bolts *M* come out through slots in the jaws, the heel having a backing at *O*. When setting a casting the bolts are left free while the jaws are brought up against the outside of the casting with just enough pressure to get a bearing. The bolts are then set up tightly on the gripping ring, so that the work is held firmly but without distortion. This method is very good and can be applied successfully to many varieties of thin work. (The July number of MACHINERY, page 888, shows another application of a similar set of jaws applied to a much larger piece of work.) The hook-bolts are of tool steel and are hardened and drawn to a deep straw on the hook end. The backing up of the hook-bolt at *O* is very important, for unless properly supported at this point its action is greatly impaired and it soon becomes bent out of shape and is absolutely useless.

Ring Pot Locating Fixture without Chuck-jaws

Another cast-iron ring pot of somewhat different form is shown in Fig. 2. The operations on this piece are identical with those for the casting shown in the previous illustration, but the holding method is entirely different. This form of pot is used by one of the largest manufacturers in this country. Before it is placed in the fixture, the face of the gripping ring *A* is ground square with the outside of the pot. The body of the fixture *B* is of cast iron and is screwed fast to the spindle nose of the horizontal turret lathe upon which it is used. The annular ring or pad against which the ring pot lies is faced square in position on the machine. A hardened and ground tool-steel bushing *C* is accurately fitted to the inside of the spindle and is held in position by the teat-screw *D*. It will be noted that this bushing also acts as a guide for the boring-bar pilot *E*. A tapered plunger *F* is forced outward by the spring *G* and centralizes the inside of the pot. The screw *H* simply acts as a retainer to keep the plunger in position. There are three clamps, 120 degrees apart, on the face of the fixture. One of these is shown at *K*; obviously this is tightened by the screw *M*, while the coil spring *L* serves to keep the clamp away from the work when not in use. The lug *N* prevents the clamp from twisting around when the screw is being tightened. This fixture is a very good one, except that its operation is rather slow.

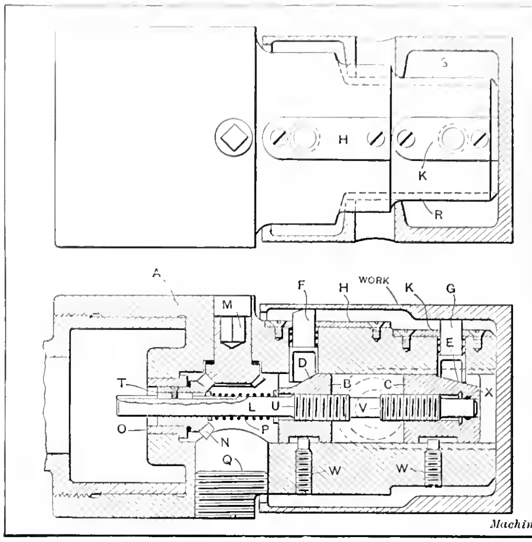

Fig. 6. Special Chuck for holding Gas Engine Pistons internally

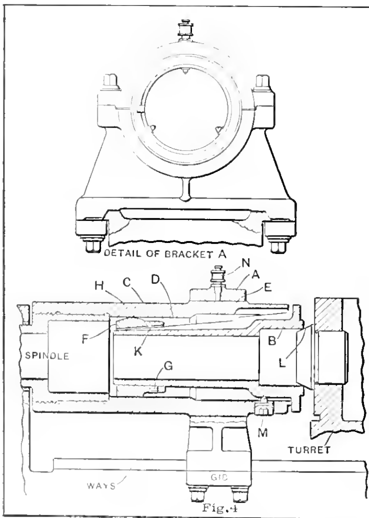

Fig. 4. Fixture for holding a Long Part—Outer End is supported by Bracket

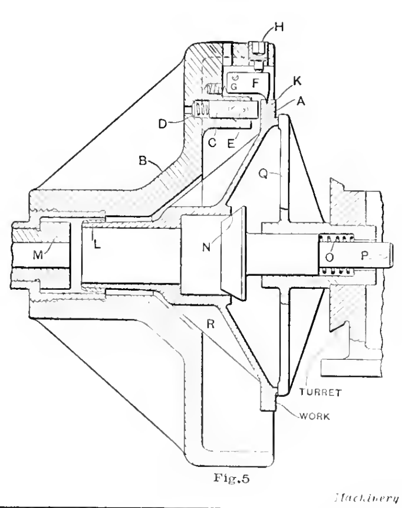

Fig. 5. Casting A held so that it can be machined at One Setting

Locating Fixture for a Ball-and-Socket Pipe Joint

The requirements for the work shown in Fig. 3 need little explanation. The piece itself is a steel casting. A cast-iron "cat-head" or fixture *A* is screwed onto the spindle nose, and is faced at *B* to an arc corresponding with the rough ball-portion of the pipe joint. The two hook-bolts *C* obviously grip the work from the inside and hold it firmly against the finished face *B*. A centering plug *E* fits the turret hole and is brought up and entered into the casting before the hook-bolts are set up tightly. This fixture was not entirely satisfactory owing to the condition of the rough castings at the end *F*, for at this point they varied greatly and were very rough, making the holding somewhat

uncertain. A method of holding this work by the interior undoubtedly would have been more satisfactory.

Chucking Device having an Outboard Supplementary Bearing

The automobile tail-shaft housing shown at *B* in Fig. 4 is made of malleable iron and is so long that chucking by means of jaws is out of the question, on account of the excessive overhang which would be necessary. The piece was to be finished complete in one setting and the fixture shown was designed and used for this purpose. The body *C* is of cast iron and is screwed onto the spindle nose. The inner cylindrical surface *D* is very carefully bored and the outer bearing surface *E* is turned and finally lapped to a nice running fit in the bracket *A*. The periphery *H* of the locating and centering bushing *F* is crowned on a radius and is slotted in various places, as shown at *K*, to receive the exterior ribs on the housing. A pointed set-screw *G* keeps the bushing in position. The tapered plug *L* is located in the turret hole and serves to center the work, and the pointed set-screws *M* (three of which are used) are sunk into the casting and act as drivers in addition to holding it in the position determined by the tapered plug. The bracket *A* (also shown in detail) acts as an outboard bearing for the long body of the fixture and prevents the vibration which would otherwise result from the excessive overhang. A glass oil cup was an added refinement to the equipment and may be noted at *N*. This fixture has been used with great success by one of the large manufacturing firms in the West.

Method of Chucking One-half of a Rear Axle Housing

The male portion of an automobile rear axle housing is shown in Fig. 5. This is machined in one setting on a horizontal turret lathe. The body of the fixture *B* is of cast iron and is screwed onto the nose of the spindle. Three steel pins *C* are located 120 degrees apart, around the inside of the fixture body, the coil springs *D* forcing them outward and the set-screws *E* securing them in place when properly located against the work. The method of clamping is somewhat peculiar and should be carefully noted. The swinging dogs *F* have a knife-edge at *K* and are pivoted on the pins *G*, which are set back in such a position that the action of the dogs (controlled by the hollow set-screws *H*) has a tendency to carry the work back against the body of the fixture and the spring jack pins. A steel bushing *L* is forced onto the small end of the work and assists in centering it in the spindle. This bushing is crowned on a radius the same as that shown in Fig. 4. The taper locating plunger *N* is forced out by the spring *O* and is restricted in its action by the pin *P*. The two-arm support *Q* is of cast iron and is of assistance in keeping the work in position while the various screws and dogs are being tightened. The bushing *M* acts as a guide for the boring-bars and reamers used in machining the work. The work is driven by the ribs *R*, which enter slots in the body of the fixture. This method of holding gave satisfactory results, although considerable care was necessary to avoid springing the casting, when tightening the clamping dogs.

Equalizing Pin Chuck for a Gas Engine Piston

One of the many varieties of internal holding piston chucks is illustrated in Fig. 6. Although rather expensive, it is an excellent example of this type of chuck, and is very well made. All working parts are of steel or bronze and all parts requiring such treatment are carefully hardened and ground. The body of the chuck is of machine steel, carbonized, pack-hardened and ground; the pins, cams, operating rod, screws and bushings, are of tool steel, while the miter gears are of bronze. The body of the chuck *A* is screwed onto the spindle nose and is ground or lapped at all important points. The operating cams *B* and *C* are slotted in three places around the periphery at *D* and *E*, these slots being angular and forcing the six pins *F* and *G* out against the interior walls of the piston. It may be noted that the steel plates *H* and *K* are let into the body of the chuck, and act as retainers for the pins. These plates are clearly shown in the upper view. The operating rod *L* is revolved through the action of the miter gears *M* and *N*. The latter has a key *T* engaging a long spline in the operating rod, which is thereby permitted to move longitudinally. The threaded portion *U* is 6-pitch right-hand thread, while that at *V* is 6-pitch left-hand thread. The forward cam is packed with felt at *X* to keep out the dirt. The bushing *O* is of tool steel, hardened and ground. The plug *Q* simply closes the hole which has been put in for assembling purposes.

By referring to the upper view it will be seen that the chuck body is cut away on the sides at *R* and *S*, on account of the wrist-pin bosses in the piston, and the overhanging lip at *R* acts as a driver. In designing a chuck of this kind, it must be remembered that while the rear clamping pins may be equally spaced, the position of the forward pins will be determined by the diameter and spacing of the wrist-pin bosses, and an end view will be found essential to determine the correct position. In general it will be found that two of the forward pins seldom can be spaced more than 80 degrees apart and often the spacing cannot be made more than 55 or 60 degrees. Another point in design which is of great importance is the amount of clearance between the ends of the wrist-pin bosses and the flattened sides of the chuck body. It is seldom safe to allow a clearance of less than $\frac{3}{16}$ inch on each side, over the finished sizes called for on the drawing of the piston. The location of the stop-pins *W* is also important, and sufficient allowance should be made in the length of the cam slots to take care of variations in the piston castings. A chuck of this type gives results which are satisfactory in every respect.

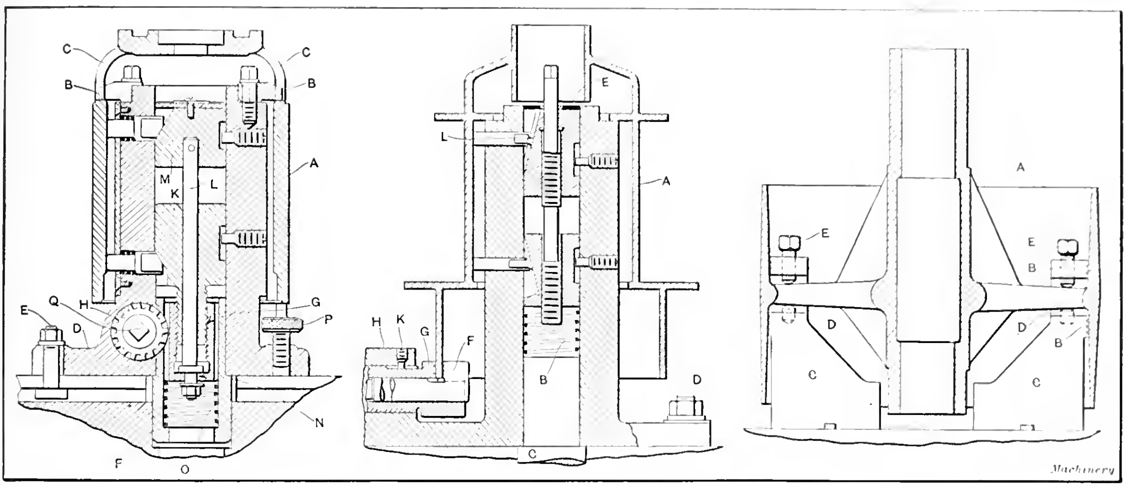

Fig. 7. Vertical Boring Mill Fixture for holding Part A internally

Fig. 8. Vertical Fixture having Internal Clamping Pins and Hook-bolt Clamps for Lower Flange

Fig. 9. Special Chucking Jaws for Large Pulley

An Equalizing Pin Chuck for an Electric Generator Frame

The examples which have been referred to in the foregoing are all adapted for use on the horizontal type of turret lathe, but we shall now go a step farther and take up chucking devices designed for the vertical turret lathe and the vertical boring mill. As machines of this type are adapted more to heavier classes of work, the fixtures should be designed with relation to the work and also to the power of the machines

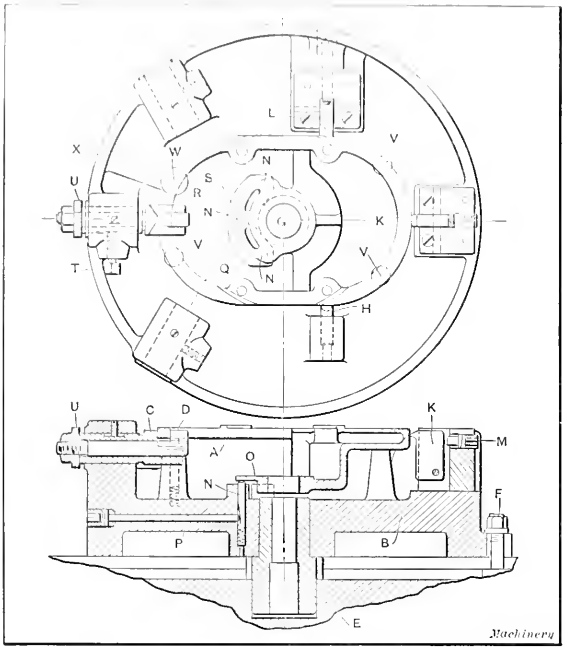

Fig. 10. Ingenious Chucking Device for holding Odd-shaped Aluminum Casting without Distortion

upon which they are to be used. For machining the steel generator frame shown on the fixture in Fig. 7 the working points specified by the manufacturer are at *B* between the ribs *C* on the upper portion of the casting *A*. It was further specified that the work must be held by the core to insure an evenly balanced casting.

The design of this chuck resembles that shown in Fig. 6, in that both chucks are fitted with pins and operating cams; the operating mechanism, however, is entirely different. The body of the chuck *D* is of cast iron; it is carefully reamed and lapped at important points, and is securely fastened down to the table of the machine by three screws having tee-shaped heads, which enter the table T-slots as shown at *E*. The fixture is centered by the hollow stud *F*, which is of tool steel, hardened and ground inside and out. This stud also acts as a bushing for the operating sleeve *G*, and is cut away for clearance on one side where the spiral gear *H* passes through it. This gear meshes with another which is cut on the outside of the operating sleeve. The latter is of bronze and it is threaded internally with a 6-pitch Acme thread, corresponding with that cut upon the lower end of the cam *K*. The operating rod *L* is pinned into the upper cam *M*, and is shouldered and journaled at its lower end where it passes through the operating sleeve at *N*. The coil spring *O* is so proportioned that it simply supports the cam mechanism and assists in releasing. It will be noted that the arrangement of this internal mechanism permits a "floating" action for the cams, so that the clamping pins all bear uniformly against the inner walls of the casting. In setting up the work on the fixture, it is dropped over the top until the lower end rests on the three adjusting jacks *P*, which are placed 120 degrees apart and are knurled for finger adjustment. The upper locating arms *R* are swung back out of the way while the casting is being set in position, but as soon as this has been done they are brought around into the position required. The jacks are next raised until the casting has been properly located against the arms; then a long-handled socket wrench is inserted at *Q* and the gearing is revolved until the pins are securely seated against the inner walls of the work.

A Combination Device having Equalizing Pins and Hook-bolts

The piece shown at *A* in Fig. 8 is a clutch pulley for a gasoline tractor. It is made of cast iron and the method of holding from the inside was decided upon because it seemed to offer better facilities for machining. As in a former example, the body of the fixture contains the cams and the operating rod which is threaded right- and left-hand, as before. The lower ends of the pins and the slots in the cams are dovetailed in this instance, so that the outward and inward movements are controlled mechanically, no springs or plates being required. The fixture is centrally located on the machine table by the plug *C*, which fits the center hole in the table and is held down in the usual manner by the T-bolts shown at *D*. The coil spring *B* simply acts as a support for the cams and rod. An annular groove is cut in the upper cam at *E* and this is packed with felt to assist in keeping the dirt out of the working parts. The lower part of the fixture has three bosses (one of which is partially shown at *H*), which contain the floating jaws and hook-bolts, *G* and *F*, for clamping the lower flange of the pulley. The construction of these parts is more clearly shown in Fig. 10, and, as they are identical the reader is referred to the portions marked *C* and *D* in that illustration. The results obtained by the use of this fixture were at first very satisfactory, but, after a time, the dirt which gradually accumulated in the dovetail cam slots, began to cause trouble, until, finally, it became almost impossible to operate the mechanism. Then, too, in several cases the dovetail part broke off completely, necessitating new pins, so that the chuck as a whole cannot be considered an absolute success. No trouble would have been experienced if the cam slots and pins had been made as shown in Fig. 7, with coil springs and retaining plates.

A Set of Special Jaws for a Large Crowned Pulley

The large farm engine pulley shown at *A* in Fig. 9 is of cast iron, and it must be held by the inside in such a way

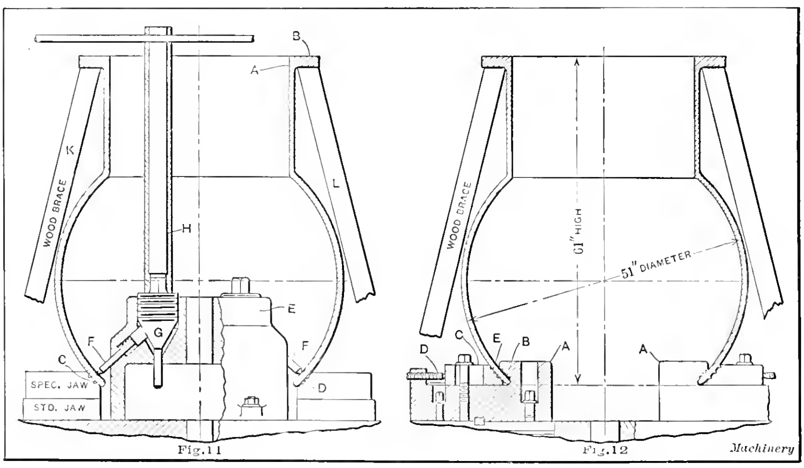

Fig. 11. Vertical Boring Mill Fixture for holding Large Ball Joint

Fig. 12. Another Method of holding Large Ball Joint

that it will not be distorted while fairly heavy cutting is being done on the periphery of the pulley. A four-jaw table was selected on which to hold the work, as there were eight spokes in the pulley. The chuck jaws *C* were made of 0.40 per cent carbon steel and were slotted out for the spokes

as shown in the illustration. The hardened steel studs *D* were set into the slots, and the set-screws *E* brought down tightly on them after the jaw surfaces *B* had been brought out to center the pulley.

This method of holding pulleys or other spoked work gives very satisfactory results and is used by many manufacturers throughout the country.

A Chucking Device for a Difficult Piece of Electrical Work

The aluminum piece shown in Fig. 10 is one of the most difficult for which I have ever had occasion to make a chucking fixture. The walls of the entire piece were of very thin section, and the overhanging portion *A* was elliptical in shape and entirely unsupported. It was necessary to so hold this casting that it could be machined without distortion. The body of the fixture *B* is of cast iron. It is centrally located on the table by means of the hollow bushing *E*, and clamped down by T-bolts shown at *F* in the table T-slots. A portion of the fixture shown in the upper view at *G* was cut out to form a V, in which the cylindrical portion of the casting is centered. One of the sides of the casting is located against the knife-edged pin *H* (shown in the upper view), and the casting is forced into the V and against this knife-edged surface by the swinging clamps *K* and *L*. It will be noted that these clamps also have a knife-edge and that the pins upon which they are hung are in such a position that their action is downward, thereby tending to hold the work securely against its supports. Hollow set-screws *M* control the action of these swinging clamps. There are three spring-pins *N* which are used to support the very thin flange *O*, and the springs which force them upward are carefully proportioned so that they have just sufficient strength to insure contact without springing the work. These pins are locked in their positions by the long hollow set-screws *P*, shown in the lower view.

One of the principal points of interest in this fixture is the method of gripping the overhanging elliptical portion *A*, without distorting the casting. This is accomplished by means of the floating jaw *C* and the hook-bolt *D*. There are three of these floating clamps which grip the work at points *Q*, *R* and *S* (see plan view). It will be noted that the clamps are free to "float" laterally, until the set-screws at *T* are tightened. The knurled hexagon nut *U* is threaded onto the head of the hook-bolt, and is lightly tightened by means of the fingers before the final tightening with a wrench. As these clamps have a perfectly free floating action, until the binding screws are tightened, obviously there can be no distortion of the piece, and yet it is held rigidly at these points. When the work is placed into the fixture it rests upon three fixed points shown in the plan view at *V* and a fourth point *W*. The latter is held upward by a light spring and it is locked in position by the long hollow set-screw *X*.

The work accomplished by the use of this fixture was true and accurate, no evidence of springing out of truth being apparent.

Boring Mill Fixtures for a Large Ball Joint

The work shown at *A* in Fig. 11 is a large ball pipe joint for a suction dredge, and it is to be faced on the upper surface *B*. Two designs were made for this work, neither of which was used, but as the conditions are somewhat peculiar the fixtures will be described, and may be taken for what they are worth. The special jaws *C* and *D* are bored to an arc corresponding with the ball, and the work rests upon and is centered by these jaws. The body of the clamping device *E* is of cast iron and is bolted down to the table. It contains four pointed screws *F*, which, normally, are kept away from the work by means of coil springs. The ends of the screws are beveled to the same taper as the operating screws *G*, which are threaded at their upper ends with a coarse pitch thread, and have squares to receive the end of the long socket-wrench *H*, by means of which the screw is revolved, thus causing the points to sink down into the casting. Wood braces are used to support the flange which is to be faced. Four are used, although only two (*K* and *L*) are shown in the illustration. This fixture would have been rather expensive, but doubtless would have produced satisfactory results.

Fig. 12 illustrates another fixture for holding the same piece of work, which probably would have given more satisfactory results than the one shown in the previous illustration. It could have been manipulated more rapidly, because it is more accessible to the operator. Four sets of special jaws *A* are used for holding the work. The part *B* is formed to an arc corresponding to that part of the work which it grips, and has teeth to assist in obtaining a firm "bite." The supplementary sliding jaw *C* is forced into position by the set-screw *D*, thus clamping the work tightly between *B* and *E*. Wooden supports are used under the flange.

In the foregoing the writer has tried to cover the majority of conditions commonly met with in chucking problems, and the examples illustrated are given as representative methods which doubtless can be applied to nearly all operations that may be required in the general course of manufacturing.

* * *

"ECONOMY IN TOOL DESIGN"

BY JAMES McINTOSH*

An article appeared in the September number of MACHINERY, engineering edition, entitled "Economy in Tool Design," which shows two milling fixtures, Figs. 2 and 3, to the disadvantage of the latter. I wish to defend a system introduced by me in 1904. Fig. 3 represents good practice in the rapid production of duplicate parts. The failure of the example described by the contributor of the article referred to was due to defects in design. In the first place, it is foolish to expect a thumb-screw to hold six pieces firmly in position while a 5/8- by 1 3/4-inch slot is being milled, even with the finest feed. The thumb-screw will inevitably be loosened by the vibration and general action of the cutter teeth. In the second place, the revolving feature is needless and defective, being an addition to my original design that adds to the cost and invites failure. This fixture reduced in height, without the turntable and provided with V-blocks embracing the part to be milled by the shank, would have been successful. It should be rigidly secured to the table and provided with a tongue to fit the table slot. The first section filled with parts is milled while the second section is being loaded, and after the cutters have passed into section No. 2, section No. 1 may be changed, the table dropped and the cut set for section No. 1.

The defect in registering mentioned must obviously appear, inasmuch as the slightest degree of looseness of the index pin will be doubled, because of the short distance of the pin from the fixture center, compared with that of the outside pieces to be milled.

The satisfactory fixture Fig. 2 is said to be "expensive but proved to be an accurate and rapid producer." Let us compare the feed travel required for milling with both jigs. We will take twelve pieces, one filling of Fig. 3, and the same number for Fig. 2. The latter jig must feed 3 3/8 inches to mill one piece, this distance being required to include the entry of the cutter. To mill twelve pieces, the feed will be 40 1/2 inches. The operator must stop or run the cutter off the job twelve times.

The feed travel required for the jig in Fig. 3 is only 10 1/4 inches—made up as follows: 3 3/8 inches for the first piece and 1 3/8 inch for each of the next five in line, or 10 1/4 inches to cut a double row, or twelve—six in a row. Hence the discarded jig using the same feed is evidently four times faster by feed time and is even faster because the feed fixed on sets the pace of the operator. This is not the case with the jig shown in Fig. 2 any more than with a standard table vise.

* * *

Metallic sodium hardens lead without changing its color. Two per cent of sodium will harden lead so that it will ring when struck; a larger amount causes it to become brittle. The lead-sodium alloy is sometimes used as a bearing metal. One of the bad features of the alloy is that it corrodes rapidly in damp air or in contact with water.

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ALTERNATING-CURRENT MACHINERY TROUBLES—1

BRIEF AND CONCISE ANALYSIS OF THE DIFFICULTIES MET WITH AND THE REMEDIES TO APPLY

BY E. A. LOF*

[In September, 1906, MACHINERY published a data sheet supplement entitled "Diseases of Dynamos and Motors," which gave directions for overcoming the difficulties which are met with in the operation of direct-current electrical machinery. This data sheet somewhat revised was later republished in MACHINERY'S Reference Book No. 34, "Care and Repair of Dynamos and Motors." Several requests have been received from the readers of MACHINERY asking that similar directions be published relating to alternating-current machinery, and the following article has been prepared to cover the subject in a concise and yet complete manner.—EDITOR.]

In treating of the chief troubles of alternating current apparatus, the following classes of machinery will be dealt with: (1) alternators; (2) synchronous motors; (3) induction motors; (4) transformers; (5) synchronous converters. Troubles due to mechanical causes, such as heating of the bearings, etc., will not be considered in this connection as the same remedies that are given in the matter previously published on direct-current machinery apply to this class of apparatus also.

ALTERNATORS

Practically all alternator troubles may be subdivided into the following: Failure to generate; excessive heating; poor voltage regulation; and bad parallel operation.

Failure to Generate

The failure of an alternator to generate is very often due to exciter troubles, and it is therefore essential that exciter failures be analyzed in detail. Exciter troubles were considered in the data sheet supplement previously published under the heading "Dynamos." With the assumption that full exciter voltage is applied to the field terminals, the failure of an alternator to generate the normal terminal voltage at no load may be due to any of the following causes:

Armature winding open circuited.— Failure to generate from this cause can only occur with Y-connected machines, while for the delta-connected machines full voltage will be obtained across all terminals. The open circuited phase can be found by a magneto and bell, ringing from the neutral to each of the terminals.

Field winding open circuited.— This is the most general cause, and the break usually occurs in the connection between the coils.

Field coils short circuited.— Sometimes a short circuit may take place between adjacent field turns. This may be caused by mechanical injury, or by high induced voltages set up in the field winding, if the circuit is suddenly opened without being at field discharge resistance. A short circuit eventually results in a burnout. A resistance test should be taken of the field winding with the drop across each individual coil. A short circuited pole will show a reduced drop.

Reversal of individual field coils.—This may occur when reconnecting disassembled machines. It results in a reduced terminal voltage. Tests for determining if coils are reversed can readily be made by an ordinary compass.

Excessive Heating of Field Coils

Generator overloaded.—No defect of machine. Relieve generator of part of the load before the consequent overheating reaches a dangerous point. The generator may also become overloaded due to incorrect instrument calibrations.

Low power factor of load.—If the power factor of the load is too low, the field distortion due to armature reaction will increase, thus weakening the resultant effective field. Increased excitation, followed by increased heating, is therefore required in order to maintain the voltage. Generator can only carry partial load when the power factor is lower than that for which the machine is designed.

Operation below normal speed.—In this case the field excitation must be increased to maintain the rated voltage, which may result in excessive heating of the field coils. Check speed.

Operation above rated voltage.—This may be due to incorrect voltmeter readings, or intentionally in order to compensate for excessive voltage drop. It can only be obtained by increasing the field excitation and heating may result.

Short circuit in field winding.—This will render a portion of the field winding inoperative and a consequent increase in the exciting current is required to compensate for the now smaller number of effective field turns. It can best be located by resistance measurement of the field system. To guard against any danger of an internal breakdown of the field coils, field discharge switches with resistances should always be provided. Where this has not been done, turn in all resistance of both rheostats before opening the alternator field switch.

Excessive Heating of Armature Iron

The causes of excessive heating of the armature iron are generally the same as those causing overheating in the field coils, as previously outlined, *i.e.*, overload, low power factor of load, slow speed, operation above rated voltage, and short circuit in field winding.

Excessive Heating due to Defective Insulation between Stator Laminations

This will result in energy losses with consequent heating due to hysteresis and eddy currents. Can only be remedied by rebuilding the core.

Excessive Heating of Armature Coils

Generator overloaded.—May be due to incorrect meter readings, or may also be intentional.

Conduction of heat from armature iron.—Due to causes referred to under "Excessive Heating of Armature Iron."

Open circuit in one phase.—This occurs only with delta-wound armatures. The result is that the entire load is placed on the remaining two phases, thus overloading them and causing overheating. An open circuit can be tested out simply by a magneto and bell, or by applying to the armature winding a low voltage with an ammeter in the circuit, comparing the results for the different phases.

Grounding of one phase.—With Y-connected windings having a grounded neutral, a ground in any one phase will short circuit part of the winding. With delta or non-grounded Y-wound windings there must be two grounds in order to make a short circuit.

Short circuit in armature coils.—This will sooner or later result in the burning out of the short-circuited coils, due to excessive circulating currents therein. The overheating of certain coils can generally be detected by smoke issuing therefrom or by feeling the end connections with the hand. A definite method to detect a short circuited phase is by resistance measurements. This is readily accomplished with Y-connection having grounded neutral, and involves only a comparison of the resistances of the three phases, from the neutral to each terminal. With delta-connection or Y-connection with insulated neutral it becomes necessary to measure the resistance of two phases at a time and compare the results, which will then reveal which phase is short circuited.

Collector rings.—Overheating of the collector rings is often caused by an excessive field excitation, the same as overheating of the field coils. This cause can readily be detected by inserting an ammeter in the field connection and measuring the field current. Heating of collector rings may also be caused by excessive brush friction due to too high brush-tension. Incorrect brush alignment or dirty collector rings may also be the cause.

Poor Voltage Regulation

Low power factor.—A poor regulation is often found to be caused by the fact that a highly inductive load is being placed

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on the machine, which has not been provided for in the design of the machine or guaranteed. If the load cannot be changed, the only remedies are to redesign the alternator or provide synchronous condensers which will supply the magnetizing current for the inductive load and thus raise the power factor of the load at the generator.

Alternator speed variations.—Variation in voltage may be caused by poor speed regulation of the prime movers, due to defective governors.

Exciter troubles.—A speed variation of the exciter sometimes causes voltage fluctuations, especially when the exciters are direct-connected to the main generators and thus subject to the speed variations of the latter under different load conditions.

Automatic voltage regulators.—Almost all plants of any importance are nowadays provided with T. A. automatic voltage regulators, and, if so, moderate speed variations or load changes should not impair the regulation. Troubles may, however, occur with the regulator, and can be investigated as follows:

Should the regulator fail to build up its voltages, see that the reversing switches are thrown to the extreme position, either up or down; see if the rheostat shunt circuit switches are closed on the exciters which it is intended to run; look for improper connections.

Should the voltage fall, examine the rheostat shunt circuit connections to see if they are not so connected as to short-circuit the exciter field instead of its field rheostat.

If, after placing the regulator in service, the potential fluctuates to the extent of several volts, proceed as follows:

See if contact screws are loose. If so, they should be properly adjusted and set-screws securely tightened; observe both levers at the points where the core stems are attached, to see that there is no friction at these points.

The regulator should not be subjected to excessive vibrations, such as might be the case when it is mounted on iron brackets. If this is so, some rigid support should be provided to overcome the vibration.

The dashpot should be carefully inspected to see that it is actually full of oil to within 1/8 inch of the top; the dashpot should also be examined to see that it is securely attached to the supporting posts; the dashpot may be adjusted for too free a movement. This adjustment should be made as free as possible without causing pumping of the voltage at no-load.

Examine cores to see that they do not touch the inside of the magnet spools.

Carefully inspect all wiring, also look for flat spots on the commutators, loose brushes, or any other poor contact, that might cause an unsteady voltage.

If there is an error in the voltage from no-load to full-load without the compensating winding in circuit, it must be due to improper adjustment of the alternating current magnet core.

If, after the load has become steady in going from no-load to full-load, the main alternating current voltage has fallen off, the alternating current magnet core should be slightly lowered until the voltage is the same at full-load as at no-load. If the main alternating current voltage is too high, the alternating current core should be raised slightly to overcome the error and the voltage will be the same at full-load as at no-load.

If there is excessive arcing at the relay contacts, check the connections of the rheostat shunt circuit to see that they are properly made, and that the rheostat only is being short circuited. The connections of the condensers should be checked.

Bad Parallel Operation

Resonance.—The trouble mostly encountered in the parallel operation of engine-driven alternators consists in a tendency of the impressed oscillations or impulses to coincide with the natural periods or swing of the alternator, causing resonance. This trouble can often be overcome by the attachment of simple dashpots to the governors, which delay the governor sufficiently to prevent the troublesome periodic action and which at the same time do not prevent sufficient promptness in governing.

It is often feasible to decrease the amplitude of the oscillations when the generators are rope- or belt-driven, by changing the length of the drive. The rotor displacement can be reduced or increased by providing a heavier or lighter flywheel. The natural period of swing of the alternator can be changed and resonance avoided by increasing or reducing the reactance of the machine.

With gas-engine-driven generators it is customary to place amortisseur windings in the pole faces to act as an additional drag on the engine to prevent displacement. Sudden tendencies to change in speed cause currents to be induced in the low resistance bars of this winding which produce a torque similar to that of a squirrel-cage induction motor and help out the flywheel to some extent.

Excessive cross currents.—Cross currents between alternators operating in parallel may be either wattless, or they may represent a transfer of energy. The former is caused by a difference in the excitation or voltage of the two machines, while the latter is caused by periodic oscillations of the generators, this being generally due to irregularities in the speed of the prime movers. They can therefore be reduced by improving the parallel operation as previously described.

SYNCHRONOUS MOTORS

Excessive Heating

Excessive heating in the different parts of a synchronous motor is generally caused by the same defects as for alternators and may be located and corrected in the same manner.

Power factor correction.—Excessive heating is very often caused when the field excitation of the motor is increased for low power factor correction, in order that the motor may draw a leading current and compensate for heavy inductive loads in other parts of the system. Such increased excitation will therefore increase the total armature current, slowly at first, but thereafter more rapidly, at low leading power factors. Hence over-excitation should be kept within certain safe limits, both as to its effect in regard to the armature as well as the field heating.

Open field circuit.—In the same manner as an increase in the field excitation causes the motor to draw a leading current from the line, a decrease in the normal excitation will cause the motor to draw a lagging current from the line, thus also increasing the total armature current and the heating. It becomes important, therefore, with synchronous motors to have the field current permanently established.

Voltage too low.—A synchronous motor should be operated normally at its rated voltage, as a reduction in voltage means increased current, and increased heating of armature.

Frequency low.—Operation at normal frequency is desirable, as at a reduced frequency and normal voltage the iron losses are increased due to higher density, and consequently also the heating.

Wrong polarity.—Since the winding of a synchronous motor armature is in series all the way around the circumference and under all of the poles, except in exceedingly rare cases, the trouble from a reversed pole is not very serious. Everything operates fairly satisfactorily, the only trouble being that the fields require more current than they should, to make up for the pole that is opposing the other fields. If, therefore, excessive field current is required for the minimum input to the motor, it would be well to try the polarity of all the spools, using a compass for the purpose.

Difficulties in Starting

The revolving fields of most synchronous motors have amortisseur windings, and are started by reducing the voltage to the armature winding. Failure to start and come up to synchronous speed may be due either to faults of the starting auxiliaries or to the motor.

Open circuit.—Difficulty in starting may be caused by an open circuit in one of the lines to the motor. When this happens, a polyphase motor becomes single phase and is not self starting. The motor will, therefore, stand still and soon get hot.

Applied voltage too low.—The starting torque of a synchronous motor is proportional to the square of the applied voltage. When, therefore, a synchronous motor will not start, it may be due to the fact that the voltage on the line is pulled down below the value necessary for starting. If the motor is provided with a starting compensator it may be possible to re-connect the leads and thus obtain a higher terminal voltage. Care, however, should be taken that the starting current does not become too high.

Increased friction.—Difficulties in starting may be caused by an increase in the static friction, due to bearings being too tight, cutting of bearings, belt friction, etc. For very large motor generator sets it sometimes becomes necessary to reduce the bearing friction by oil pressure, so as to reduce the current drawn from the line during starting.

Field excited.—If the field is on, most synchronous motors will not start at all.

Incorrect design of starting winding.—It sometimes happens that the manufacturer has not been properly informed as to the true operating conditions, and that the proper starting winding has not been furnished. A motor driving a generator will, for example, require a high starting torque compared to the pull-in torque, while for a motor driving a fan or centrifugal pump the reverse will be the case. A motor with a high-resistance starting winding will have a high starting torque, but at the same time such a winding increases the motor slip and may prevent the motor from pulling into synchronism if the load at this point is high. Such a condition would require a low-resistance starting winding.

Synchronous Speed

All synchronous motors must have 92 to 96 per cent synchronism, depending somewhat on the flywheel effect of the load, before the field excitation can be put on. If the excitation is applied below this speed the motor fails to pull into synchronism and either shuts down entirely or runs along at a reduced speed, taking a heavy fluctuating current. In some cases additional torque near synchronism can be obtained by short circuiting the field winding through the field rheostat. This has the effect of reducing the resistance of the motor winding to some extent and causing the motor to have less slip with a given load. The gain from this source is small, however, in most cases, as the self-inductance of the field winding is so high as to allow very little current to flow, even if the field is dead short circuited, so that the total effective resistance of the rotor winding is not materially reduced. In some cases, where the torque is nearly sufficient, however, enough may be gained to take care of the conditions. If the field is short circuited before the motor is started, there will be a reduction in starting torque and an increase in current from the line, so that, if this method is resorted to, arrangements should be made to short circuit the field after the motor has come to constant speed.

It often occurs, when the motor has reached synchronous speed and the direct current excitation has not been previously applied, that when it is excited by direct current, the poles will not be in the proper position relative to the stator conductors. If the direct current excitation is increased sufficiently, the rotor will "slip a pole," and then, the poles being in the proper relative position, the rotor will lock into synchronism. This method of forcing the rotor to "slip a pole" may cause excessive currents to flow in the armature conductors, as it tends to lessen the flux to the stator magnetizing currents, which generate the counter electro-motive forces. However, this condition may be prevented and the desired results obtained by either reversing the polarity of the applied excitation, by slightly loading the machine mechanically, or by disconnecting the motor from the supply. There is, of course, an even chance that the same polarity may be in the same relative position to the stator conductors.

Incorrect Connections

Incorrect connections usually manifest themselves by unbalanced entering currents and by the fact that the starting torque is very much less than it should be, or perhaps negligible. The circuits should be traced out and the connections remade until the three entering currents in the case of three-phase, or the two entering currents in the case of two-phase, agree approximately. It should be noted that these currents do not agree even with correct connection when the armature is standing still. The reading should be taken with the armature revolving slowly, mechanically, which, with the proper connection, should average up the entering currents.

Failure of Motor to Develop Full Load Torque

The failure of a motor to develop full load torque after having attained synchronous speed is due entirely to failure of excitation.

Exciter failure.—The exciter should be inspected as to whether it is operating satisfactorily.

Open circuit.—This may be the case either in the leads between the exciter and the motor field, or in the connections between the field coils. The majority of the troubles of this nature are generally to be found in the coils themselves. In starting a synchronous motor, a transformer action exists between the armature winding and the field winding, the comparatively large number of turns on the field causing a high voltage to be induced in the field windings, resulting in a breakdown of the same. A field discharge switch and resistance should therefore always be provided with synchronous motors.

Motor Stops under Maximum Load

The maximum torque of a synchronous motor is in proportion to the square of the voltage and over-excitation of the field will also increase it to some extent. If the motor, however, breaks down from excess of load it will not recover when the load is removed, as will the induction motor, but it is necessary to remove the field excitation and start up in the regular way.

Hunting

When synchronous motors are operating in parallel under normal conditions, periodic variations in motive power or load may cause the machines to oscillate in speed. These oscillations, unless opposed in some manner, may become more and more aggravated, until the machines either "fall out of step" or serious line surges occur. One of the most valuable features of the amortisseur winding is its tendency to prevent these oscillations. When the machine is retarded or accelerated, the bars of the winding are cut by the flux. The cutting of the flux produces energy currents in the bars which tend to dampen out these oscillations. The energy that would otherwise be expended in retarding or accelerating the motor is thus absorbed and dissipated.

INDUCTION MOTORS

Failure to Start

No voltage.—No voltage at the motor terminals may be due to blown fuses or breaks in the connections to the motor. See also "Defects in Starting Compensator."

Low voltage.—Low voltage is the most frequent external trouble causing a motor to refuse to start. Since the torque of an induction motor is proportional to the square of the applied voltage, a reduction in the applied voltage has a very great effect upon the starting torque. A low applied voltage may be due to several causes. The motor leads may be connected to too low a voltage tap on the compensator or the voltage drop in the supply circuit may be excessive. In testing for low voltage, measure the voltage at the motor terminals as soon as the motor is thrown on the line. Although the no-load voltage may be all right when the motor is thrown on the line, the heavy starting current taken may pull the voltage down too low, if there is not carrying capacity enough in the transformer windings and the line. In considering the sizes of transformers and lines for induction motors, allowance must be made for the excess in starting current as compared to the running current.

One phase of stator open circuited.—Reading of current can be obtained only in two legs of the three-phase leads if the motor is Y-wound and the motor will not start by itself. In the case of a three-phase delta-wound motor, an open circuit in one phase will result in an open circuited delta, ex-

cited with three-phase current. Such a winding will produce a rotating magnetic field and consequently develop a starting torque, although of smaller value than the normal three-phase torque. If, therefore, the normal starting torque is just sufficient to start the load, the motor will most likely refuse to start when suffering from this defect.

One phase of stator reversed.—The motor will have a greatly reduced torque and probably will not start with any load.

All phases of rotor open circuited.—Motor will not start, and the current taken is the exciting or no-load current. This trouble can be distinguished from blown fuses and open circuits in the stator and leads by connecting an ammeter in the line; if it shows current flowing in each of the phases, the trouble is in the rotor. If there were open circuits in the stator or in the leads, no current would flow in the affected lead.

One phase of rotor open circuited.—Running light, the current taken in the three lines will be practically balanced, but the motor in starting has a decided tendency to remain at half synchronous speed.

Defects in starting compensator.—When a motor will not start, having been connected to a compensator, the cause may be entirely in the compensator. This may have become open-circuited, due to a flash within. The compensator switch may have become deranged, so that it will not close, or a connection within the compensator may have become loosened. Possibly when a motor will not start when connected to a compensator just put into use, a secondary coil may be bucked against another secondary coil within the compensator, so that no voltage is produced by the compensator at the motor. This results in no particular heating which would account for the motor not starting. An ammeter in the motor leads would show the absence of current, or a voltmeter the absence of voltage between the lines.

Starting resistance too high.—A few tests may be made in short-circuiting some of the units in the starting resistance.

Controller troubles.—The motor will sometimes run one way and refuse to start in the other direction. The cause of this is that the contacts on the primary drum touch in one position, but fail to make contact when thrown to the other position. If the motor will not start in either direction and the fuses are all right, set the controller on the first notch and pull out the fuses one at a time, leaving the two fuses of one phase in each time. If the motor hums loudly on each phase, the primary connections are all right, and the trouble must be looked for either in the secondary drum contacts, the collector rings or the wiring.

Excessive load at starting.—This is often the case and can only be remedied by removing some of the load. Excessive bearing friction or too tight belts may often be the cause of this trouble.

Excessive Current at Starting

Voltage too high.—It is often found that a motor is connected to a compensator in such a way that the applied voltage is too high, resulting in an excessive starting current. Compensators are usually supplied with various taps, and one should be chosen which produces the least disturbance on the line, giving at the same time the desired starting torque on the motor.

Wrong connections.—Sometimes a mistake in connection is made on the compensator so that full voltage is used at starting and the lower voltage after throwing over the switch. Thus the motor at starting takes excessive current, and, since the maximum output is in proportion to the square of the voltage, the motor capacity is much reduced when it is apparently running on the operating position.

Overheating and Failure to Carry Load

Voltage too low.—Since the torque is proportional to the square of the voltage it can be seen that lowering the voltage has a positive effect upon the ability of the motor to carry load, and may be the cause of its stopping.

Overload.—The load put on the motor may be more than the designed maximum output. Excessive bearing friction or worn bearings may also be the cause for overloading. For some reason the bearings may have become worn, so that the air-gap at the bottom has gradually so reduced that the rotor commences to rub on the stator. The friction may then become so great that the load represented by it is more than the motor can carry, with the result that it shuts down.

Too frequent starting.—On account of the increased current required, a motor should not be started too often, as this may cause overheating.

Speed too low.—With variable speed motors it is often found that full load is carried on the motor at reduced speeds. This will cause an overheating of the motor unless it is specially designed for this service.

One phase of stator open circuited.—In this case the motor will continue to operate single phase, with a pronounced lack of power.

Short circuit in stator.—A short circuited coil in the stator will cause it to buzz and hum, and if the motor is run for any length of time the coil will overheat and smoke.

Open circuit in Y-connected rotor.—This usually manifests itself by overheating, and if the motor is running under load, the speed will drop considerably, on account of the fact that the rotor is running on single phase, so that only a portion of its winding is operative.

Short circuit in rotor winding.—This will cause an overheating of the rotor, and the short circuits are generally caused by the winding being grounded in two places.

Unbalanced voltages.—The maximum output can be seriously affected by the fact that the voltages applied to the motor are not equal in amount.

Changed voltage.—If a standard induction motor is run on a changed voltage, the heating will vary in accordance with the losses. The copper losses being greater than the core loss results in increased heating at reduced voltage, when operating with the same horsepower output.

Variation of frequency.—An increase in the frequency results in a considerable reduction in the maximum load which an induction motor can carry.

Sparking

The cause of sparking of the collector ring brushes with phase-wound induction motors is generally the high current density therein, caused by an excessive overload. This furthermore causes the collector rings to become pitted, and the brushes to wear away rapidly. Excessive brush pressure may also cause overheating of the collector rings.

Vibration

Vibration may be due to mechanical unbalancing, but this occurs chiefly in high-speed machines and is, as a general rule, easily detected. Loose parts are also often responsible for this defect. When due to an unbalancing of magnetic pull caused by a combination of faulty air-gap and eccentricity of rotor circumference, it may in some cases be remedied by the adoption of a multiple wound stator. It can always be improved by the proper adjustment of the air-gap by "truing up" the rotor.

* * *

The introduction of the motor truck has added a new vehicle for pleasure as well as business. Motor trucks are finding favor with parties bent on straw rides, outings, moonlight excursions, etc. Motor truckmen in some places are able to add substantially to their incomes from these sources. The motor truck may be used all day for hauling goods and all night, if need be, for lighter pursuits with no detriment to its "health," provided ordinary care is bestowed on upkeep. A two-ton truck can comfortably seat eighteen or twenty people and carry them at a rate of ten or twelve miles an hour, and a trip of twenty miles into the country and return can be easily accomplished in five hours. A charge of a dollar a head yields good pay for the service.

* * *

A hard solder of low fusing point that is used extensively by one of the largest electrical companies, is composed of 34.36 per cent copper; 49.24 per cent silver; and 16.40 per cent zinc. Borax is used as a flux.

A NEW ZEALAND SCHOOL WORKSHOP

SOME EXAMPLES OF WORK DONE BY STUDENTS IN THE ANTIPODES

BY JOHN PEDDIE*

Readers of Mark Twain's "A Tramp Abroad" no longer labor under the delusion that New Zealand is somewhere close to Australia and that you cross to it by a bridge. Another delusion which is not quite dispelled, however, is that New Zealand is a new country, inhabited by savages and backwoodsmen, among whom the industrial problems of the older countries are unknown. New Zealand has industrial problems of the same kind that afflict older countries, and is trying to solve them in much the same way, *i. e.*, by the erection and equipment of technical schools and colleges, where special education is given to young people of both sexes to fit them for various trades and professions.

Fig. 1. Examples of Students' Work in Toolmaking

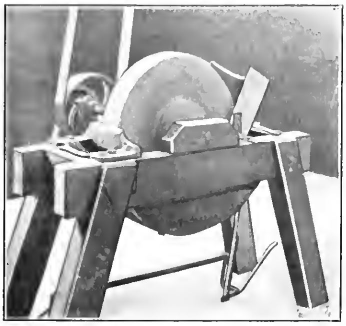

Fig. 2. Grindstone Frame made in Woodworking Shop

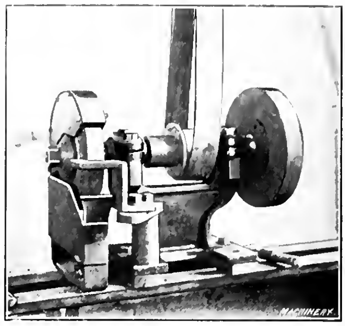

Fig. 3. Grinder Head built in a New Zealand School Workshop

It is the purpose of this article to deal with the practical workshop instruction given in the Christchurch Technical College to youths who propose to follow the engineering or machinist trade. In addition to the work to be described, day school pupils receive instruction in patternmaking and blacksmithing. Free evening pupils take one lesson of two hours per week in the workshop and are also required to take two other subjects per week in the classroom. These subjects comprise English, shop mathematics, mechanics and mechanical drawing. As regards practical instruction given in the workshop to evening students, who are mostly apprentices to the machinist trade, it ought to be remembered that the whole time actually available in one year amounts to only seventy hours, or less than a fortnight's full time in a shop. When this fact is kept in mind, an unprejudiced observer will probably admit that the majority make surprising progress.

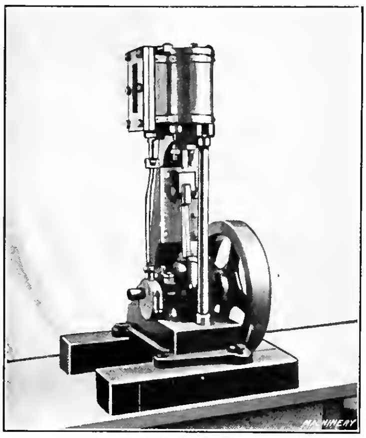

Fig. 4. Small Steam Engine built by Students

We do not claim that in such a length of time we are able to give instruction in a great variety of processes nor can we allow the student to spend sufficient time on any one process to gain great manipulative skill. Neither, on account of the number who are receiving instruction at one time, can each individual be given as much attention as would be beneficial. The cost of the classes would be regarded as prohibitive if the numbers were kept low enough to admit of this. But we find apprentices coming to us in order to learn processes which they are afforded no opportunity of learning in the workshop where they are employed. Some are being kept entirely on fitters' work and wish to gain some familiarity with machines. Some are getting plenty of practice in plain turning and boring and would like to learn to cut screw threads or turn and bore tapers. Some have devices of their own which they wish to perfect, and if these appear to be practical, every facility is afforded for bringing them to a successful issue. The writer is of the opinion that the value of any exercise depends greatly on the interest it excites in the student. For this reason the mere fact of a student wishing to devise and construct any tool or apparatus is a good reason for allowing him to do it. If, in addition, a class of workmanship suitable for the project is insisted on, considerable educational value is secured.

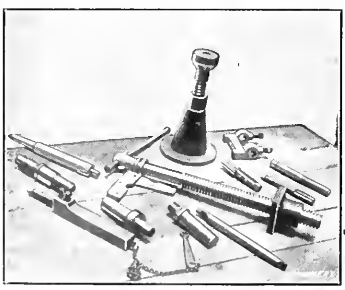

Fig. 5. Examples of Lathe and Vise Work

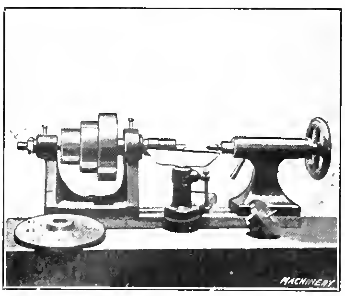

Fig. 6. Lathe Heads built by Students

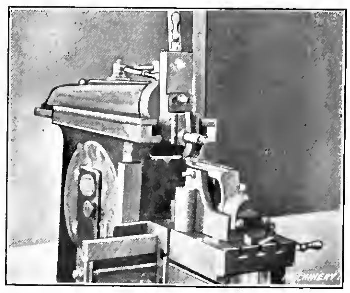

Fig. 7. Fixture made for planing Lathe Heads

It is a striking fact that the founders of the most successful engineering firms of the world have started in life as fine ingenious workmen. Their chief characteristic has been a love of working with and thinking about the tools and machines which they so successfully produced. In general, their purely scholastic attainments have rarely been worth recording. Dr. Smiles in his introduction to the life of Brindley observes in this connection: "Nor did any of the great mechanics who have since invented tools, engines, and machines, belong to the educated classes. They received no college education. Some of them could scarcely write their own names. But where learning failed natural genius triumphed. These

* Address: Technical College, Christchurch, New Zealand.

men gathered their practical knowledge in the workshop or acquired it in manual labor. They rose to celebrity chiefly through their habits of observation, their powers of discrimination, their constant self improvement, and their patient industry."

The writer quotes the preceding to emphasize the importance of the workshop as a training school for mechanics, not with the view of depreciating theoretical training. The great mechanics mentioned by Smiles would no doubt have been still greater mechanics if they had had a college education, unless that education had been of such a nature as to paralyze their natural powers. Again, it should not be the purpose of such a school as this merely to produce skillful submissive drudges to be employed by the employing class. If it does not tend to develop intelligent, resourceful men, who are well informed regarding matters related to their trades, the work of the school can hardly be called complete. It is to be regretted that many employers simply demand a supply of human machines, possessing all the gifts and none of the failings of the human family, and because they do not often get them they talk loudly of inefficiency. If you look up past records of the engineering profession back to the days of Boulton and Watt, you will find that the most notable characteristic of the workman has been his inefficiency.

Many boys who go through the engineering course in the day school do not take up that profession on leaving. While some might claim that the special training they have received has therefore been wasted, many educational authorities maintain that it is precisely those who do not intend to follow engineering work who derive the most benefit in after life from such a course of study. The writer finds that better work is generally done by day school boys than by older lads in the evening classes who are engaged as apprentices with the various engineering firms in the city. This is no doubt owing to the class of work that is given to the apprentices in the shops, and the scramble for quantity of output. Most of the work shown in the accompanying illustrations has been done by day school boys.

Fig. 1 shows a set of exercises (mostly hand tools) made by day school boys during a two years' course. Each boy in addition to making these tools will have done a considerable amount of lathe work on jobs for school use. Examples of the latter kind may be seen in Figs. 2, 3, 4 and 10, which show a grindstone stand, a grinder head, a steam engine and a shear, which have been entirely made by students. The grindstone frame was made by boys in the building class. Water is applied to the stone by depressing the foot lever, which raises a pan till the water reaches the stone. Fig. 5 shows various samples of lathe and vise work. When a student has learned to cut screw threads on a practice piece, he generally makes something of actual use, as indicated by the screw jack, vise screw, threaded mandrels, etc. The screw shown to the left of the picture is for a hand drilling machine and has a hole bored through its length by the aid of the center rest. Several counterbores and boring tool holders like the ones shown have been made by the students.

Fig. 6 shows a pair of lathe heads for wood-turning, of which several sets have been made for use in the school. Several special fixtures and tools were made for producing these heads. For planing the heads, the fixture shown in Fig. 7 was made. The heads are located in this fixture by a recess in a clamp member which fits over the bearing boss at each end of the head. A cylinder which serves to align the bearings with the tongue on the base of the head-stock is shown on the table. The head is tightened up in the fixture by set-screws at the end, and a set-screw at the top of the fixture serves to take up side play. The top of the fixture is used to adjust the tool for height, and the width and location of the tongue is found by one or two metal gages.

Fig. 8 shows a fixture that was made for use on one of our lathes on which the heads were bored. This fixture is clamped in the cross-slide groove, the heads being scraped to fit the slot in the fixture. This rig is easy to set up when wanted. The boring-bars shown beside it were also made by students and afforded good practice in filing slots and fitting, as well as hardening and tempering the cutters.

A surface gage designed by the writer for boys to make is shown in Fig. 9. The fine adjustment is obtained through the spring. The making and tempering of this spring, forging the small bracket for the clamping head, and fitting and riveting it affords quite a variety of exercises. Many creditable tools of this type have been made, though the style shown in the group in Fig. 1 is perhaps more serviceable. Up to the present time, we have not had a milling machine, but now a No. 1 B. & S. universal is being installed as well as a Norton cutter and reamer grinder.

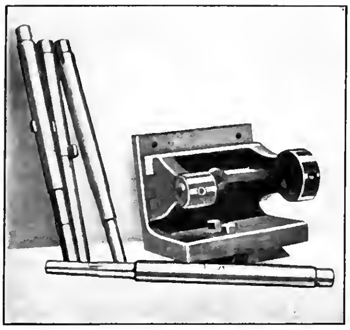

Fig. 8. Fixture made for boring Lathe Heads

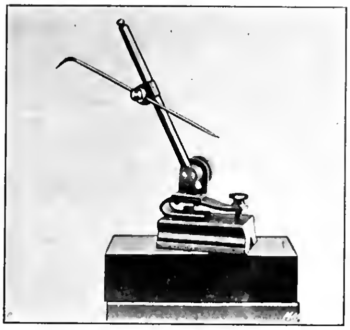

Fig. 9. Surface Gage made by Students

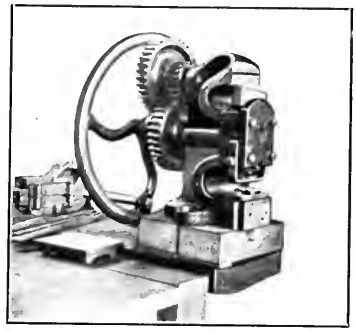

Fig. 10. Shear built entirely by Students

* * *

ARE IRON AND STEEL CHIPS COMBUSTIBLE?

BY JOHN A. GRAHAM*

I read with interest the description of a burning pile of steel chips in the October number of MACHINERY, but I do not agree with the writer's statement that the steel burned. It was stated in the article that the chips were passed through a centrifugal separator to remove the oil, but it must be remembered that this operation removes only the excess oil, and that the chips on leaving the machine are by no means absolutely dry; there is still a very thin film of oil remaining on them.

Bearing this fact in mind and the fact that the chips are very finely divided, it will be understood that the amount of oil contained in a large pile of chips is considerable, and on account of the porosity of the mass it will contain almost sufficient air to provide for the complete combustion of the oil. The sinking of the pile was no doubt caused by the crushing of the spiral or tube-like form of the chips, which naturally followed when the mass became heated.

Another point not to be overlooked is the fact that iron, when burning, absorbs oxygen; 56 pounds of iron requires 24 pounds of oxygen to form 80 pounds of ferric oxide. This reaction is accompanied by a large increase in volume. What would Mr. Rushmore think if he saw that pile of chips not only "burning" but increasing in size as it burned? Inasmuch as he does not state that he found any iron oxide after the fire, it is evident to me that it was not the iron that burned but the oil adhering to the chips.

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STEAM POWER PLANT PIPING DETAILS—7*

PROVIDING FOR EXPANSION AND CONTRACTION STRAINS IN PIPING SYSTEMS (Continued)

BY WILLIAM F. FISCHER†

In Fig. 52 is shown a cross-sectional view of what is known as a standard-traverse unbalanced expansion joint of the slip type, and Fig. 53 shows what is known as a balanced expansion joint of the slip type. These expansion joints are manufactured by the Pittsburg Valve Foundry & Construction Co. and are made in all sizes to match standard steam pipes up to 24 inches in diameter, and for working steam pressures up to 250 pounds per square inch.

The expansion joint shown in Fig. 52 is known as an unbalanced joint because the steam pressure is unbalanced and acts at each end of the joint in a direction opposite to the arrows *X* and *Y*, tending to pull the joint apart and separate sleeve *B* and hub *C*. In order to prevent the joint from being pulled apart by the steam pressure, bolts *E* are attached to hub *A* and allowed to slide freely through holes drilled in the flanges of hub *C* and gland *D* as indicated. A nut on the end of each bolt prevents the joint from being pulled apart under pressure. This type of expansion joint consists simply of a cast-iron hub *A* into which is screwed a smooth finished brass tube or sleeve *B*, which, in turn, slides freely through a packed, steam-tight joint in the cast-iron hub *C*.

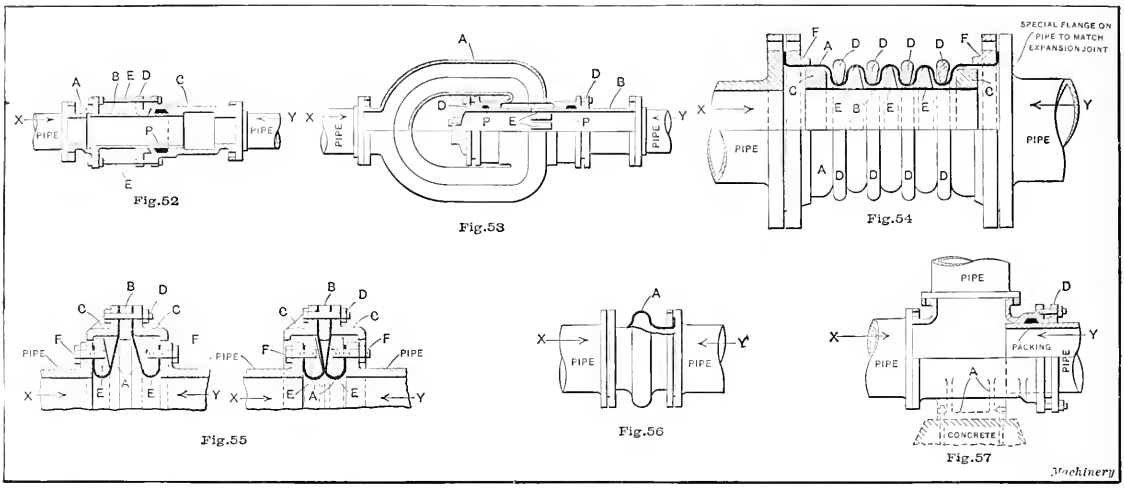
The steam packing *P* is compressed by screwing down the packing gland *D* until the joint is sufficiently tight to prevent the leakage of steam through the packing. When the steam main expands in the direction of the arrows *X* and *Y*, the sleeve *B* slides through the packed joint in *C*, thus relieving the expansion strains on the piping system.

With the balanced type of expansion joint shown in Fig. 53, there is no danger of the joint being pulled apart due to the pressure of the steam, as the construction is such that the steam pressure is balanced. This is accomplished by passing the sliding sleeve *B* through the joint and packing each end of the cylinder steam tight, as shown at *P*, thus preventing the pressure from separating the members *A* and *B*. The packing is compressed by screwing down the glands *D*. By studying the illustration, it will be seen that if blind flanges were attached at each end of the joint and steam was admitted to the joint, the pressure of the steam acting against the flanges at each end would have no tendency to pull the joint apart. The sleeve *B* is made to slide freely through chamber *A*, thus relieving the expansion and contraction strains in the piping system. The rectangular holes *E*, in sleeve *B*, provide for the passage of the steam from one section of the expansion joint to the other depending upon the direction of the steam flow.

With this type of expansion joint there is less danger of the sleeve binding in the joint than there is with the unbalanced type shown in Fig. 52.

Slip expansion joints are sometimes used for high pressure work where sufficient space is not available to accommodate a long radius expansion bend. Where it is possible to use them, however, expansion bends should always be given the preference. The Wainwright improved expansion joint, shown in Fig. 54, is manufactured by the Alberger Condenser Co. With this type of joint, the compactness of the slip expansion joint is secured without the necessity of providing stuffing-boxes, which, unless properly cared for, are apt to leak and cause more or less trouble.

This type of joint, known as a corrugated joint, is made for both low pressure and vacuum exhaust mains, and also for high pressure steam mains. For low pressure and vacuum exhaust mains the joint consists simply of a main corrugated tube *A* made of soft wrought copper, two flanges *F*, and an inner tube *B*, the equalizing rings *C*, *D* and *E* being omitted.



Figs. 52, 53, 54, 55, 56 and 57. Different Forms of Expansion Joints used to take up Contraction or Expansion in Power Plant Piping

The expansion joint shown in Fig. 54 is for use with high pressure steam and consists of a main corrugated copper tube *A*, which is rolled over the face of the connecting flanges *F*, and an inner cylindrical tube *B*, made of brass or hard composition, to the ends of which are attached the rectangular cast-iron rings *C*. The triangular shaped cast-iron equalizing rings *D* and *E* are provided to limit the movement of the corrugations in any one section, and thus cause each of the corrugations to take up its share of the travel and prevent the expansion strains from falling on any one corrugated section of the outer tube.

The inner equalizing rings *E* are made to slide freely on the inner tube *B* as the joint contracts or expands. The outer equalizing rings *D* also act as reinforcing rings which assist in holding high steam pressures as well as equalizing any movement of the corrugated sections. The construction of this joint is such that it can be readily covered with non-conductive pipe covering material by first placing two overlapping tubes of sheet iron over the outer rings of the joint and then applying the covering over these tubes in order to provide free movement of the corrugated sections without danger of breaking up the covering as the pipes expand or contract.

* The sixth installment of this series was published in the September number of MACHINERY.

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The expansion joint shown in part section in Fig. 55 is made by the Central Steam Co. This joint is more compact than most joints of equal traverse and requires no packing of any kind as there are no sliding or rotating parts to be packed tight under pressure.

This expansion joint consists of two annular diaphragms *A* made of heavy annealed copper, which are clamped at their outer edges between the inner cast-iron stop ring *B* and outer stop rings *C*; the diaphragms are clamped at their inner edges between the backing rings *E* and the flanges of the pipe to which the joint connects. The inner edges of the diaphragms *A* are rolled over the outer face of the backing rings *E* as shown in the illustration, and firmly secured by bolts *F*. Lips cast on the outer edge of the stop rings *C* prevent the joint from being pulled apart due to the pressure in the steam main. In operation, the joint is placed in the line with the backing rings *E* drawn out as far as the stop rings *C* will permit as shown at the left-hand side in Fig. 55. As the steam main expands, the backing rings *E* and diaphragms *A* are forced toward each other in the direction of the arrows *X* and *Y*, the joint being shown at the end of its traverse at the right-hand side of Fig. 55. When the pipes begin to expand, the weakest diaphragm acts first until the outer edge of the backing ring *E* comes in contact with the inner edge of stop ring *C* which stops its travel, thus causing the other diaphragm to act in a similar manner and take up its part of the travel.

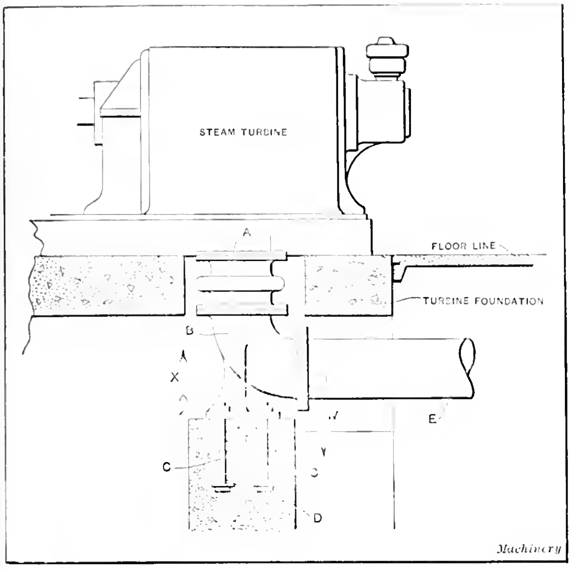

Fig. 58. Arrangement of Expansion Joint between Turbine and Condenser

The diaphragms of these expansion joints are made without corrugations and the joints are so constructed that the maximum bending of the copper diaphragms *A* at any point, due to change of position, will not exceed ten degrees. The backing rings *E* are made of finished cast iron, thus presenting a smooth unbroken surface to the copper diaphragms. Joints of this type are largely used for underground heating mains and are made in several different types to suit the service for which they are required.

The expansion joint shown in Fig. 56 is for use on short exhaust mains, and is used quite extensively on vacuum exhaust mains, being placed between the steam turbine or engine and the condenser, as shown in Fig. 58. This joint consists of a corrugated copper tube *A* of practically the same inside diameter as the exhaust main, and two loose ring flanges. The corrugated copper tube is rolled over the inner faces of the ring flanges and is firmly clamped between the flanges of the expansion joint and the flanges of the pipe or fittings to which they connect. This joint, having but one corrugation, is not as well suited for use on long exhaust mains as the types previously described. For long exhaust mains, where considerable expansion has to be taken care of, the number of corrugations should be increased so that all of the bending is not thrown on a single corrugation. Very long exhaust mains, when served by a single expansion joint of the type shown in Fig. 56, are apt to cause considerable bending action on the corrugated section of the joint, which, in turn, is very apt to cause the copper to crystallize and break in service. For long exhaust mains a type of expansion joint having a number of reinforced corrugated sections, similar to that shown in Fig. 54, is better suited to the service, as the bending action is more or less uniformly distributed over a number of corrugated sections instead of being concentrated on a single one.

The expansion tee, shown in Fig. 57, provides another means of caring for expansion and contraction in exhaust mains. The tee shown in the illustration is arranged with a stuffing-box and gland at one end through which the pipe moves as the steam main expands or contracts. These tees are only made to special order, and may be obtained with a stuffing-box and gland at each end, if so desired. In a case of this kind it is advisable to provide a ribbed base flange on the tee, opposite the outlet flange, as shown at *A*, the base flange being anchored to a concrete pier or other suitable support.

Caring for Expansion and Contraction in Steam Turbine Exhaust Mains

Fig. 58 shows a common method of arranging the exhaust main leading from a steam turbine to the steam condenser, when the turbine is provided with a bottom exhaust outlet as shown.

The corrugated copper expansion joint *A* is connected direct to the exhaust flange of the turbine and to the flange of the base elbow *B*. The elbow *B* is anchored to concrete pier *D* by means of the anchor bolts *C*.

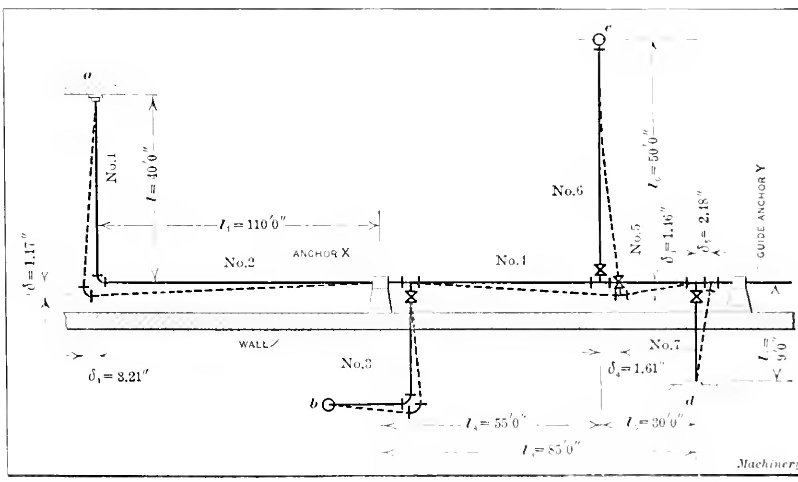

Fig. 59. Layout of Piping illustrating Method of calculating Stresses due to Expansion

Pipe *E* leads to the condenser, which is not shown in the illustration. It is also advisable to install an expansion joint in the horizontal exhaust main *E*, as the expansion joint *A* only takes care of the expansion in the vertical line. Owing to the small clearance space usually allowed between the rotating blades and the casing of a steam turbine, the exhaust mains should always be equipped with an expansion joint between the turbine and exhaust pipe in order to pre-

vent expansion strains in the piping system from being transmitted to the turbine casing. In vacuum exhaust mains, the pipe or fittings beyond the expansion joint should be securely anchored in such a manner as to prevent the pipe from being raised bodily against the expansion joint and crushing it.

The necessity of anchoring vacuum exhaust mains will be better illustrated by the following example. Assume the vacuum exhaust main shown in Fig. 58 to be 36 inches inside diameter, leading direct to a condenser which operates under a vacuum of 28 inches, as recorded on a mercury vacuum gage. A column of mercury approximately 2 inches high will exert at its base a pressure of one pound per square inch. Therefore 28 inches of mercury is equivalent to a pressure of $28 \div 2 = 14$ pounds per square inch, and the condenser is working under a pressure of $15 - 14 = 1$ pound absolute, or approximately 14 pounds lower than atmospheric pressure. In other words, the pressure of the steam flowing through the exhaust main and elbow *B*, Fig. 58, is approximately 1 pound (absolute) per square inch, while the pressure of the surrounding atmosphere is approximately 15 pounds per square inch (absolute), depending upon the altitude. This leaves an unbalanced pressure of $15 - 1 = 14$ pounds acting on each square inch of outside surface of the exhaust main. This unbalanced pressure tends to lift the base elbow *B* bodily (in the direction of arrow *X*) and crush the corrugated expansion joint *A*.

The internal cross-sectional area of a 36-inch inside diameter pipe $= 36 \times 36 \times 0.7854 = 1017$ square inches. Therefore the total pressure tending to lift the elbow and crush the expansion joint $= 1017 \times 14 = 14{,}238$ pounds, which acts upward in direction of arrow *X*. From this, we must subtract the weight of the elbow and exhaust pipe which acts downward, in the direction of the arrow *W*. A 36-inch cast-iron base elbow *B* will weigh, on an average, about 2200 pounds. Assuming the length of the horizontal exhaust pipe to be 10 feet, it will weigh in the neighborhood of 4000 pounds, one half of which will be supported by the condenser and the other half (2000 pounds) by the concrete pier *D* (Fig. 58). From the preceding, we find the weight of the base elbow and exhaust pipe acting downward, in the direction of the arrow *W* to be $2200 + 2000 = 4200$ pounds. Subtracting this from the upward pressure of 14,238 pounds we find $14{,}238 - 4200 = 10{,}038$ pounds to be the pressure tending to crush the expansion joint.

In this case, in order to prevent the joint from being crushed, it is necessary to add sufficient weight to concrete pier *D* to hold the elbow down. This means that the weight of concrete pier *D* should be in excess of 10,000 pounds to be safe, say 15,000 pounds. As concrete weighs about 150 pounds per cubic foot we require about $15{,}000 \div 150 = 100$ cubic feet of concrete in pier *D*. Assuming the pier to be 4 feet square at the top, the depth required would be $100 \div (4 \times 4) = 6$ feet approximately. Assuming that four anchor bolts *C* are used to anchor the elbow to the pier, the size of the bolts required should not be less than 3/4 of an inch in diameter, or if two bolts are used, they should be 1 1/8 inch in diameter. The anchor bolts should project far enough below the top of the concrete pier to prevent them from pulling out or shearing through the concrete, and they should be provided at the end with suitable steel or cast-iron washers, to distribute the load over a sufficient area to accomplish the desired results. The concrete pier shown in Fig. 58 may be omitted, if so desired, and steel channel irons or I-beams built into the turbine foundations to support the weight of the piping and at the same time prevent the elbow from being raised against the expansion joint, by enabling the base elbow to be anchored to the steel work.

In one case that came to the writer's attention, a base elbow in a vacuum exhaust main supported on a concrete pier, as shown in Fig. 58, was raised against the expansion joint and crushed it. The concrete pier was pulled up bodily with the elbow. Calculation showed the concrete pier to be very much lighter than would be required to hold the elbow down against the unbalanced pressure acting upward. It is always advisable in designing a case of this kind to be certain that proper weight is allowed and to see that the elbow is properly anchored against the uplifting pressure of the atmosphere.

Calculating the Bending Stresses in a Piping System due to Expansion

To calculate the exact stresses and deformations that take place in a steam main due to expansion and contraction of the different branches of the piping system would be a difficult and rather tedious operation. In the first place, the different branch pipes of the system are, as a rule, of varying lengths and do not always lie in the same plane, in which case shearing, tensile, compressive, bending and torsional stresses are frequently developed in certain branches of the system. The tensile, shearing, and torsional stresses developed are, as a rule, very slight and in all ordinary cases they may be neglected entirely. Direct compressive stresses of any magnitude are only developed when the pipe is anchored at two points close together in such a manner as to prevent the pipe from expanding (See the fifth installment of this article, August, 1913). Bending stresses are developed in almost every branch of a steam piping system, however, as will be shown by the following and should therefore be considered in the design of the piping system.

As an example showing the approximate bending stresses caused by expansion of the different branches of a piping system, consider the branch pipes Nos. 1, 3, 6 and 7 in Fig. 59 to be rigidly connected at points *a*, *b*, *c* and *d* respectively, to the flanges of the units which they serve. Also consider the main steam header to be rigidly anchored to the wall at the point *X*, and supported by a guide anchor at point *Y*, in such a manner that the pipe is permitted to slide freely through the guide. In this case, when steam is turned into the piping system, the expansion of the branch pipes, and the main header, will cause the whole piping system to deflect and assume the position shown by the dotted lines (Fig. 59). The expansion of branch pipe No. 1 causes branch No. 2 to deflect at the end an amount δ. At the same time, the expansion of branch pipe No. 2 causes branch pipe No. 1 to deflect an amount δ_1 as shown by the dotted lines and the figures in the illustration. As the main header is anchored rigidly at point *X*, we will, in this case, ignore the expansion of branch pipe No. 3, as the expansion and deflection in this branch of the system are calculated in exactly the same manner as that for branches Nos. 1 and 2. Next we have the expansion in branch pipe No. 4 which causes branch pipe No. 6 to deflect at the end an amount δ_4. At the same time, the expansion of branch pipe No. 6 causes branches Nos. 4 and 5 to deflect an amount δ_3, this deflection reaching a maximum at the intersection of the branch pipes Nos. 4, 5 and 6. Furthermore, the expansion of pipes Nos. 4 and 5 causes pipe No. 7 to deflect an amount δ_5, all as shown, greatly exaggerated, by the dotted lines in Fig. 59. The next thing to determine is the expansion of the different branches of the piping system, in order that we can determine the deflection at the different points, as shown by δ, δ_1, δ_2, δ_3, δ_4 and δ_5.

Assume the pipe to be of wrought iron, erected during the winter months at a temperature of 40 degrees F. and to be conveying saturated steam at approximately 200 pounds gage pressure, after erection.

By the aid of Table II (See the fifth installment, August, 1913) we find the expansion of the different branches of the piping system to be as given in Table VIII.

Having found the deflection of the different branches of the piping system, let us consider the resulting bending stresses produced in the different branches of the system. For ordinary purposes of calculation, branch pipes Nos. 1, 2, 6 and 7 may be considered as cantilever beams, fixed at one end and deflected at the other end, as shown. Also, pipes Nos. 4 and 5 may be considered as a beam supported at each end and deflected as shown at δ_3. For a cantilever beam fixed at one end and loaded at the other, we have: Greatest deflection δ at the end of the beam:

$$\delta = \frac{f\, l^2}{3\, E\, Y} \qquad (7)$$

from which the extreme bending or fiber stress f in terms of the deflection is given by the following:

$$f = \frac{3\, E\, Y\, \delta}{l^2} \qquad (8)$$

For a beam supported at both ends and loaded with a concentrated load at any point of its length, we have: Greatest deflection

$$\delta = \frac{f}{27\, E\, Y} \times \sqrt{3 l_2 \; (2l - l_2)^3}. \qquad (9)$$

from which the extreme bending or fiber stress f in terms of the deflection is:

$$f = \frac{27\, E\, Y\, \delta}{\sqrt{3 l_2 \; (2l - l_2)^3}}. \qquad (10)$$

where l = length of beam in inches, between points of support.

E = modulus of elasticity of piping material, in pounds = approximately 29,000,000 for steel pipe.

f = extreme fiber stress in pounds per square inch.

Y = distance in inches from neutral axis of beam to the most distant fiber $= \frac{\text{outside diameter of pipe}}{2}$

l_2 = greatest distance in inches from either point of support to concentrated load.

Assuming all of the pipe shown in Fig. 59 to be 8-inch standard pipe, 8⅝ inches outside diameter, we have (Formulas (7) to (10) inclusive), $Y = 8.625 \div 2 = 4.313$ inches. Taking the modulus of elasticity E as 29,000,000 and substituting in the formulas the various lengths in inches, we find the extreme fiber stresses due to bending, to be as follows:

TABLE VIII. DEFLECTION OF PIPING DUE TO EXPANSION

Branch Pipe No.	Length of Pipe in Feet multiplied by Expansion Constant		Expansion in Inches		Deflection	Branch Pipe No.
1	40 × 0.0292*	=	1.17	=	δ of	2
2	110 × 0.0292	=	3.21	=	δ_1 of	1
4	55 × 0.0292	=	1.61	=	δ_4 of	6
4 and 5	85 × 0.0292	=	2.48	=	δ_5 of	7
6	50 × 0.0292	=	1.46	=	δ_3 of	4 and 5

Machinery

* Constant 0.0292 is found in the tenth column of Table II, opposite 40 degrees F. initial pipe temperature

Extreme fiber stress in the outermost fibers of pipe No. 1 due to bending $= f_1$, and from Formula (8):

$$f_1 = \frac{3\, EY\delta_1}{l^2} = \frac{3 \times 29{,}000{,}000 \times 4.313 \times 3.21}{(12 \times 40)^2} = \frac{1{,}204{,}491{,}510}{230{,}400} = 5230 \text{ pounds per square inch.}$$

Extreme fiber stress in the outermost fibers of pipe No. $2 = f_2$:

$$f_2 = \frac{3\, EY\delta}{l_1^2} = \frac{3 \times 29{,}000{,}000 \times 4.313 \times 1.17}{(12 \times 110)^2} = \frac{439{,}020{,}270}{1{,}742{,}400} = 252 \text{ pounds per square inch.}$$

Extreme fiber stress, pipe No. $6 = f_6$.

$$f_6 = \frac{3\, EY\delta_4}{l_6^2} = \frac{3 \times 29{,}000{,}000 \times 4.313 \times 1.61}{(12 \times 50)^2} = \frac{604{,}121{,}910}{120{,}000} = 5034 \text{ pounds per square inch.}$$

Extreme fiber stress, pipe No. $7 = f_7$:

$$f_7 = \frac{3\, EY\delta_5}{l_7^2} = \frac{3 \times 29{,}000{,}000 \times 4.313 \times 2.48}{(12 \times 9)^2} = \frac{930{,}572{,}880}{11{,}664} = 80{,}000 \text{ pounds per square inch, approximately.}$$

If pipe No. 7 were 8 feet long instead of 9 feet, as shown, the extreme fiber stress would be $\frac{3 \times 29{,}000{,}000 \times 4.313 \times 2.48}{(12 \times 8)^2} = \frac{930{,}572{,}880}{9216} = 100{,}970$ pounds per square inch, in either case sufficient to cause rupture of the piping material.

The allowable safe fiber stress on piping material of wrought iron or mild steel may be taken as 12,000 pounds per square inch, allowing a factor of safety of 5 for the strength of the material. Therefore, all stresses falling below 12,000 pounds per square inch may be considered safe, while stresses above 12,000 pounds per square inch should be considered unsafe.

In the preceding examples, the bending stresses falling on branch pipes Nos. 1, 2 and 6 would be considered well on the safe side, as they fall below 12,000 pounds per square inch. The bending stresses of 80,000 pounds per square inch falling on branch pipe No. 7 should be considered unsafe, as it exceeds the breaking strength of the material. In this case, the piping connection should be changed and proper provision should be made to relieve the strain at this point; otherwise the pipe flanges would be very apt to fail and cause considerable damage to the plant.

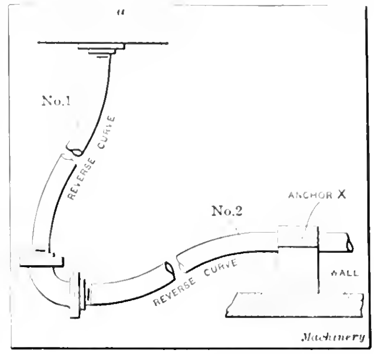

Fig. 60. Actual Condition of Pipes Nos. 1 and 2 when bent by Expansion

Considering pipes Nos. 4 and 5 as a beam 85 feet long supported at each end and deflected as shown by δ_3, we find by the aid of Formula (10) the extreme fiber stress in the outer fibers of the 8-inch pipe to be:

$$f_4 = \frac{27\, EY\delta_3}{\sqrt{3 l_4\, (2\, l_3 - l_4)^3}} = \frac{27 \times 29{,}000{,}000 \times 4.313 \times 1.46}{\sqrt{3 \times 660 \times (2 \times 1020 - 660)^3}} = \frac{4{,}932{,}900{,}000}{2{,}281{,}136.24} = 2162 \text{ pounds per square inch.}$$

The preceding examples are all worked out for 8-inch pipe. For any other size of pipe the conditions would be the same except that the value of Y would be increased or decreased in the formula to suit the outside diameter of the pipe. For example, if the outside diameter of the pipe had been 12¾ inches instead of 8⅝ inches, as shown, the value of Y would be $\frac{12.75}{2} = 6.375$ inches. In any case, Y is equal to one half the outside diameter of the pipe in inches.

All of the examples are based on assumptions which are approximate only, but correct enough for all practical purposes. They are intended to give the reader a general idea of the bending stresses liable to be encountered in the different branches of a piping system due to expansion of the pipe and fittings in the line. The exact calculation of stresses and deformations in any branch of a steam main similar to that shown in Fig. 59, would be a very difficult and tedious operation. For example, in the preceding calculations it was assumed, for convenience, that branches Nos. 1 and 2 acted as a cantilever beam fixed at one end and loaded at the other, in which case the pipe would bend in one direction only, as shown by the dotted lines in Fig. 59. In reality, however, the pipe is not free at the end, but is fixed by the flanged elbow which connects pipes Nos. 1 and 2, in which case the pipes would tend to bend to a reverse curve, about as shown in Fig. 60, providing the elbow was sufficiently heavy to resist all bending stresses and retain its original shape as shown. In reality, pipes Nos. 4 and 5 are partly fixed at each end by the fittings to which they connect, but as this would greatly complicate the calculations, the pipes have been assumed to be merely supported at each end, as previously mentioned.

INERTIA OF RECIPROCATING PARTS

BY E. D. GAGNIER*

In bringing the reciprocating parts of an engine to rest at the end of the stroke a force F is developed which is given by the following formula:

$$F = \frac{WDN^2}{70392} \qquad (1)$$

It is frequently desired to know the value of this force in terms of the piston speed and stroke. This result is given by the following formula:

$$F = \frac{WS^2}{1955D} \qquad (2)$$

Formula (2) was derived by combining the formula $S = \frac{DN}{6}$ with Formula (1). In the preceding formulas:

W = weight of reciprocating parts;
F = inertia of reciprocating parts;
D = stroke in inches;
N = revolutions per minute;
S = piston speed in feet per minute.

The diagram presented in this connection gives the inertia of the reciprocating parts for engines with strokes ranging from 5 to 30 inches, operating at piston speeds of from 500 to 1200 feet per minute, as will be seen.

In deriving Formula (1) the weight of the reciprocating parts is considered as concentrated at the crank-pin. The force required to bring the parts to rest is found by the formula $F = \frac{WRN^2}{2933}$. This formula is derived by substituting $\frac{2\pi RN}{60}$ for V in the expression for centrifugal force $\frac{WV^2}{32.16R}$. The stroke in inches (D) is $24R$, R being given in feet. Substituting $\frac{D}{24}$ for R in the expression $\frac{WRN^2}{2933}$ gives the value of the force of inertia of the reciprocating parts F which is given in Formula (1).

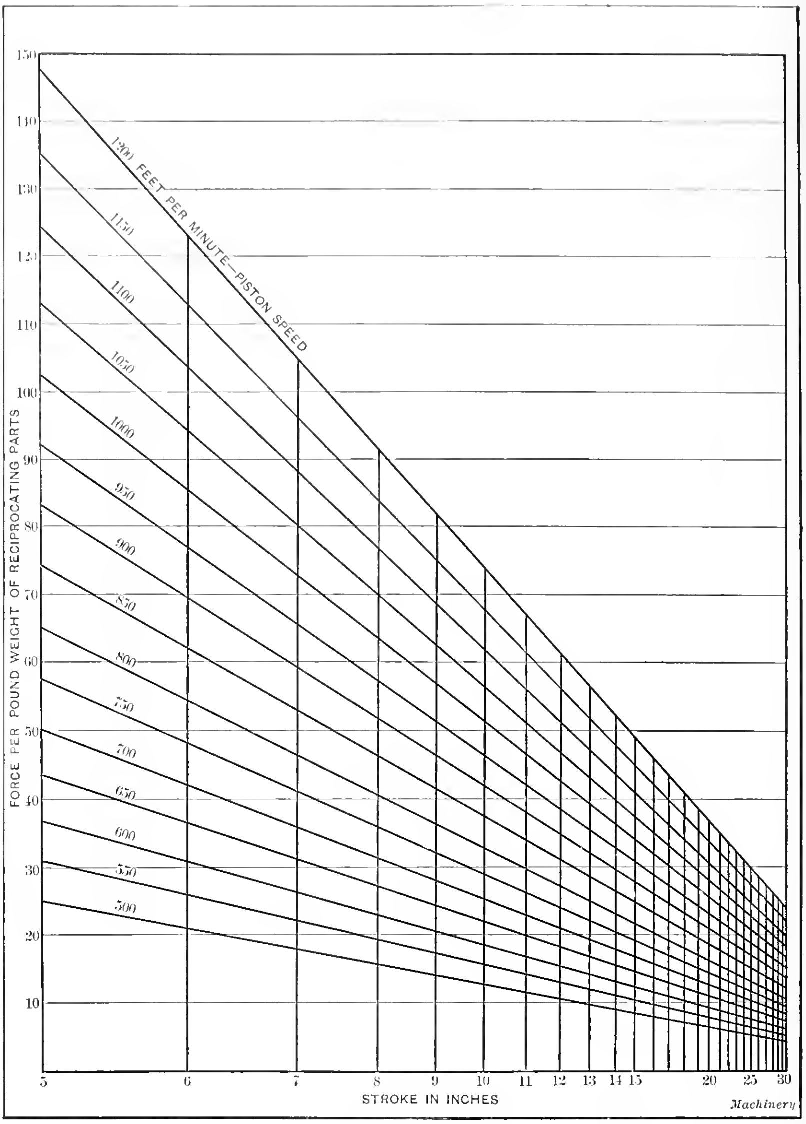

Diagram giving Inertia of Reciprocating Parts for Various Piston Speeds and Strokes

* * *

PASSING OF MILE FOR ELECTRICAL MEASUREMENT

In the infancy of the electrical industry many units in general practice were naturally used to signify various quantities and conditions of the new form of energy. Many of the available units were not well suited to electrical measurements, because electricity and the various industries to which it has given rise have developed standards which are entirely different from all precedents. It was therefore necessary to devise new units in order to insure a better understanding of the actual conditions and to provide for greater efficiency in the long run. It is undoubtedly because of this early necessity for breaking away from old traditions that the electrical engineering profession has always been among the first to adopt new methods and new units. A pertinent example is the invention and use of the circular mil, which has eliminated π from computations of the cross-sectional area of wires and cables. It now seems probable that the practically universal unit of length, the mile, is to be superseded by a standard of 1000 feet. Tables on costs and prices of wires and cables have been figured on this new basis for some time. Conductor resistance, particularly in the case of copper wire, is now commonly tabulated in ohms per thousand feet instead of in ohms per mile. It is interesting to note in this connection that the Simplex Wire & Cable Co. has recently abandoned the use of one mile as a unit of length for all factory measurements. This applies not only to conductor resistance, but to insulation resistance (megohms per 1000 feet), capacity (microfarads per 1000 feet), and inductance (henrys per 1000 feet). By adopting one thousand feet as the unit of length for all electrical measurements at the Simplex factory and thus eliminating (from about a thousand calculations daily) the factor 5280, an immense amount of figuring is avoided. In comparing the new standard with the mile, a close approximation for general use—involving an error of less than six per cent—is to multiply or divide the mile standards by five. For insulation resistance calculations, at least, a six per cent error is well within the limits of manufacture.

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SUB-PRESS DIE FOR PIERCING AND SHAVING

BY A. VAN WAGNER

The blank shown at *A* in Fig. 1, although an innocent looking piece, was nevertheless the cause of considerable work, owing to the high degree of accuracy required. This blank had to be exactly interchangeable with either side up. Two sets of dies were made, *viz.*, a blanking die and a finishing or shaving die, and two sub-presses of the Blake & Johnson type were used. The blanking die was built in the usual manner. An allowance of 0.005 inch was left on all edges of the blank for shaving. The small holes were not pierced in the blanking operation but simultaneously with the shaving operation, as this method minimized the chance of error in locating the holes accurately in relation to the shaved surfaces.

The die for the shaving operation was built in the following manner. The die-plate *B* was made in two hardened and ground sections, inserted in a soft steel receiving holder as shown. By making this plate in two parts, it was possible to grind all surfaces. The large section of the die was first left for truing up with a diamond lap. After hardening, the large circular portion was ground on the master plate. The remaining surface grinding was simple, care, of course, being taken to make all surfaces square and in correct relation to the circular part as well as the piercing hole. The two circular sections *b* were worked up in one piece. The work was first bored and turned; it was then set up on the master plate and the two piercing holes were bored. After placing the part on a mandrel, the slots to receive the tongue pieces *c* were milled, sufficient stock being left for grinding. A wall 1/32 inch thick was left at the bottom of each slot to keep the two parts together until after hardening, which made the circular grinding much easier. After grinding, a thin saucer wheel was used to separate the two parts. The joints on each half were next ground at the same time, while the parts were soldered into a V-block.

The tongue pieces *c* were comparatively easy to make, requiring, of course, careful grinding. The grinding or truing up of the piercing holes was deferred until after the dies were assembled in the press. The five sections of the lower die were next assembled in the soft holder *E* which had been

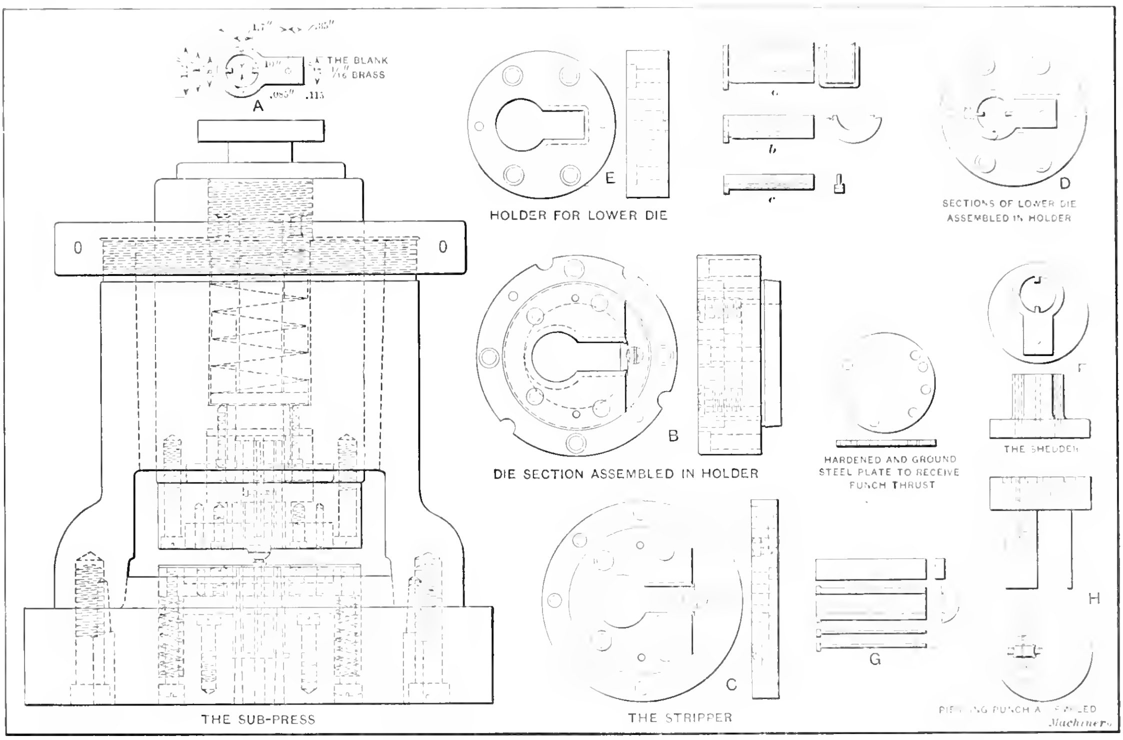

Fig. 1. Sub-press Die for piercing and shaving the Blank shown at A

carefully laid out and the necessary boring and milling done. After hardening the circular portion was first ground on a universal grinding machine. The straight walls were then ground with a saucer wheel on the surface grinder, the intersecting joint for the segment being ground off square at the same setting. Making the segment was a fairly simple job. It was relieved in the corners after milling, to allow for grinding wheel clearance. The two parts were ground on the outside, while held on a solder chuck, to fit the soft receiving holder. The stripper *C* was made in precisely the same manner as the die, corresponding surfaces being machined at the same time.

The punch or lower die, which is shown assembled at *D*, required considerably more work. It was made in five parts which were hardened, ground and lapped all over. The part *a* was rough-planed and then mounted on a master plate in its correct position. The circular portion and the piercing hole were bored on the bench lathe; all the straight surfaces were then milled, 0.005 inch being left on all surfaces with the exception of the piercing hole, where 0.002 inch was carefully bored and slotted. Care was taken that the sections did not fit so tightly as to cause springing of the parts. The shedder *F* was worked up "from the solid," all operations, as far as possible, being performed on the master plate. The piercing holes were left 0.002 inch small until after hardening; then the shedder was set on the master plate and the holes trued with a diamond lap.

The piercing punches are shown in detail at *G*, and mounted in their holder at *H*. The punch for piercing the large circular opening was made in three pieces. The center or spacing section is a plain rectangular shape as shown. The circular outside pieces were first milled to a little over grinding size. Each half was milled out through the center and relieved in the corners for wheel clearance. A screw hole was also drilled through all three parts. An arbor or mandrel was next milled square on each end, one end being the same size as the slot in the sections and the other end the finish size. The outside or circular surfaces were turned on one end of the mandrel, and after hardening the other end was used for grinding. The inner slot to receive the rectangular

section was ground out by holding the parts in a V-block so as to machine them both simultaneously. After assembling the sections in the holder and doweling them, the die work was practically completed.

The sub-press was allowed to run in the punch press for about a day, the bearing being tightened occasionally to insure a permanent bearing of the plunger in the cylinder. The centers of the plunger were then trued and the upper housing or frame was finished to fit the base concentrically. The base was then put on the faceplate and turned to a snug taper fit in the upper frame; at the same time the necessary boring was done to provide seats for the lower die or punch and the stripper plate. The plunger was again faced off and bored to form seats for the die and piercing punch pad.

After assembling the dies in the press, soft shoulder plugs were tapped lightly into the piercing holes in the lower die,

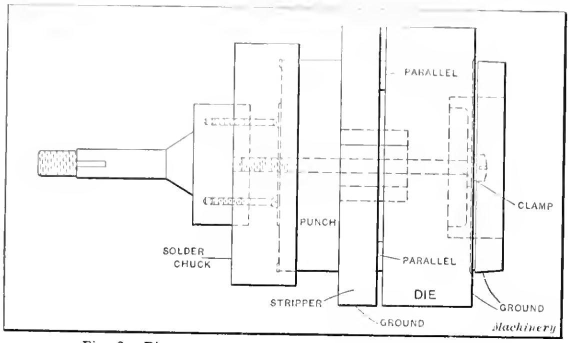

Fig. 2. Dies mounted on Solder Chuck for grinding

while in the corresponding holes in the shedder, hardened and ground shoulder centers were tapped in. The press plunger was then carefully lowered until small center marks were made in the soft plugs; these centers were then indicated on the faceplate and diamond lapped true. The way the dies were ground concentric to insure accurate alignment in the press is illustrated in Fig. 2. A solder chuck was recessed to fit the base of the lower die-holder closely. The stripper and die were then mounted in the manner shown and ground as required.

The gage-plate or "nest" for locating the blanks in the shaving die is shown in Fig. 3. This was dovetailed to 45

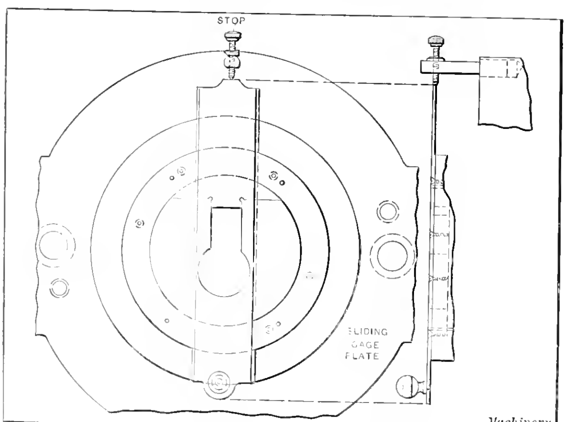

Fig. 3. Sliding Gage-plate of Sub-press Die

degrees and made a good sliding fit in the side plates. This form of gage seemed to be the best, as it is handy to operate and accurate. The time required for making this die was about 350 hours.

* * *

Drawings and blueprints which are to be varnished before sending out into the shop may be treated in the following manner: Dissolve gelatin in water and coat the drawing, using a soft brush. After this coating has thoroughly dried, give the drawing a coat of common clear varnish.

IMPRESSIONS FOR BOSSES ON DROP-FORGINGS

BY JAMES CRAN*

"Why are impressions for bosses on drop-forgings preferably put in the upper die?" When the foregoing question appeared in the April number of MACHINERY, the writer refrained from answering, naturally thinking that someone actively engaged in the manufacture of drop-forgings would come forward with the proper solution of the problem. In the writer's opinion, the cause for impressions in the upper dies filling more readily than impressions in the lower dies, is *not* that given by Mr. C. F. Brainerd in the October number.

On the face, especially to laymen, it does seem reasonable to suppose that one side of a heated piece of metal a few degrees hotter than the opposite side would flow more readily into the impression of the die on that side than the metal on the other side. It is very doubtful, however, when we consider that iron or steel to be forged is generally heated to from 1400 to 1800 degrees F., that a few degrees difference between the upper and lower sides of a forging would make a perceptible difference in the filling of the impressions.

To prove the incorrectness of this theory, a piece of lead as cold as the dies may be placed between them and a few blows struck. The result will be that the lead acts exactly the same as a piece of hot iron or steel—it flows better into the impressions in the upper die than into the lower one.

Before proceeding with the problem in question, the writer wishes to have it understood that he is not a drop-forger but that he has had a wide and varied experience in making forgings on the anvil and under a steam hammer; he is thoroughly familiar with the principles of drop-forging and has had ample opportunities for studying the problems that arise from time to time in the working of iron and steel.

The fact that the impressions in upper dies fill more readily than those in lower dies, is due to the reaction of the metal being forged. The potent elements in any kind of forging are force and resistance. In drop-forging the lower die acts as the resistance which meets the force of the falling upper die. It is a well-known fact that all ductile metals respond or react more to a moving body than to a stationary body, especially when the moving body is applied with impact or shock to the metal being forged. The effect of reaction is to cause the metal to flow freely into the upper impressions.

A good illustration of reaction to impact may be had by putting a handle in an ordinary hammer. A mechanic does not think of placing the hammer head over a hole in something solid and driving the handle as he would a fence post, but when he has the handle fitted approximately to the shape of the eye, he starts the handle into the eye while resting on something solid and then takes the handle in his hand with the head clear of everything and strikes it on the end. Thus he drives the handle into the hammer head. The inertia of the hammer head causes it to react on the blows struck on the end of the handle, and the head is forced onto the handle much more quickly and firmly than would be possible if the latter were driven into the head while resting on a solid body.

Another example of reaction may be had by forcing a piece of pipe sharply into a barrel of water. It will be found that the water inside the pipe rises several inches higher than the surrounding water in the barrel. When forgings are made by compression, instead of concussion as in hydraulic forging, the metal acts in a manner very similar to its action in drop-forging. It flows better into the impressions in the dies on the side from which the pressure is applied than into the dies on the stationary side. If, however, the pressure is applied equally from both sides, the dies on each side fill equally.

Very deep impressions in dies fill better when they are provided with air vents, and it will be found that better work can be done in forging long bosses and hubs by using a light hammer with a long stroke than by using a heavy hammer with a short stroke. The reason for this is that a light hammer with a long stroke gathers speed as it descends and strikes a much sharper blow when it reaches the point of impact, thereby causing greater reaction in the metal being forged.

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TESTS FOR LEAF SPRINGS AND THEIR TREATMENT*

HEAT-TREATMENT OF SPRING STEEL AND ITS EFFECT ON THE ELASTIC LIMIT, RESILIENCY AND RESISTANCE TO FATIGUE

BY E. F. LAKE†

The automobile industry has justly been credited for a vast improvement in all the materials that enter into its construction. In the steels, several alloying materials have been developed and the manufacturing methods and processes have been improved to give steels greater strength, greater resistance to frictional wear and greater resistance to vibratorial and torsional strains. This has enabled the designer to make various steel parts lighter than when they were made of the weaker materials and, incidentally, it has made it easier to machine some of the high-grade alloyed steels. In the early days of the industry, it was necessary to go to Europe for cylinder castings, but the cast irons and foundry methods have been improved so much that they are now all made in this country. Likewise the steel castings, malleable iron castings, brasses, bronzes and other non-ferrous metals and alloys have been considerably improved. Especially is this true of aluminum alloys, as the demands for lightness in the automobile, and the use of such large quantities of light materials, were directly responsible for the investigations that perfected these alloys and built up this industry.

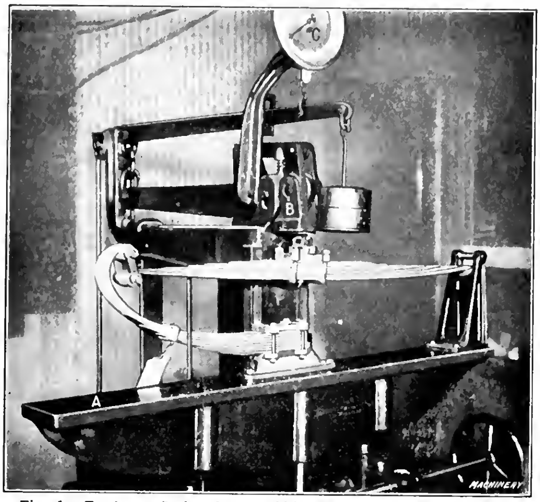

Fig. 1. Testing a Spring for Durability and the Load it will carry per inch of Deflection

In the finished materials, probably the most noted example of a betterment of the product is the gears that are used for the transmission—differential and driving. The strains and wear that these will resist are wonderful when compared with the gears made before the advent of the automobile. While this is partly due to the alloying materials used in the steel and the methods employed in manufacturing the metal, it is due chiefly to the methods, processes and apparatus that are used in annealing, hardening and tempering the gears.

The suspension of automobile bodies, however, has been neglected, as the leaf springs are made in practically the same crude inaccurate way that our fathers, grandfathers and great-grandfathers made them. What little improvement there is has been made with an idea of cheapening the cost of manufacture. Thus, the old coal fires have been replaced by gas-burning furnaces, and the machinery for cutting, punching, rolling, etc., has been improved. With all the scientific and accurate methods that have been developed for heat-treating steels very little of it has found its way into the spring-making shops, and yet the degree of resiliency in springs is entirely dependent upon the accuracy of the annealing, hardening and tempering. If this part of the work were performed with the correct temperatures, the steel could be given the greatest resiliency it is capable of attaining. Only a few degrees variation from the correct temperature, however, will sacrifice a large part of this resiliency and also reduce the metal's elastic limit and resistance to the alternating vibrations that springs receive in service.

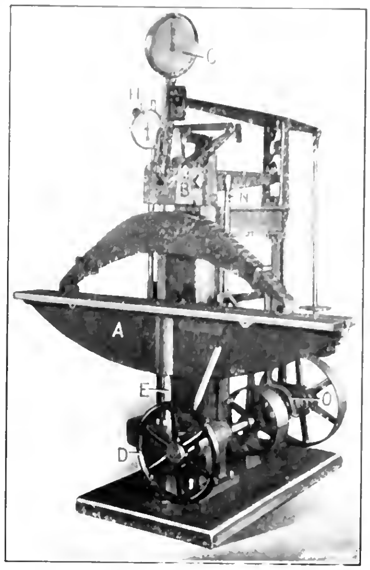

Fig. 2. Static Spring-testing Machine of 20,000 Pounds Capacity

Machines are now being designed and built that enable the large spring users, such as automobile factories, to give springs numerous tests that show whether or not they have been correctly hardened and tempered. This practice is forcing the spring-makers to investigate the furnaces, apparatus and methods that others use for scientifically and accurately heat-treating steel, and, in the end, it will cause a revolution in the methods of manufacturing springs.

Spring Testing Machines

One of the tests now given springs is shown in Fig. 1. The spring is fastened to platen *A* which is raised until the spring presses against the head *B*; then by raising the platen still farther, the dial *C* of the scale beam shows the load (in pounds) that the spring will carry for each inch of deflection or fraction thereof. The fatigue test can also be given

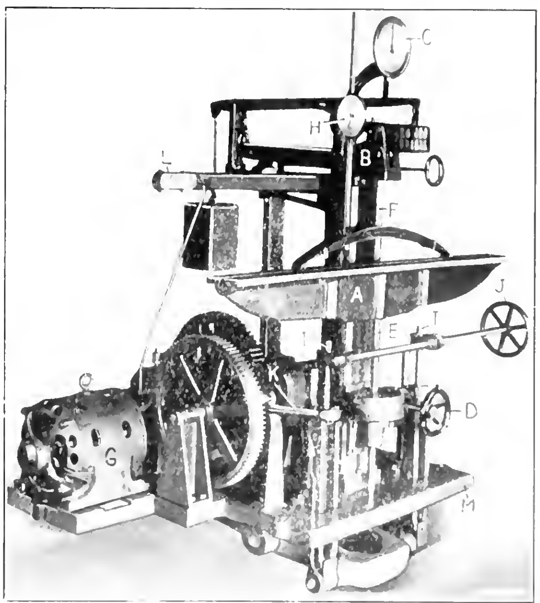

Fig. 3. Static and Vibratory Spring-testing Machine of 6000 Pounds Capacity

the spring by forcing it against head *B* until the normal load it carries when on the motor car is recorded on the dial. After that the machine is adjusted so that the platen will

* For further information on electrical methods of heat-treating steel, see "Electric Furnace Heat treatment of Steel" in the October, 1913, number of MACHINERY, and other articles there referred to.

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move up and down continuously, any given distance, until the spring breaks. The number of deflections, or upward movements of the platen, is recorded on a counter and constitutes the record for the test. The distance that a spring settles from its normal position or shape for a given load can also be measured.

The whole machine, as manufactured by the Tinius Olsen Testing Machine Co., Philadelphia, Pa., is shown in Fig. 3. Here platen *A* can be raised by handwheel *D* and screw *E*, until the spring is brought into contact with head *B*. A control lever that is back of supporting column *F* can also be used to raise and lower the platen with the motor *G*. The forward motion of the lever throws in a clutch for lowering and the backward motion operates another clutch for raising. After the spring is brought into contact with head *B*, the motor power should be used. The amount of spring deflection shows on dial *H* which registers every 0.02 inch, the circumference of the dial being 3 inches. At the same time the load required for this deflection is registered on dial *C* as previously mentioned. The capacity of the machine is 6000 pounds.

The whole spring can be given the fatigue test (after it has been brought into contact with head *B* and the load applied that it would carry when in use) by raising rods *I* with handwheel *J*, until they support the platen, and then lowering screw *E* out of the way. After that the motor is started and a clutch is thrown in by lever *K* that moves the platen continuously up and down at the rate of either 60 or 120 strokes per minute. Counter *L* records these strokes and gives the number of vibrations the spring withstands before breaking. The amount of spring deflection is adjusted by a screw crank at the back of the machine and can be made anything between 0 and 10 inches. The part below base *M* is normally under the floor.

A testing machine of 20,000 pounds capacity, for testing heavy truck springs, is shown in Fig. 2. This gives the load the spring will carry per inch of deflection, but does not subject springs to the fatigue test. It will show whether or not the springs have been correctly hardened and tempered, as improperly heat-treated springs will not deflect the correct distance under a given load. The reference letters correspond to those used in Fig. 3 for similar parts on both machines. This machine can be belt driven if desired. At *N* is shown the lever that engages the clutches at *O* for raising and lowering platen *A*.

Fig. 4. Spring Steel quenched at the Correct Temperature for Hardening

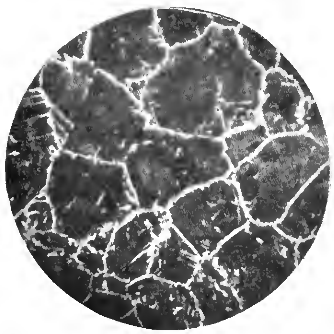

Fig. 5. Structure seen when quenched at 200 degrees F. above the Transformation Point

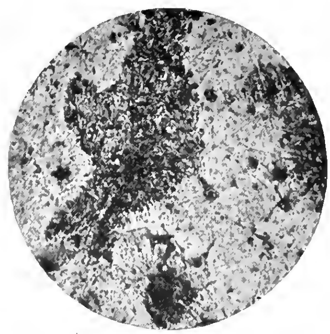

Fig. 6. Spring Steel quenched in Oil that was too Hot

Effect of Hardening Temperature on Composition of Steel

When the plates that comprise a spring have been heated too far above the transformation point, in the hardening operation, it coarsens the grain of the metal and decreases its strength and durability. Such springs will break with much fewer deflections than those that are hardened at the correct temperature. This shows that they will not last nearly as long when put into service on the car.

When the temperature of steel is being raised, it lags at the transformation point, while a new grain structure is being born, and every particle that goes to make up the mass has absorbed all of the heat at this point. After that its temperature will rise steadily to the melting point. If instantly cooled to atmospheric temperature the moment this new grain structure is born, the steel will have the finest and densest grain it is capable of assuming and, consequently, the greatest strength. Each degree of temperature to which the metal is heated above this transformation point and then quenched results in decreasing the strength and resistance to fatigue.

The microscope best reveals such conditions of steel. When heated to the correct temperature and then quenched, the hardened steel will show only a fine-grained structure called martensite, as seen in Fig. 4. The gradual coarsening of the grain when steel is quenched at temperatures above the transformation point is well illustrated by Fig. 5. The temperature of this specimen was 200 degrees F. too high when it was quenched. Distinct demarkations appear between the crystals, and, with a higher temperature, these increase until they become absolute cleavages. Fig. 6 is typical of a steel that was heated correctly but quenched in oil that was too hot. In Fig. 7 will be seen the fine dense grain of a steel that was hardened and drawn correctly.

Fig. 7. Spring Steel that was hardened and then drawn at Correct Temperature

Effect of Hardening Temperature on Fatigue Tests

The loss in fatigue is best illustrated by the chart shown in Fig. 8. Here fifteen samples of spring stock were hardened at each of the temperatures shown at the right, and they were all tempered at 700 degrees F. From the average of each set of fifteen the curve was plotted. Other samples were drawn at 750, 800, 850 and 900 degrees F., but the alternating vibrations, before breakage occurred, did not vary materially from the samples drawn at 700 degrees, although this did make a considerable difference in the elastic limit and reduction of area. The chemical analysis of the steel was as follows: Carbon, 1.01 per cent; manganese, 0.56 per cent; silicon, 0.155 per cent; sulphur, 0.046 per cent; and phosphorus, 0.044 per cent. The sulphur and phosphorus were too high, as these should not be above 0.03 per cent, the better grades of spring steel containing less than this. This might account for the alternating vibrational figures being so low, although the test was made very severe in order to shorten the time consumed in making it. Other fatigue tests, however, show that the ratio between the figures at which the breakage occurred is essentially the same as though the test were made less severe. Practically the same ratio of difference is shown in the elastic limit and contraction of steel hardened at these temperatures.

At hardening temperatures below 1450 degrees, the specimens took a permanent set when they were bent in the test, which indicated that this was below the correct hardening temperature. This coincided with the transformation point

which proved to be 1425 degrees; the 25 degrees between this and 1450 degrees being about the right amount to allow for the loss of heat between the heating furnace and the quenching bath. It will be seen from the chart that when the hardening temperature was raised to 1500 degrees, or only 50 degrees too high, there was a loss of 15 per cent in the steel's resistance to fatigue, and when the temperature was raised 100 degrees or to 1550 the loss was 29 per cent. Quenching at 150 degrees above the correct hardening temperature caused a loss of 43 per cent; 200 degrees, 57 per cent; and 250 degrees, 69 per cent. At this latter point of 1700 degrees, the steel began to crystallize and the curve dropped rapidly downward. When it reached the burnt stage, the fatigue resistance would have been practically nil.

If the spring plates are not heated up to the transformation point before being quenched, the steel will have very little hardness and the springs will take a permanent set when the load is applied. That this often happens is shown by the lop-sided appearance of some automobile bodies, which is caused by a spring settling. What has saved many a spring designer from utter failure is the fact that even thoroughly annealed steels have an elastic limit, and therefore it is only necessary to pile enough leaves on top of one another to make a spring that will carry a given load and resist the strains without settling. This does not make easy riding, however, as such springs have very little resiliency as compared with those that are properly heat-treated. For instance, the chart Fig. 11 shows that thoroughly annealed carbon spring steel has an elastic limit of 75,000 pounds per square inch, but when hardened at the correct temperature and drawn at 750 degrees F. the elastic limit is raised to about 133,000 pounds. Thus it would require nearly twice as much of the annealed steel to carry the same load that correctly hardened and tempered steel would carry.

One test of a semi-elliptic spring, which was made in the machine shown in Figs. 1 and 3, shows the weakness of a spring that is too soft. The spring tested had six plates and held about 1000 pounds when on the car under normal load; therefore, it was pressed up under head B until the scale dial registered 1000 pounds. At each upward movement of the platen, it was then deflected 2 inches until 225,000 alternating vibrations had been recorded on the counter without a breakage. To hasten the test the movement of the platen was increased to 3½ inches and the spring was deflected 32,290 additional times before breakage occurred. The top leaf then broke next to the spring seat about 3 inches away from the central bolt hole. A new top leaf was put on the spring and 24,100 additional alternating vibrations were recorded at the 3½-inch deflection before the next breakage, which occurred in both the fourth and fifth leaves and at the point where the top leaf broke.

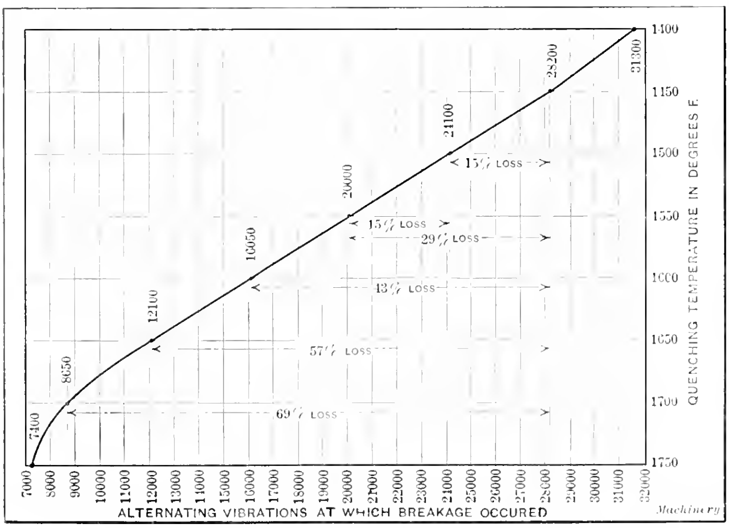

Fig. 8. Average Result of Fatigue Test on Fifteen Samples of Spring Steel, hardened at Temperatures shown at the Right and drawn at 700 Degrees F.

When the spring had been given only 25,000 of the 2-inch deflections, it had taken a permanent set, or settled 1 3/4 inch below its normal position when carrying a load of 1000 pounds. This would mean that it should be condemned as a spring, as its resiliency had been greatly decreased by incorrect heat-treatment. It continued to settle under the test; at 100,000 deflections the settling had reached 2 inches and at 200,000 it was 2 3/4 inches. A similar spring settled 3/4 inch at 500 deflections; ½ inch at 1000; 9/16 inch at 2000; and 11/16 inch at 5000. The test was then discontinued, as the spring was considered worthless.

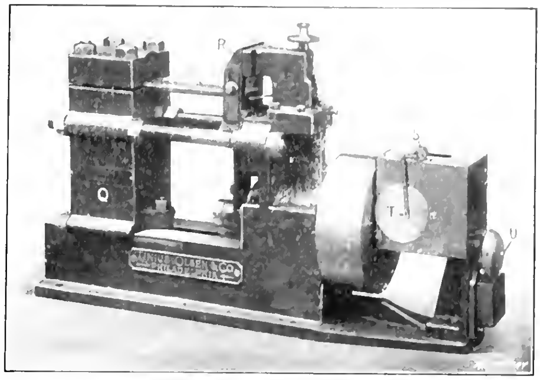

Fig. 9. Bench Fatigue-testing Machine for Specimens 2 inches wide

Testing the Spring Leaves separately

There are numerous ways of making these fatigue tests on small samples. This method often gives better results and is more economical than when a whole spring is used. For instance, each spring leaf or plate can be tested separately and also various places on the same leaf. This will show whether they have been heat-treated uniformly throughout their entire length and also whether each leaf in any one spring is the same. A spring, like a chain, is no stronger than its weakest member or section. One of the simplest ways of making this test is to use an ordinary shaper and fasten the sample in the vise that holds the work. Then a special tool for clamping the top of the specimen can be used in place of the tool-holder. The distance between the vise and this special clamp can be adjusted to suit the specimen, as well as the distance it should be bent back and forth. The number of vibrations can be computed from the number of minutes the shaper runs before breakage occurs and the number of movements that the slide of the shaper makes per minute.

A special machine that is built for this test is shown in Fig. 9. This machine is small, of simple design, and is made to rest on a bench, a number being operated from one lineshaft. It is powerful enough to bend specimens 3/8 inch thick, 2 inches wide and 4 inches between the clamps, a distance of 1 inch, at the rate of 500 vibrations per minute. The vibratory length of specimen P can be made any distance between 4 and 8 inches by moving pillar-block Q. The number of bends or vibrations that slide R gives the specimen is recorded on counter S and dial T, which stops and rings bell U when the specimen breaks.

Modern Fatigue-testing Machine

The latest style of fatigue-testing machine to be placed on the market is shown in Fig. 10. This machine was developed by G. B. Upton of Cornell University and G. W. Lewis of Swarthmore College, who turned over to the Tinius Olsen Testing Machine Co. all the rights for its manufacture and sale. The first machine was sold about one year ago, but several improvements were afterward made, and the

latest improved type, which has just been brought out, is here shown. It can be driven by power at the rate of 600 revolutions per minute, and a hand crank will drive it at 100 revolutions per minute. As variable crank-disk *A* revolves, it moves connecting-rod *B* and lever *C*. The latter tilts jaw *D* in opposite directions and bends specimen *E* which is gripped in jaws *D* and *F*. Jaw *F* is pivoted on a pin and the power exerted to bend or vibrate the specimen causes it to force arm *H* against springs *I* and *J*. Through lever *K* a record of this is scribed on chart *L* which revolves once for every 300 revolutions of crank-disk *A*. The revolutions of crank-disk *A* are recorded on an automatic counter. The angle of bend can be altered by changing the position of connecting-rod *B* on disk *A*, and the vibratory length can be made anything desired by lowering jaw *D*, which is held in place by the specimen being tested. Stop *N* prevents it from dropping when the specimen breaks and, with foot-pedal *O*, aids in setting the specimens. A brake for stopping the machine engages the flywheel and is operated by lever *P*.

With this machine, fatigue tests can be made in from 5 to 60 minutes that would take as many hours in the other machines. Breakages can be made with from 500 to 10,000 revolutions of crank-disk *A* by making the crank throw 1, ¾ and ½ inch, which would be sufficient for finding a figure of merit by which to compare specimens. The 500 cycles would take 5 minutes and the 10,000 about 60 minutes. The vibratory length of specimens between jaws *D* and *F* should be the same in all comparative tests; usually 1/10 inch gives very good results.

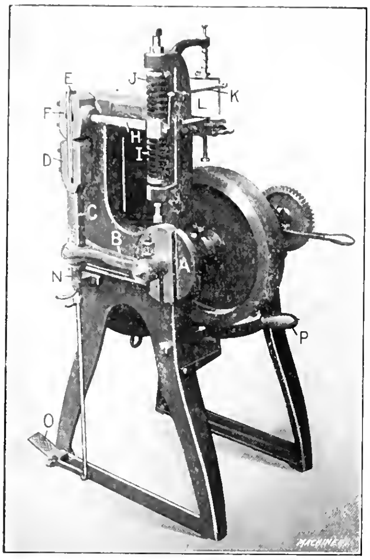

Fig. 10. The Upton-Lewis Fatigue and Toughness-testing Machine

In addition to the results obtained by other fatigue machines, this one gives the transverse load that is required to bend the specimen the maximum distance. This is computed from the strength of springs *I* and *J*, length of lever arm *H* and the travel on chart *L* of the pencil held in lever *K*. When the load begins to weaken, a shortening of the stroke of the pencil takes place and from this might be obtained the elastic limit of fatigue, if it may be so called. The angle of bend of specimens is figured from the throw of crank-disk *A* and length of arm *C*. Curves can be plotted that will show the relation of the fatigue alternations to the transverse load.

Methods of Heat-treating Springs

The old method of heat-treating springs, which is now in use in nearly all spring shops, consists of heating the plates to about 1800 degrees F. in a furnace that is supposed to be maintained at that temperature, as this heat is required to bend steel to its proper shape by the old hand methods. Each plate is then taken out and bent to the shape that will make it fit the leaf directly below. After that they are usually put back into the furnace, heated to the hardening temperature, and then quenched in oil. Then they are again placed in the furnace, until the oil burns off, to temper them.

To heat carbon steel spring plates all day in a furnace that is maintained at 1800 degrees, and have their temperature within 150 degrees of the transformation point when they enter the quenching bath, is a physical impossibility with the best of spring-fitters. The exhausting work before a furnace on a hot day affects the man's judgment of temperatures. The difference in light between a cloudy day and one of bright sunshine will also affect the man's judgment of the hardening temperature of the steel, as this must be done by noting the color. (Pyrometers only record the temperature of the furnace.) Likewise a bad stomach might affect the spring-fitter's eyes enough to make his judgment of the hardening temperature vary considerably. Numerous other reasons could be given for the lack of uniformity, strength,

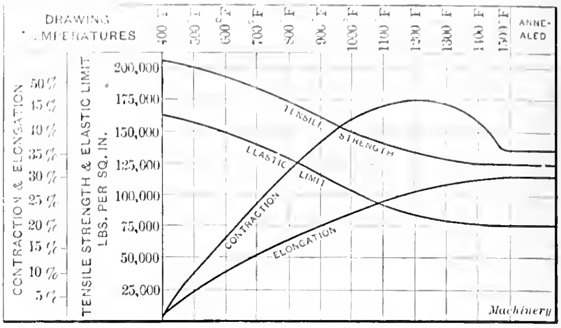

Fig. 11. Alteration in Tensile Properties of Spring Steel, caused by Variation in Drawing Temperature

and durability of leaf springs. In the heat-treatment of other products better methods have been adopted, and the spring-makers are just beginning to realize this and are now looking for more accurate methods. In most cases, however, they are beginning where the others have left off.

To put the spring plates back into a furnace with a high temperature and burn the oil off to obtain the drawing temperature is more like a huge joke than a reality, and yet this is being done every day. Hardening oils have a flash point that is anywhere between 400 and 600 degrees F., while the best results are obtained when spring plates are drawn at temperatures between 700 and 800 degrees. Furthermore, it is impossible to judge the temperature of steel in a furnace heated to 1800 degrees until the steel begins to show red. If steel is held in a dark place, this red will show at 800 degrees, but in the glare inside the furnace the red cannot be seen until nearly 900 degrees has been reached. From the time the oil flashes and burns until the steel becomes red, the steel remains black; hence it is impossible to judge any temperatures between these two points. The majority of spring leaves are tapered at each end, and where the central portion is from ¼ to ½ inch in thickness the ends would be only ⅛ inch thick. Thus the thin ends get red before the middle of the leaf, or absorb the temperature of

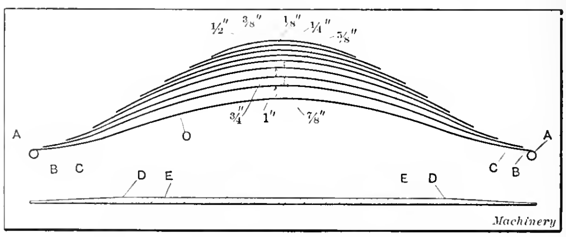

Fig. 12. Camber given Springs and Taper of Plates

the furnace faster, and the leaf is not hardened uniformly throughout its length.

In a furnace heated to 1800 degrees F., steel will absorb a temperature of 200 degrees in about 20 seconds and 500 degrees in about 40 seconds, while it only takes about 15 seconds to pass through the correct tempering range between 700 and 800 degrees. Thus the time factor would prohibit obtaining the correct drawing temperature by the method referred to. In designing springs for the load they are to carry, the thickness of the plates and the number of leaves are based on the elastic limit of the steel. The elastic limit is changed greatly by the temperature at which the steel is drawn, as can be seen by an examination of the chart Fig. 11. This shows that the elastic limit drops about 35,000

pounds between drawing temperatures of 600 and 900 degrees. Thus the spring designers have to allow an enormous factor of safety and make the springs a great deal heavier than they would if the spring leaves were heat-treated at accurate temperatures.

As proof of this, a noted example is that of the front spring on Ford automobiles. Nearly every spring-maker has said that it was too light and yet it keeps on doing its work year after year. The reason is that it is bent to shape in one furnace, heated for hardening (and quenched) in another furnace, and heated for the drawing temperature in still another furnace. In that way, pyrometers can be, and are, used and each furnace is maintained at the correct temperature. With the proper furnaces and apparatus and one man to look after the pyrometers and adjust the furnace valves so the correct temperature will be maintained, there is no excuse for a variation of 25 degrees in the hardening or 15 degrees in the drawing temperatures. Then if the steel is left in the furnaces until it attains their highest temperature and afterward is properly quenched, the metal can be given the greatest strength and durability of which it is capable. This modern way is also much cheaper than the old methods and it is surprising that it has been adopted by only one spring-maker.

Most of the spring-makers have installed pyrometer outfits, but to use pyrometers in these 1800-degree furnaces, in which the fabricating, hardening and tempering are all done, is a waste of time. However, they are a "talking point" and advertising feature to use when spring buyers visit the shop. The pyrometer is usually connected to the furnace, hung on a wall in the office or shop, and not checked or calibrated for months at a time. Under these conditions, the pyrometer readings are never reliable. In one case, the couple or fire end was inserted in the furnace inside cast-iron tubes that fitted into the floor of the furnace where the steel plates lay while being heated. As the tubes were built into the brickwork and always remained in the furnaces, they would absorb their temperature and protect the couple. On testing these it was found that furnace No. 1 recorded a temperature of 1550 degrees F. on the office pyrometer, while a pyroscope gave 2020 degrees as the temperature of the tube inside the furnace and 2015 degrees as the temperature of the steel that was being heated; furnace No. 2 registered 1750 degrees in the office and 1860 degrees on the pyroscope; and furnace No. 3, 2100 and 2000 degrees, respectively. In another case, five different couples inserted in the same accurate temperature furnace gave pyrometer readings in the office of 2200, 2175, 1875, 2100 and 1950 degrees, respectively, while an accurately calibrated checking pyrometer of the same make registered 1835 degrees. Unless pyrometers are checked every day and calibrated when they do not register correctly, they are more misleading than judging by color.

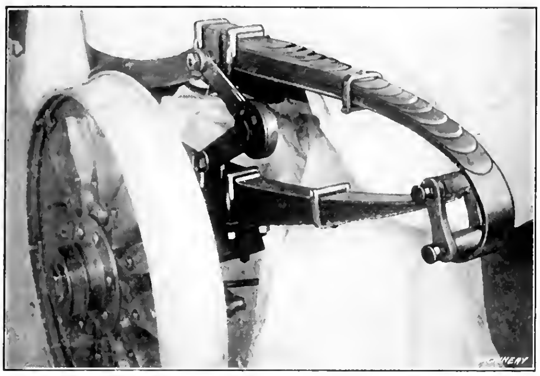

Fig. 13. Shock Absorber on a Special Spring made from Leaves one-eighth inch Thick

As the spring-fitter and his helper work for piece-work prices, it is a great temptation to raise the temperature of the furnace. The higher this temperature, the softer will be the steel and the easier it is to pinch it to the shape of the next lower leaf. A chance can then be taken on striking the correct hardening temperature, or drawing the temper of the spring leaf in this furnace. Thus the hand spring-fitter is no friend of the pyrometer which tells the office the correct temperature of his fire. In a number of cases they have been known to run the temperature of the furnace up high enough to melt down cast-iron tubes and cause the molten iron to flow around the thermo-couple and put the pyrometer out of commission. Numerous times the furnace temperature, that was supposed to be maintained at 1800 degrees, has been found to range anywhere from 1900 to 2100 degrees F. while springs were being hardened and tempered.

Under such conditions, no wonder it is difficult to obtain uniform results in the various tests that the spring users are now giving their springs and that they are demanding more accuracy in their heat-treatment. Nor is it any wonder that crystallization is often found in the spring plates. Crystallization is produced by the heat-treatment that springs are given in their manufacture and cannot be produced from any other cause, notwithstanding the fact that spring-makers like to claim that it is caused by the alternating vibrations that springs receive in service. The microscope has never revealed any crystallization in the numerous fatigue test breaks of properly heat-treated steel.

Before steel reaches the fitter's fire it may be made too crystalline to be restored by the subsequent heat-treatment it receives. In building springs, the first operation on bottom plate O, Fig. 12, is the forming of the eyes A. Each end of the steel bar is placed in a furnace and heated to a high enough temperature to bend this eye. This temperature is high enough to coarsen the grain greatly, and often crystallization is produced. If only heated as far back as B, the squeezing and hammering that the metal receives when the eye is being formed will reduce this coarsened grain to its normal state. It is, however, often heated back to the zones between B and C and made more brittle there than in the rest of the plate.

The same condition exists in the rolling of the taper on the ends of the other leaves. If the steel in the zones between D and E is heated to the high temperature that is required for rolling, the rolls will not compress the coarsened grain back to its normal degree of fineness, as they only touch that part of the leaf which is between D and the end. This view also shows the camber given the various leaves of a spring. When the center bolt is put in, it clamps the leaves tightly together. Thus, when the spring is deflected, the strains are first taken up by the outer ends of each leaf and gradually transmitted toward the center. If they fitted tightly together before being bolted, the strains would center around the bolt hole and make this the weakest part of the spring.

Sample springs made from alloyed steels have, at various times, withstood some wonderful tests. These were only wonderful, however, because of the contrast between them and the commercial springs which were so poor. These samples were carefully handled in making, were not overheated at any time, and were quenched and drawn at the correct temperatures to give them their greatest elastic limit, toughness, resiliency and resistance to fatigue. By installing modern furnaces and apparatus and subdividing some of the operations, the commercial springs could be made nearly as good as the sample.

Some spring-makers have claimed that if springs were correctly made shock absorbers would not be needed. One only has to ride in a car, however, to find that there is nothing to prevent his head from hitting the top, when the wheel drops into a slight road depression and the severe deflection given the spring causes it to rebound. When deflected all of the leaves resist their part of the strain, but on the rebound the shackle gives, and only the main leaf resists this strain until the clip is reached that binds some of the leaves together. This can be plainly seen in Fig. 13 which shows a Truffault-Hartford shock absorber attached to a special spring. This spring was made from leaves 1/8 inch thick, as a greater resiliency can be obtained with many thin leaves than with a few thick ones. The easy riding qualities of the car clearly demonstrate this fact.

LETTERS ON PRACTICAL SUBJECTS

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UNIQUE ARC WELDING OPERATION

Electric arc welding is now in general use for certain classes of work, and apparatus for generating and controlling the arc has been perfected and may be classed as standard. Its field for application is a wide and varied one, and as its possibilities become more widely known its use will no doubt be extended to cover many operations now performed by other means at a greater outlay of time and money.

An example of one of the many uses to which a welding outfit may be put is illustrated by the accompanying engravings which show a cast steel clamp of approximately thirteen inches inside diameter. This was designed for assembling certain machine parts and holding them against the faceplate of the lathe for finishing. The clamp, as originally made, was in two sections (one of which is shown in the right-hand view of Fig. 1), and was intended to be tightened around the parts to be assembled, by means of bolts passing through lugs on opposite sides of the clamp. It was necessary, in order to operate the finished article successfully, that the assembled sections be drawn together with an approximately even pressure from all directions, but on trying out the device, it was found that those sections at the joints, and for several inches on each side, did not come together properly, and after several trials, it was decided that a four-part clamp would have to be used.

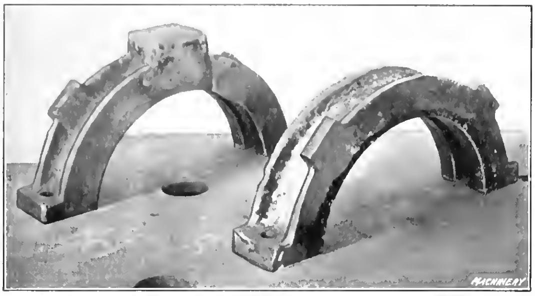


Fig. 1. Steel Casting to which Bolt Lug was electrically welded as shown to the Left

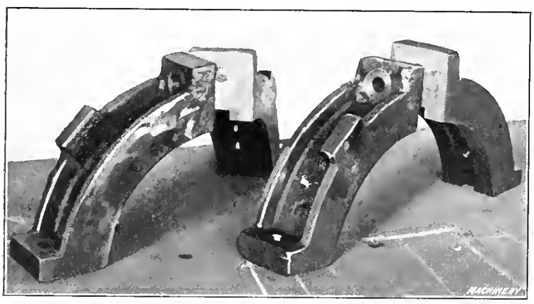


Fig. 2. Four-part Clamp with electrically welded Bolt Lugs

To avoid the delay which would have been entailed by having the pattern returned from the foundry, making the necessary alteration, and getting new castings, the welding outfit was brought into play on the existing castings. Two pieces of iron were obtained and cut to shape to fit roughly between the outer flanges of the sections. These were then welded into place, half way between the ends, as shown in the left-hand view of Fig. 1. The half rings were then cut through these lugs, and holes were drilled for bolts, after which the clamp was again ready for use. Fig. 2 illustrates the completed four-part clamp.

The welding, in this case, was done with the carbon arc, using current of approximately three hundred amperes. The operation consisted of fusing pieces of metal into the joint between the two parts to be united, and, at the same time raising the metal on each side of the weld to the point of fusion. The time consumed in welding was one and one-half hour, while the machining operations for making the extra pieces of iron, and the cutting and drilling after welding, required about four hours more; therefore, with a total time expenditure of five and one-half hours, and the aid of the welding outfit, there was accomplished what otherwise would have required, at a minimum estimate, eight to ten days from the time of getting the pattern back, until the new castings were machined and ready for use.

Westfield, N. J. ALAN M. BENNETT

CLEARANCES AND TOLERANCES

In the engineering edition of MACHINERY for March, 1913 (page 525), there was a suggestion that only three terms be used, *viz.*, "finish," "tolerance" and "clearance," when referring to the condition of machined work and its variation in size. Following this suggestion, the accompanying table was prepared for the use of designing draftsmen, so as to avoid any possibility of confusing the terms "tolerance" and "clearance." The table is practically self explanatory. The nominal size of the male part is given, with the proper clearance and tolerance. It will be noted that the table is divided into three parts, namely: for very accurate work, accurate work, and ordinary work. While this table is only for running fits, one for driving and shrink fits could be developed on the same lines.

CLEARANCES AND TOLERANCES FOR SLIDING AND RUNNING PARTS

Very Accurate Work			Accurate Work			Ordinary Work		
Nominal Size Male Part, Inch	Clearance, Inch	Tolerance, Inch	Nominal Size Male Part, Inch	Clearance, Inch	Tolerance, Inch	Nominal Size Male Part, Inch	Clearance, Inch	Tolerance, Inch
1	0.0002	0.0001	1	0.0005	0.0002	1	0.001	0.0005
2	0.0004	0.0002	2	0.0010	0.0005	2	0.002	0.0010
3	0.0006	0.0003	3	0.0015	0.0005	3	0.003	0.0010
4	0.0008	0.0004	4	0.0020	0.0010	4	0.004	0.0020
5	0.0010	0.0005	5	0.0025	0.0010	5	0.005	0.0020
6	0.0012	0.0006	6	0.0030	0.0020	6	0.006	0.0030
7	0.0014	0.0007	7	0.0035	0.0020	7	0.007	0.0030
8	0.0016	0.0008	8	0.0040	0.0020	8	0.008	0.0040
9	0.0018	0.0009	9	0.0045	0.0030	9	0.009	0.0040
10	0.0020	0.0010	10	0.0050	0.0030	10	0.010	0.0050

Machinery

The desired clearance to be subtracted from the nominal male dimensions and the remainder placed on the drawing as the required size, thus, 1.998".

The tolerance permitted from specified dimensions to be placed on the drawing as an exponent to the desired dimension; thus $2.0^{+0.001}$ inches.

The minus sign (−) is used for the male part, the plus sign (+) for the female part, and plus-or-minus sign (±) when immaterial.

The clearances given for the different classes of work allow for a sufficient difference in size to admit of motion and lubrication. A departure from the figures listed may be necessary in exceptional cases, depending upon the nature of the machined surface or its finish, the kind of materials in contact, and the length of the fit. The tolerance may also, in exceptional cases, be reduced when greater accuracy is desired. Tolerance *only* is allowed in the female part, but both clearance and tolerance should be allowed in the male part. This table is only one of many that could be prepared to suit the various requirements of machine manufacturers. The meaning of the three terms, "finish," "tolerance" and "clearance," which are the only terms used, is as follows:

Finish: The condition of the surface of the material, as "file finish," "ground," "paint," etc.

Tolerance: A tolerated departure from the dimensions specified on the drawing; this should always be expressed in the form of an exponent, as $2.0^{+0.001}$ inches.

Clearance: This term signifies the difference between working parts to admit of motion and lubrication. The

amount of clearance determined upon is always taken from the nominal size of the male part and the remainder is the dimension to be placed on the drawing, as $1.998^{-0.001}$ inch.

TOLERANCE

ADJUSTABLE INDEX MECHANISM

The illustrations show an adjustable index mechanism which has been developed by the writer and is, so far as he knows, an original idea. Several experienced toolmakers and machinists have looked over this design and pronounce it to be one which should find application for indexing various classes of work.

Referring to Fig. 1, the parts of the mechanism may be briefly described as follows: The circular slide *A* is dovetalled into the block *B* and has a taper extension which fits into the index plate *C*. The outside edge of the slide *A* is hobbed out to mesh with the worm *D*; this worm has 50 threads to the inch. The pitch line of the teeth on the slide *A* is at a distance of 2.28 inches from the center of the index plate, which makes it necessary to give the worm *D* two complete turns to index through 1 degree. The thimble *E* has 30 graduations so that each graduation corresponds to a movement of 1 minute. The block *B* is mounted on a spring steel support *F* which is fastened to the shoe on the lathe bed as shown in the illustration.

Referring to the detail of the index plate shown in Fig. 2, the method of using this mechanism may be briefly outlined as follows:

For 2 divisions take 0, 30, one revolution.

For 3 divisions take 0, 20, 40, one revolution.

For 4 divisions take 0, 15, 30, 45, one revolution.

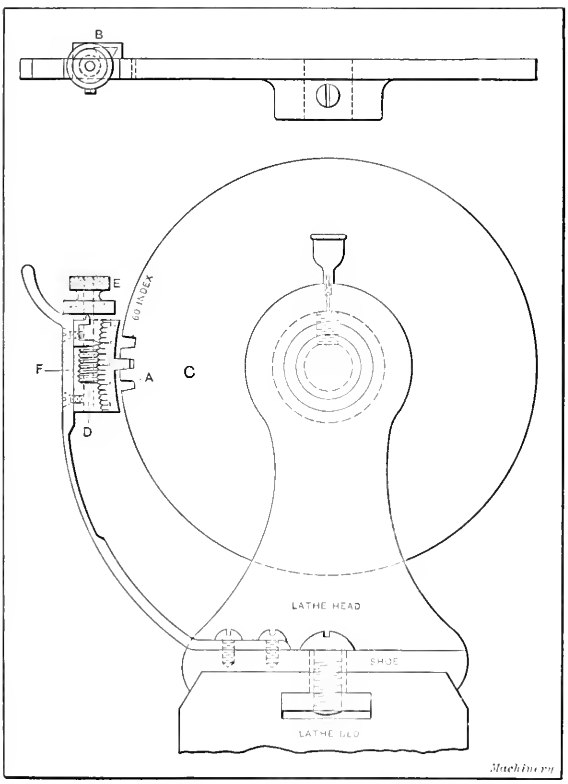


Fig. 1. Adjustable Index Mechanism for a Bench Lathe

For 8 divisions take 0, 15, 30, 45, one revolution; shift pawl 3 degrees, then take 7, 22, 37, 52, two revolutions.

For 20 divisions take 0, 3, 6, 9, etc., to 57, one revolution.

For 40 divisions take 0, 3, 6, 9, etc., to 57, one revolution; shift pawl on index 3 degrees and take 1, 4, 7, 10, etc., to 58, two revolutions.

For 80 divisions take 0, 3, 6, 9, etc., to 57, one revolution; shift pawl 4 degrees 30 minutes, and use the same numbers three times in succession, shifting pawl 4 degrees each time. (Four revolutions in all.)

For 120 divisions go around once making 60 divisions; shift pawl 3 degrees and go around again in same numbers.

By this system it is possible to get any of the following list of indices without, in any case, making more than six turns of the index plate.

One revolution 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60; two revolutions, 8, 24, 40, 120; three revolutions 9, 18, 36, 45, 90, 180; four revolutions 16, 48, 80, 240; five revolutions 25, 50, 75, 100, 150, 300; six revolutions 72, 360.

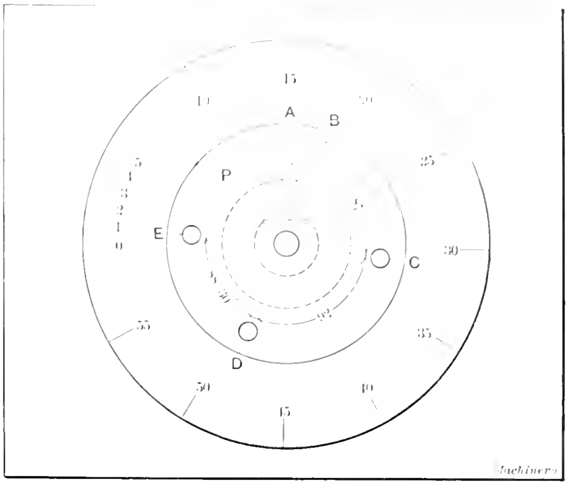


Fig. 2. Detail of Index and One Operation for which it is used

The use of a practical illustration will show another way in which this index mechanism may be conveniently used. Fig. 2 shows a plate *P* in which two notches and three holes are to be located and machined. To index this piece of work, the mechanism is set at the zero mark, after which the notch *A* is milled in the plate. The pawl is then shifted two degrees on the segment after which the index is turned to bring the notch No. 3 up to the pawl. The notch *B* is then milled in the plate. Next shift the pawl 3 degrees and engage notch No. 17 with the pawl; the hole *C* is then drilled. Next shift the pawl 2 degrees and engage notch No. 32 with the pawl; the hole *D* is then drilled. Next shift the pawl 4 degrees 30 minutes and bring notch No. 46 up to the pawl; then drill hole *E*. The desired notches and holes have now been correctly located and machined.

Elgin, Ill. ERLN LEA

USE OF RUBBER STAMPS ON TRACING CLOTH

A rubber stamp with a so-called "cushion-pad" is preferred as it allows more pressure on the stamp without blurring the imprint. Sprinkle powdered pumice stone over the part of the tracing to be stamped and rub this in thoroughly; then blow off the surplus. Thoroughly ink the stamp either on a new pad or a freshly inked pad, as it is very important to have plenty of ink on the stamp. Place the inked stamp over the desired spot and press on it firmly for a moment. Remove the stamp and sprinkle lampblack all over the stamped portion. By means of a rag over the index finger press down on the lampblack so as to soak up the ink, and then thoroughly rub in. After rubbing in the lampblack blow off the surplus. When the tracing is dry the entire surface may be cleaned off with gasoline. It is well to rub lightly over the stamped portion. Convenient receptacles for the powdered pumice stone and lampblack are talcum-powder cans, as they allow the contents to be sifted over the tracing without soiling the hands.

The stamped portion will print as clearly as the regular India drawing ink, if the foregoing directions are properly carried out. A good method of stamping tracing cloth was mentioned in MACHINERY some time ago, printers' ink being

used. But the scheme just described has an advantage over the printers' ink method, in that it allows cleaning the tracing with gasoline; this would remove the printers' ink.

By the use of rubber stamps considerable time can be saved in drafting rooms. The titles for drawings could be stamped by having a holder in which loose rubber letters were properly arranged. Stamps having general notes or instructions, the name of the company, or blank headings such as Drawing No. ....., Date ...., Drawn by ...., Traced by ...., Checked by ...., Scale ...., etc., would prove great time savers and give the drawings a uniform and neat appearance.

A. E.

A RAPID RETAPPING WRENCH

The piece *A* shown in Fig. 1 is part of the ball bearing used on a motorcycle. This part has seven notches milled on the inside of it to receive an adjustable lock mechanism. The piece is first formed, bored and tapped and the notches are then milled. This necessitates retapping the piece before it is hardened, the solid tap *B* being used for this purpose. The tool has a square shank and is clamped in a bench vise. The piece to be tapped is then turned onto the tool by hand until the notched section is reached, after which the wrench *C*, shown in Fig. 2, is used to complete the operation. The eccentric is solid and the handle *D* allows the wrench to obtain a tighter grip on the work as the strain is increased so that the necessary power is obtained to drive the work onto the tap. It will be seen from the illustrations that the clamp ring *E* is cut away at the point *G* to give the tool the necessary amount of "spring."

Dayton, Ohio. O. L. Allen

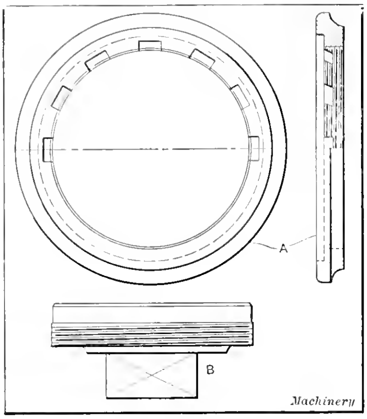


Fig. 1. Work for which Retapping Wrench was designed

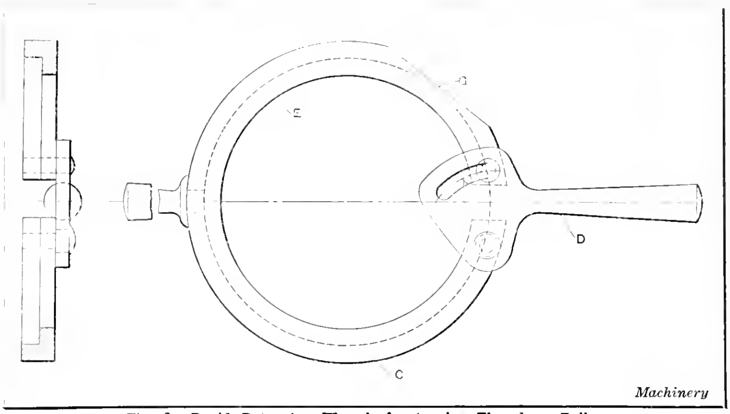


Fig. 2. Rapid Retapping Wrench for tapping Thread on Ball Bearing Parts shown at A in Fig. 1

THE ETHICS OF CONTRIBUTING TO THE TECHNICAL PRESS

I would like to ask the readers of Machinery for their opinion concerning the right of an employe to write descriptions of improved tools or methods that are used in the shop where he is employed, for publication in the technical press. It is not my desire to bring out a technical discussion of the legal points of the case, as the preservation of harmony between employer and employe depends rather upon the way in which they regard the matter. As an example, let us suppose that John Henry is employed by Blank & Co. John is a progressive man and utilizes his spare time during working hours, and also at home, in studying out and developing improvements along the particular line of work in which he is engaged. For the sake of argument, it must be assumed that his daily task is not slighted by so doing. Some of the ideas which he develops are adopted by his employer although John receives no compensation other than the good will of the heads of the firm. It is evident that such ideas are regarded as a natural product of John's daily work.

Under such conditions, I should like to know whether John has a moral right to write a description of his improvement for publication in a trade journal. Would he be treating his employer fairly by so doing? Should he first ask and receive his employer's permission to write such an article? Has his employer the right to refuse such a request? Would John be behaving dishonestly if he did not turn over any new ideas which he develops to his employer? Could he ignore his employer in the matter of publishing an article and still remain loyal? If not, where does John stand and how is he to know what ideas he has a right to describe, and what sort of ideas has his employer the right to expect him to keep from the public? There are many John Henrys and many firms such as Blank & Co., whom I believe would like to hear the other fellow's opinion on this subject.

Delphos, Ohio. A. J. Brickner

NICKEL PLATING WITH BICHLORIDE OF MERCURY

The following formula for "nickel plating" brass and copper parts has proved very satisfactory in our shops during the past four years. In using this method, the first step is to see that the parts to be plated are quite clean and free from grease. The work is then dipped in a saturated solution of bichloride of mercury or else a paste is applied by rubbing. This treatment causes a film of mercury to be deposited on the work, and when this result has been obtained the pieces are dried in sawdust and then lacquered in the usual way.

If a paste is found more convenient to use than the solution, it may be prepared by adding water to the powdered bichloride of mercury to obtain the required consistency. It is essential that the parts be lacquered after they have been plated in this way; otherwise the mercury will wear off in a short time.

Bichloride of mercury may be obtained at almost any drug store. If difficulty is experienced in purchasing it, it may be prepared by allowing metallic mercury to dissolve in hydrochloric acid until the strength of the acid is used up. The liquid is then boiled off, leaving white crystals of bichloride of mercury in the vessel. Either a glass or earthenware vessel should be used to prepare the bichloride of mercury, as hydrochloric acid will act upon any metal vessel which may be used.

East Orange, N. J. George Garrison

DRILLING GLASS

In the June number of Machinery, Mr. S. Queer states that he has found it much easier and quicker to drill glass by hand than by the method described by Mr. O. M. Hance in the December, 1912, number. I did not read Mr. Hance's article but feel sure that the following method will prove more rapid than that described by Mr. Queer.

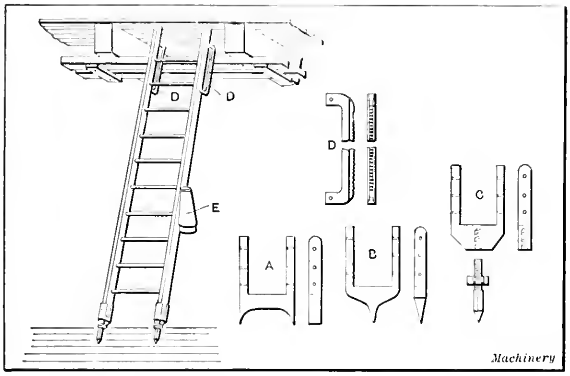
I use an ordinary twist drill of the size of the hole which is required. A mixture of turpentine and camphor is used as a cutting compound. The glass is drilled about half way

through and then turned over so that the remaining depth may be drilled from the opposite side. No jig or other fixture is required for this purpose. When the work is turned over, the bottom of the hole will be clearly shown by a white spot and by centering the drill on this spot, a good, clean hole can be produced. I have drilled quite a few holes in glass, using a small drill press running at high speed, and had no more trouble than if I were drilling cast iron.

Auburn, N. Y. JAMES BURKE

SAFETY EQUIPMENT FOR LADDERS

Almost every industrial plant maintains one or more ladders which are used in attending to shafting and for similar purposes, the ladder seldom being laid down lengthwise. This



Assembly and Detail Views of Safety Equipment for Ladders

is due to the fact that there is no room in the average factory for a ladder to be laid down without being in the way. There are few forms of shop equipment that require more caution in their use than a ladder which is used to reach the belts and shafting in a factory, and no matter how careful the workman may be there is still a certain amount of danger.

Insecure footing for a ladder on the floor is frequently the cause of accidents, due to the ladder slipping away from its overhead support. Most ladders used in factories are provided at their lower ends with forged braces which prevent the ends of the ladder from splitting. These braces are forged with a single or double point which digs into the floor and prevents the ladder from slipping. There are a number of different designs of these braces, two common forms of which are shown at *A* and *B*. The chief objection to the brace shown at *A* is that it does not afford a reliable grip when placed across the grain of the floor. The brace at *B* is more reliable until it becomes worn down, but this form is rather difficult to sharpen.

The form of brace illustrated at *C* is an improvement over the two preceding designs. It consists of a piece of square stock hardened and ground to a point at one end and threaded at the other end. The threaded end fits into a tapped hole in the forging secured to the foot of the ladder, and is furnished with a check-nut to guard against its working out of place. When the points of these braces become dull, they can be easily removed and sharpened.

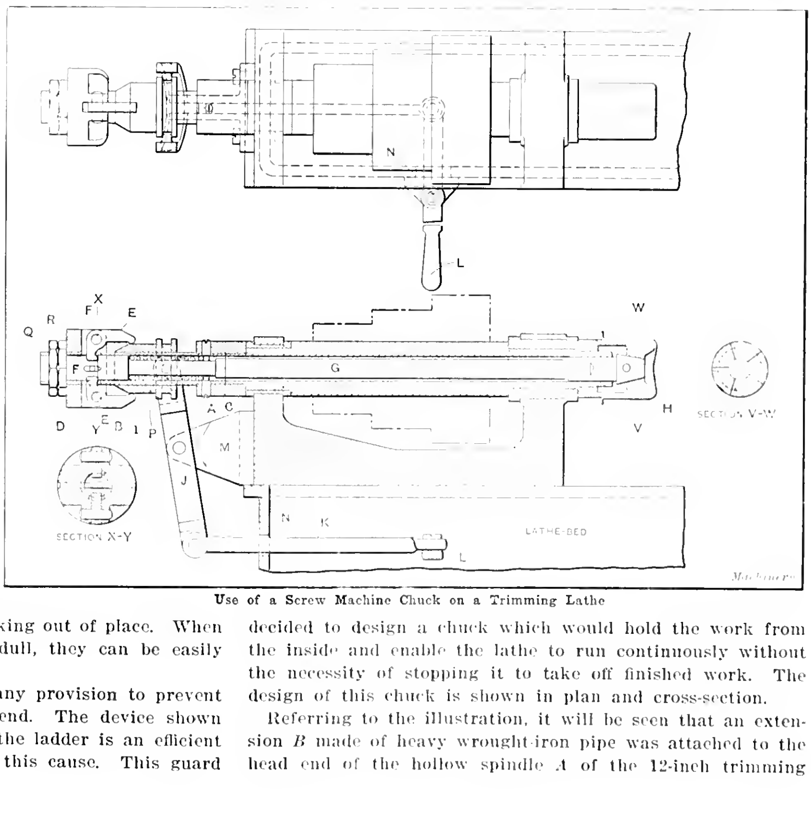
Very few ladders are made with any provision to prevent them from slipping at their upper end. The device shown in detail at *D* and also attached to the ladder is an efficient means of preventing accidents from this cause. This guard is made of ¾ by 1 inch flat stock, the ends being bent back at right angles and teeth milled on the front edge of the guard. Holes are drilled at each end of the guard to receive screws for securing it to the ladder. Where a ladder is equipped with these guards at its upper end and has points at its lower end securely imbedded in the floor, there is little danger of slipping, no matter how roughly the ladder is handled.

The danger or accidents from loose or torn sleeves being caught in belts, gears or other moving parts has been written about too often to require repetition. It is not out of place, however, to state that for an employe wearing a shirt or jumper with loose sleeves to go up a ladder to adjust moving parts of a machine is to invite a serious accident. To avoid this danger, it is advisable to have a pair of sleeves attached to every ladder used in a factory, as shown at *E*. These sleeves can be slipped on over an ordinary pair of shirt or jumper sleeves before going up the ladder, and practically do away with the danger of being caught. There are a number of different kinds of sleeves made and no particular kind is recommended. It is only necessary that the sleeve shall be made of stiff material, the most suitable being those made of fiber or matting. The important thing to remember in order to avoid accidents when working on a ladder is to see that the feet are firmly imbedded in the floor so that they cannot slip and also that the ladder is securely anchored at its upper end. As a supplement to the use of these safety devices, a point should be made of instructing the workmen in regard to the danger which they run in mounting a ladder and the proper method of avoiding it.

Hartford, Conn. JAMES E. COOLEY

SCREW MACHINE CHUCK ON A TRIMMING LATHE

Some time ago I was called upon to trim a large number of metal caps which had been drawn from 24 gage sheet brass. One of these caps is shown in position on the spindle of the trimming lathe, from which the general form is apparent. I first tried to chuck these caps from the outside, but found that the metal was too weak to support the strain. After trying one or two other methods without success, it was



Use of a Screw Machine Chuck on a Trimming Lathe

decided to design a chuck which would hold the work from the inside and enable the lathe to run continuously without the necessity of stopping it to take off finished work. The design of this chuck is shown in plan and cross-section.

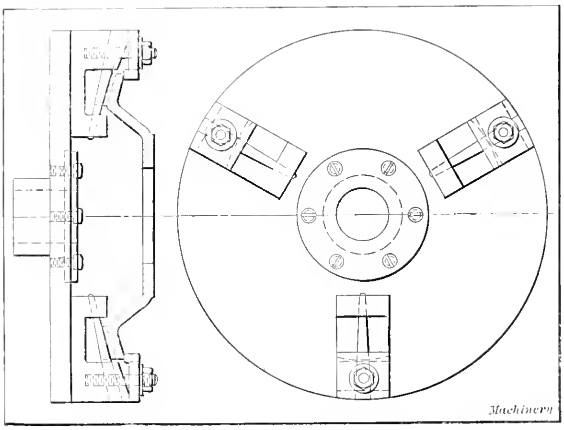
Referring to the illustration, it will be seen that an extension *B* made of heavy wrought-iron pipe was attached to the head end of the hollow spindle *A* of the 12-inch trimming

lathe which was used for machining these caps. The extension is held to the spindle by means of a collar *C* and the other end of the extension is equipped with a locking collar *D* which carries the hardened tool-steel levers *E* pivoted on pins *F*. When the hand lever *L* is thrown over, the levers *E* push the expander rod *G* against the expanding mandrel *H*, which grips the work ready for the trimming operation. The cone-shaped member *I* which actuates the levers *E* is a sliding fit on the extension spindle *B*, and is moved by means of the fork *J* connected to the hand lever *L* by the link *K*. The fork *J* is supported from the lathe bed by means of a cast-iron bracket *M* and two slots *N* are cut in the lathe bed to allow the link *K* and handle *L* to move freely, the arrangement being clearly shown in the plan and cross-sectional views.

The expander *O* is screwed onto the front end of the expander rod *G* so that different sized mandrels may easily be used. The chuck *H* is made of machine steel and provided with five 1/16-inch slots. A spring *P* forces the rod *G* back to the idle position when the cone *I* releases the levers *E*. The throw of the expander rod *G* can be adjusted by means of two nuts, *Q* and *R*. The chuck is so designed that it will not interfere with the regular work for which the machine is used. This method of trimming caps proved to be decidedly economical and might readily be applied on a variety of trimming operations. J. S.

TURRET LATHE FIXTURE FOR MACHINING BEVEL GEARS

In the factory where the writer is employed great difficulty was experienced in securing accurate machine work on cast-steel bevel gears. As it was necessary to produce a large number of these gears at a low price, a simple turret lathe fixture of the form illustrated herewith was designed. One of the gears for which this fixture was designed is shown in place. The machine work consists of boring and facing the



Turret Lathe Fixture used for boring and facing Cast-steel Bevel Gears

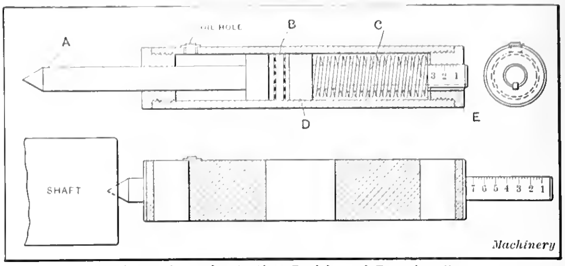
hub, it being necessary to have the bore very accurately located in relation to the pitch circle.

The fixture was designed to enable it to be clamped onto the faceplate of the turret lathe. Three taper pins are placed in the fixture at the angle of the gear teeth, the taper of the pins being such that they will fit accurately into spaces between the teeth. These pins provide a three-point bearing for the gear and locate it so that the hole can be bored in exactly the required position. The work is clamped to the fixture by means of the bolts and caps shown in the illustration. The boring and facing bars used for machining the gears are piloted into the 3-inch bore in the fixture, thus insuring the required degree of accuracy. M. W. W.

END-THRUST GAGE

The accompanying illustration shows a gage for measuring the end thrust of a shaft. In use, the point of the spindle *A* is inserted in the center of the shaft, after which pressure is applied by hand until the shaft is pushed into its desired location, the pressure which is applied being read on a graduated spindle at the opposite end of the gage. An instrument of this kind can be made with a spring and graduations which adapt it for the particular service for which it is intended.

The design of this instrument is clearly shown in the cross-sectional view. Referring to this illustration, *A* is the revolving spindle; the end of this spindle bears against the ball bearing *B* and transmits pressure to spring *C*. It will be evident that this spring is held between the collar *D* and the end *E* of the gage. The graduated plunger may be keyed into the end *E* to prevent the possibility of its turning. It will be found advisable to knurl the outside of the gage to



End-thrust Gage for testing Position of Rotating Parts

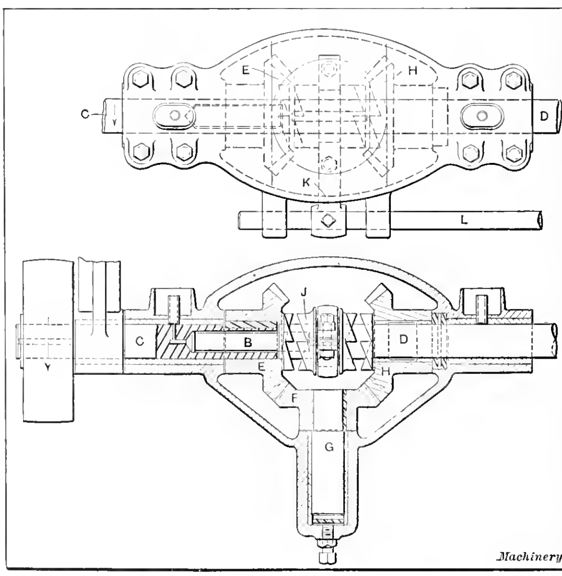
give it a neat appearance and also to afford a good grip when the instrument is used by a mechanic whose hands are covered with oil.

In the manufacture of electric motors it is found that there is a tendency for the armature to "hug" one bearing if it is not quite accurately balanced. This gage was designed for use in the testing department of a factory which had experienced trouble from this source. Gages were placed in the hands of the inspectors who were instructed to return to the assembling department any motor in which it was found that more than a specified pressure was required to bring the armature back to the central position.

RICHARD RUSSELL

REVERSE MECHANISM FOR FACING TRANSMISSION CASES

The executive head of one of the leading automobile factories of Indianapolis, upon taking charge of the work, found



Automatic Reverse Mechanism applied to Milling Machine, for Continuous Milling Operation

the aluminum transmission cases being faced on a milling machine which had been designed to work iron and steel. This proved to be a slow process. The first step taken toward increasing capacity was to change the spindle speeds from

one to five, to one to one, which increased the speed of the cutters five times what it had been. The next step was to add two more jigs for mounting the transmission cases on the milling machine table, making three jigs in tandem. As there was no mechanical return feed, the milling was all done during the forward movement of the table, which had to be returned to the starting point by hand. In order to operate the facing tools on both forward and return movements and also permit the operator to put on unfinished work and take off finished castings without stopping the machine, the feed shaft was made to reverse when the table had carried the third case past the cutters; then, on the return, the cases which the operator had put on while the first three were being faced were machined.

As the feed shaft reverse mechanism devised for this machine may be applicable to other milling machines, it will be described somewhat in detail.

The shaft *C* used to operate the feed table is driven from the side of the machine by belt. This shaft was cut and the drive end bored out to form a journal for gudgeon *B* set in the cut-off end of the feed shaft *C*. Miter gear *E* is keyed on shaft *C* and is provided with a clutch. A double-ended clutch *J* is splined to shaft *D* and miter gear *H* is journaled on shaft *D*. The gears *E* and *H* are connected by gear *F*. The two parts of the housing which enclose these gears terminate in bearings for shafts *C* and *D*. When the housings are bolted together, gear *F* is in proper mesh with gears *E* and *H*. The double-ended clutch *J* is provided with a yoke *K* which extends outward through an opening in the housing and is connected with a shifter bar *L*. When the machine is in operation, the shaft *C* and the belt pulley always run in the direction indicated by the arrow. If it is desired to feed the table forward, the clutch which is splined on shaft *D* is engaged with the clutch of gear *E*, whereas to operate the feed shaft in the opposite direction, the clutch *J* is moved into contact with the clutch of gear *H*. By attaching a rock lever to the shifter bar *L* and setting it to engage with stop arms at each end of the feed table, the reverse movement is obtained automatically, and the operator simply removes the finished parts and replaces them with unfinished castings after the cutters pass each piece.

Indianapolis, Ind. J. A. McAnulty

JIG FOR MILLING GIBS

It is the purpose of this article to describe a jig for milling dovetailed gibs of the type illustrated in Fig. 1. These gibs are about 18 inches long by 2 1/16 inches wide by 5/16 inch thick and are cored out on one side for a cam slot.

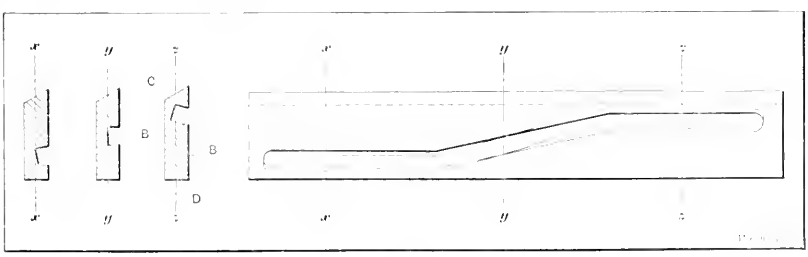


Fig. 1. Type of Gib to be milled

They are made in large quantities so that the time involved in handling the work becomes an important factor.

It was formerly the practice to plane these gibs owing to the impression that milling would not produce a straight enough job on such thin casti. gs. As the gibs were used on a cheap machine, no time could be spent in fitting, and consequently it was necessary to machine the work within the required limits of accuracy. In order to reduce the time required for this operation, the milling jig illustrated in Fig. 2 was designed. In machining the gibs on a milling machine, the surfaces *B* were first finished on a vertical milling machine, holding the work in a vise and using a face mill to avoid distortion. After this operation had been completed, the surfaces *C* and *D* were machined in the milling jig as illustrated in Fig. 2. For the first cut, only one pair of gibs was placed in the left-hand side of the jig. This pair of gibs was then transferred to the right-hand side of the jig and a fresh pair of blanks placed in the left-hand side, after which the jig was tightened up and ready for the second cut. A coarse pitch spiral cutter *A*, wide enough to span the four gibs was used, and it will

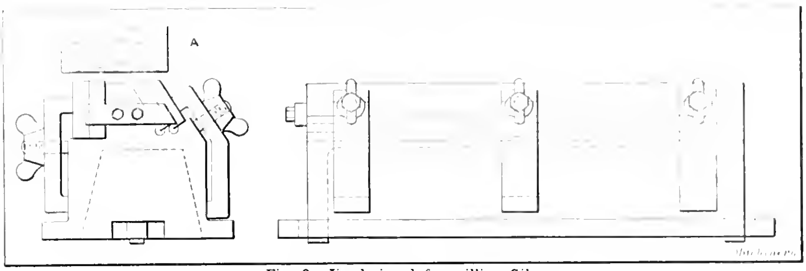


Fig. 2. Jig designed for milling Gibs

be evident that one pair of gibs was completed at each cut—except the first and last. Working according to this method, one operator was able to operate a vertical miller used for finishing the sides *B* and the horizontal miller used for finishing the sides *C* and *D*, thus effecting a material saving in production cost.

Cincinnati, Ohio. H. M. Bogart

STANDARD WIDTH AND THICKNESS OF KEYS

Realizing the advantages derived from interchangeability of machine parts, I am presenting in the following what we have found to be a satisfactory standard for the dimensions

DIMENSIONS OF STANDARD KEYS

Size of Shaft	Size of Key		Size of Shaft	Size of Key	
Diameter in Inches	Width in Inches	Thickness in Inches	Diameter in Inches	Width in Inches	Thickness in Inches
1 to 1 3/16	1/4	1/4	2 1/2 to 2 15/16	3/4	5/8
1 1/4 to 1 9/16	3/8	1/4	3 to 3 7/8	7/8	3/4
1 1/2 to 1 15/16	1/2	3/8	3 15/16 to 4 7/16	1	3/4
2 to 2 7/16	5/8	1/2	4 1/2 to 5 1/2	1 1/8	7/8

Machinery

of keys. It appears that by securing the experience of readers of Machinery along this line, a start might be made toward establishing a generally recognized standard.

The firm with which I am connected does general jobbing work in addition to manufacturing a line of machinery. When I came to the company in 1899 they were using square keys and continued to do so until several years later. These keys were usually made from square cold-rolled steel without any machine work except on the tapered keys, which were made with a taper of 1/8 inch per foot.

Complaints were occasionally received from customers in regard to the square keys. It was claimed that they weakened the shaft and hub unnecessarily, and worn and broken parts returned to the shop seemed to justify this conclusion. In 1903 it became easier to get cold-drawn steel in rectangular sections, and after careful consideration it was decided to adopt rectangular keys in place of the square ones previously used. The accompanying table sets forth the sizes which were adopted.

When taper keys were used, the shallow end of the keyway in the hub was made equal in depth to the keyway in

the shaft, the key being planed from square stock. These dimensions have proved very satisfactory and appear to be about right for general classes of service. As all sizes are in eighths of an inch, the keyways and keys can be made without requiring a large number of cutters and a variety of sizes of stock to be kept on hand. It will be noticed that the thickness of the keys is about three-quarters of their width, or as nearly this proportion as it is possible to make them without adopting smaller dimensions than eighths of an inch.

Orders are frequently received that call for "standard" key-seats and are filled from the dimensions given in the table without calling forth any complaint. It appears that many shops use standards of their own, most of which probably agree quite closely.

Watervliet, N. Y. MARTIN H. BALL

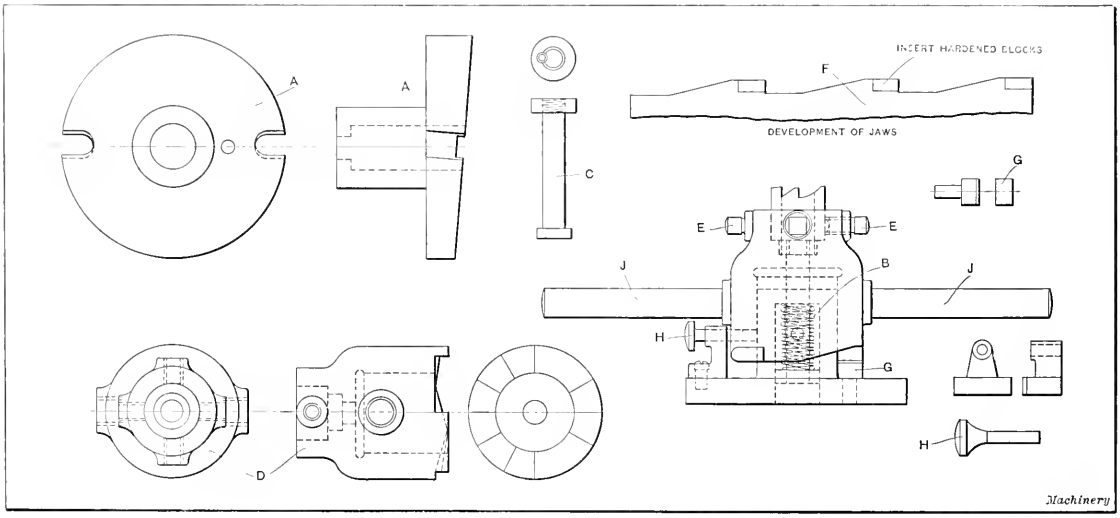
MILLING A THREE-JAW STARTING CRANK CLUTCH

A simple and efficient milling fixture for machining the jaws of a three-jaw starting crank clutch for an automobile motor is shown in detail in the accompanying illustration. In order to make clear the method of machining clutches by this means, the mechanism will first be described in some detail. The baseplate *A* of the fixture is finished at an angle on its under side in order to secure the desired angle on the clutch jaws. A keyway of the same size as the slots in the milling machine table is milled on the under side of the fixture, a key being used to prevent it from rotating. Two bolts fitting in the slots in the base of the fixture provide for securing it to the milling machine table. It will be seen that a pilot is provided on the upper side of the base, this pilot being counterbored to receive tension spring *B* and screw *C*.

The body of the fixture *D* is counterbored at its upper end to receive the clutch jaw which is held in position by means of four set-screws *E*. The lower end of the body *D* is machined to the form to which it is desired to finish the clutch jaw, the development of this cam surface on the lower side of the body being shown at *F*. Hardened steel blocks are inserted in this cam surface where the most severe strain takes place, and a hardened steel block *G* secured to the base of the fixture engages with the cam surface to give the body *D* the required motion. The spring *B* insures having the cam surface on the body of the fixture held in contact with the block *G* at all times.

In machining a clutch jaw on this fixture, the index pin *H* is inserted in one of the holes in the body *D* in order to locate the fixture in the starting position. An angular cutter is used which is 3 inches in diameter by ½ inch in width, and has the teeth cut in a surface inclined at an angle of 37 degrees. This cutter is fed into the work until its center is directly over the center of the clutch jaw which is to be machined. Owing to the angle at which the fixture is inclined, it will be evident that only that side of the cutter which is over the "high" side of the work will cut. After the cutter has been fed in as previously described, the index pin is withdrawn and the body of the fixture is rotated by means of the handles *J*. By so doing the cam surface at the bottom of the fixture runs over the hardened block *G* and guides the work in such a way that the desired contour for the clutch jaw is secured. The rotation of the fixture is continued until the cam drops off the hardened block *G*, indicating that one-third of a revolution has been completed. The fixture is then indexed by locking the index pin in the second hole in the fixture, after which the cutter is again fed in to the center of the work. By rotating the fixture as previously described the second clutch jaw is machined. The process is repeated a third time to machine the third clutch jaw. This fixture proved to be the means of producing very accurate work.

Cleveland, Ohio. E. H. PRATT



Fixture used for milling a Three-jaw Automobile Starting Crank Clutch

PREVENTING BLOW-HOLES FROM FORMING IN BRASS

Inexperienced mechanics sometimes have great trouble in preventing air- or blow-holes from forming at the joints of pieces which are being brazed together. This is generally due to the fact that the work is heated to too high a temperature, with the result that the brass begins to "boil." Brazing should always be done at as low a temperature as possible, and during the operation, the molten brass should be continually stirred to remove any air bubbles that may possibly form.

In cases where it is impossible to stir the brass, satisfactory results may be obtained by proceeding in the usual way, then allowing the work to cool to a dark red and heating it a second time, after which it is again allowed to cool. The second heating allows the metal to run into any blow-holes which may form, the air being driven out to the surface of the metal. It is of the utmost importance that the temperature be so regulated that the brass will not boil during the second heating. If this precaution is not taken, the metal will be in the same condition as it was before applying the heat the second time. In any kind of brazing the best results are obtained by heating the work just enough to cause the brass to melt, and taking care to have the temperature of the joints the same as that of the molten brass.

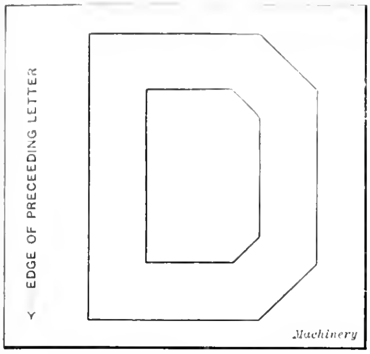
East Orange, N. J. GEORGE GARRISON

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

AN EASY METHOD OF LAYING OUT BLOCK LETTERS

Block letters can be easily and quickly laid out by procuring a piece of quadrille paper and attaching a carbon sheet on the under side of it with the carbon surface facing the work. By laying out the first letter to the desired size and proceeding in the same space to lay out all the others, perfect lettering for a sign or drawing can be done in less than half the time required to construct the letters by the old method. The upper edge of the quadrille sheet may be folded so as to act as a guide for sliding the paper along the edge of a T-square or the board, to bring it into position for the next letter, thus saving the time required to line up each letter. The illustration shows a letter laid out by this method.

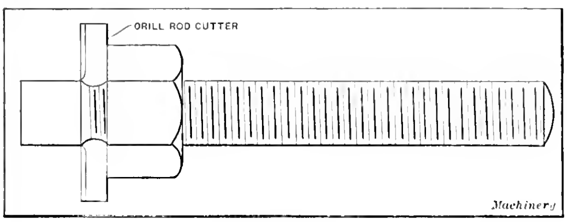


Method of laying out Block Letters on Drawings and Signs

West New York, N. J. William A. Kraus

A CHEAP COUNTERBORE

How many times have you tightened a bolt or nut upon a rough surface when you should have spot-faced to form a true seat for the nut—just because you did not want to stop to make a counterbore. Next time, take a cap-screw the size of the hole, cut the head off, drill a hole where the threads stop, stick in a drill-rod cutter, and screw a nut down against the cutter as shown in the illustration. You will find the cutter well supported by the nut, and the unthreaded end of the cap-screw acts as a pilot. The threads do not interfere with holding the shank in an ordinary drill chuck.



A Cheap Counterbore

Poughkeepsie, N. Y. H. W. Johnson

REMOVING RUST FROM STEEL

A quick method of removing rust from steel parts, which is not generally known to machinists, is outlined in the following: Rub the surface of the piece of work from which rust is to be be removed with muriatic acid. A convenient way to do this is to dip a match or other small stick into the acid and rub it over the surface of the work. This procedure is continued for several minutes, dipping the stick in as often as necessary to obtain a sufficient quantity of acid. After this treatment has been completed, the work should be washed with a solution of common washing soda and water and then dried in sawdust.

This will leave the work free from rust and scratches, but with a dull gray surface. The surface of the metal can be restored to its original color by a little rubbing I have used this method for the past three years and have not known a single case in which it failed to remove all the rust.

East Orange, N. J. George Garrison

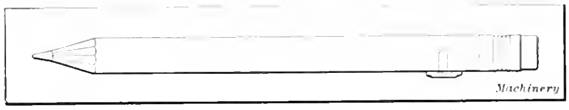
PREVENTING A SLIDE-RULE FROM STICKING

One of our draftsmen was troubled by his slide-rule sticking in damp weather. It was a Faber rule with a self-adjusting slide, but still had a tendency to warp and bind in damp weather so that it could not be used. I suggested gluing two small strips of wood—with the grain of the strips running across the grain of the wood in the rule on the under side of the rule at each end. The rule was first thoroughly dried and after the strips were glued in this way no further difficulty was experienced.

Mishawaka, Ind. Thomas J. Love

PREVENTING PENCILS FROM ROLLING

The accompanying illustration shows a very simple method of preventing pencils from rolling off the drawing board. The illustration makes the method clear without any detailed description being necessary, it being evident that the pencil is prevented from rolling by merely sticking a small sized thumb tack into it near the upper end.

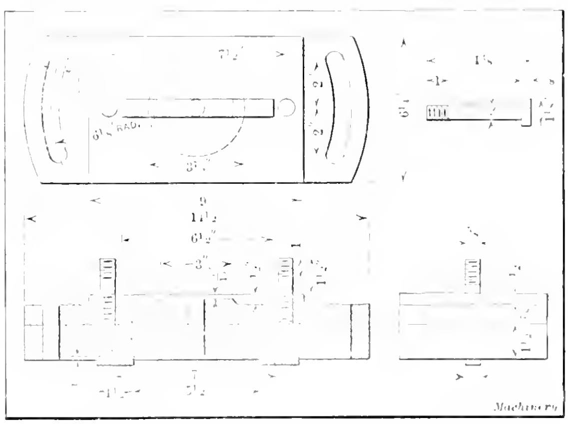


Use of a Thumb Tack to prevent Pencil from rolling

Cincinnati, Ohio. Edward Sobolewski

SWIVEL FILLER BLOCK FOR SPIRAL HEAD

The accompanying illustration shows in detail a simple milling machine attachment which will be found exceedingly useful for many other purposes than the one for which it was originally designed. As its name implies, the application of the attachment raises the spiral head and, at the same time, permits a limited amount of swiveling movement about a vertical axis. In the milling of bevel gears, it is a common practice to roll the spiral head. This, however, alters the shape of the resultant tooth to such an extent that the life of the gear is materially affected. With the attachment shown, the proper lines can be retained.



Swiveling Raising Block for Spiral Head of B. & S. Milling Machine

The construction is simple. A cast-iron plate is machined to suit the milling machine table and its upper surface is counterbored $3\frac{7}{8}$ inches diameter and $\frac{1}{2}$ inch deep. A second cast-iron plate has a boss which fits into the hole in the lower plate, and its upper surface is grooved to receive the spiral head. Both plates are bolted to the machine table with two $\frac{5}{8}$-inch square-head bolts which are shown in detail.

Hamilton, Ohio. A. M. Lount

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

ANNEALING MOLYBDENUM

G. G. Can any reader of MACHINERY give us the details of a method by which molybdenum can be annealed sufficiently to permit of being drilled?

DRAWING BRASS TUBING ON STEEL RODS

G. W. A. Can any reader of MACHINERY give me information regarding the drawing of tubing onto shafting? Some pump rods are made of steel and covered with sleeves of brass which are drawn tightly onto the rod. I wish to perform a similar operation but would much prefer to roll the outer member upon the inner to a perfect fit. Some methods analogous to that of expanding boiler tubes into the sheets, but the reverse process, of course, would fit the case in hand much better than drawing.

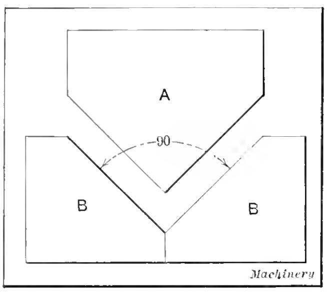
FLUX FOR OXY-ACETYLENE WELDING

A. B.—Are fluxes required for welding cast iron, steel, brass, copper and aluminum by the oxy-acetylene method?

A.—Steel ordinarily requires no flux for welding but a sealing powder is used advantageously on cast iron. Aluminum castings and thick aluminum sheets may be welded without flux but a flux is necessary for very thin aluminum sheets. Brass, bronze and copper require fluxes. The makers of oxy-acetylene apparatus furnish fluxes suitable for all these materials.

ANGLES OF ANGLE BEAM SHEAR BLADES

J. D. Y.—The accompanying illustration shows the upper and lower blades of an angle beam shear. Should the upper blade *A* be made with an included angle of 90 degrees the same as the vee in the lower blades, or should it be of a different angle? If so, what angle should be used?



A.—The relative shapes of the blades depend on the kind of shearing required. If the beams are to be sheared with a minimum of distortion, the angles of the upper and lower blades should be about the same. The question is submitted to readers who have had experience with this class of tool work.

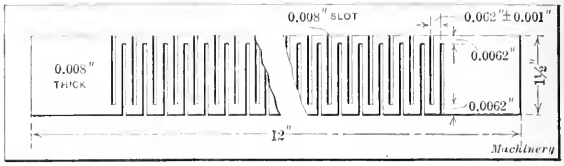
POWER OF WINDMILLS

H. A. W.—Would it be practicable to run a small machine shop with a windmill where the wind is fairly steady for days at a time? How large a windmill would be required to run a small machine shop?

A.—It would not be practicable to run a small machine shop with a windmill, for two reasons. In the first place, the speed would fluctuate so much that it would be difficult to run the tools at the proper speed, and in the second place, you could not get power enough in all probability. The power requirement of a "small machine shop" is indefinite but assuming that it is, say, five horsepower, a windmill motor would need to be very large to produce this amount of power steadily. The work done by a twelve-foot windmill of the most efficient make in a strong wind was shown to be but a fraction of a horsepower by tests conducted in 1895 and 1896 by E. C. Murphy. The results of these tests were published in the *Kansas University Quarterly*, April, 1897. The useful work done in a twenty-miles-an-hour breeze was 0.332 horsepower; in a twenty-five-miles-an-hour breeze, 0.379 horsepower; and in a thirty-miles-an-hour breeze, 0.417 horsepower. A sixteen-foot mill generated only 0.644 horsepower in a thirty-miles-an-hour breeze.

SLOTTING "NI-CHROME" STEEL RIBBON

W. C. H.—I would like to find out how we may successfully slot "ni-chrome" steel ribbon. The dimensions of the ribbon and slots are shown in the accompanying illustration. We have spent over one-and-a-half year trying to make a die that will slot this ribbon successfully but so far have not succeeded. Three different dies have been made and the last one is the best, but it is far from being satisfactory. The cutters break quickly. With a brand new sharp die, we can run about forty



feet of ribbon and then the corners of the cutters give way and wedge into the die, causing the cutters to break on the up-stroke. If we could get a die that would run one hour without breaking or grinding, it would be considered very satisfactory. "Ni-chrome" steel ribbon is the toughest material to work in a die that we have ever seen. Any information that the readers of MACHINERY can give will be thankfully received.

* * *

MANNING, MAXWELL & MOORE, INC., ACQUIRES PUTNAM MACHINE CO.

Manning, Maxwell & Moore, Inc., New York City, has purchased the entire capital stock of the Putnam Machine Co., Fitchburg, Mass. The Putnam Machine Co. is a pioneer tool manufacturer of America. It was started in a small way in 1836 by Salmon W. and John Putnam who were geniuses in tool designing and building. They were the originators of a number of improvements which have become commonly accepted features of machine design. Among these may be mentioned the feed-rod for operating the carriage of engine lathes, the adjustable lathe tailstock and the universal adjustable box and hanger for lineshafting. They produced the first set of hardened steel ring and plug gages made in America and were the first to bring out an upright drill with a revolving table and an adjustable arm swinging around the column of the drill. Their early experimental development work in gear-cutting blazed the way for the present gear-cutting machines. They were also the originators and builders of the famous Putnam steam engine.

The company has grown from a small beginning until its plant covers about fourteen acres of the most valuable land in Fitchburg; it is one of the leading builders in the world of heavy railroad machine tools, such as locomotive driving wheel lathes, coach wheel lathes, axle lathes, hydrostatic wheel presses, planers and lathes.

Of the old stockholders of the Putnam Machine Co., S. W. Putnam, son of the founder and himself a designer of wide reputation, and his son S. W. Putnam, 3d, will retain their connection with the company which will continue to be known as the Putnam Machine Co. By the purchase, the old officers and directors automatically ceased to hold office and the following are the new directors of the company: Salmon W. Putnam, Alfred J. Babcock, John N. Derby, Percy M. Brotherhood and George D. Branston, the last four mentioned being executive officers of Manning, Maxwell & Moore, Inc.

* * *

Tests have been made on the 5000-ton testing machine of the U. S. Bureau of Standards at Pittsburg to determine the strength of large brick piers. The tests were made on two piers four feet square by twelve feet high. The bricks of one pier were laid up in one-to-one cement mortar and of the other in one-to-three lime mortar. The tests developed a strength of 757 pounds per square inch in the lime mortar pier and 2917 pounds per square inch in the cement mortar pier. The fact that a strong bond increases the compressive strength of brick nearly four times that of the same bricks in a comparatively weak bond is not generally appreciated.

EIGHTH ANNUAL EXHIBIT OF THE FOUNDRY AND MACHINE EXHIBITION

The eighth annual exhibit of the Foundry & Machine Exhibition Co., which was held in the International Amphitheater, Chicago from October 10 to 17 inclusive, was very largely attended by foundry and machine tool manufacturers and those interested in modern machinery and supplies. The building selected was ideal for this purpose, there being no lack of light and power facilities. Machines were set up and in actual operation, which helped greatly to increase the general interest in the various exhibits. One hundred and seventy-four individual concerns were represented this year, which was a considerable increase over the number that exhibited last year at the convention in Buffalo. Among those exhibiting were the following:

Acme Machine Tool Co., Cincinnati, Ohio. "Acme" geared head combination flat turret lathe with complete bar and chucking equipment, driven by five H. P. constant speed motor; "Cincinnati-Acme" eighteen-inch geared head universal turret lathe.

American Tool Works Co., Cincinnati, Ohio. "American" high-duty lathe, with eight speed geared head for motor drive with miscellaneous tools, bars of material, etc., for testing purposes; "American" triple-geared plain radial drill; "American" back-geared plain radial drill; "American" single-geared crank shaper.

aloxite products, carborundum wheels; carborundum rubbing bricks; carborundum disks; aloxite wheels, etc.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. "Cincinnati" twenty-four-inch high-speed shaft-driven upright drill with patent geared tapping attachment, gear box and motor drive; "Cincinnati-Bickford" four-foot regular plain radial drill, variable speed motor drive; "Wizard" chucks and collets.

Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio. Vertical high-power, motor-driven milling machine in operation; universal high-power milling machine; universal cutter grinder, in operation.

Cincinnati Planer Co., Oakley, Cincinnati, Ohio. Thirty-six inch by thirty-six-inch by eight-foot heavy pattern, "Cincinnati" planer, with four heads equipped with "Triumph-Monitor" reversible motor drive.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio.

Clipper Belt Lacer Co., Grand Rapids, Mich. "Clipper" belt lacer; "Clipper" belt hooks, etc.

Cowan Truck Co., Holyoke, Mass. Cowan all-metal transveyors.

Davis-Bournonville Co., Chicago, Ill. Portable and stationary oxy-acetylene apparatus; acetylene generator; oxygraph cutting apparatus.

Diamond Machine Co., Providence, R. I. Disk grinding machine complete with sliding table and ring wheel chuck; steel disks; cementing press and accessories.

Flexible Steel Lacing Co., Chicago, Ill. "Alligator" steel belt lacing and "Turtle" belt fasteners.

Gardner Governor Co., Quincy, Ill. Vertical self-oiling and horizontal self-oiling air compressors.

Gardner Machine Co., Beloit, Wis. Disk grinders; setting-up

View of the Eighth Annual Machine & Foundry Exhibition in the Amphitheater Bldg., Chicago

E. C. Atkins & Co., Inc., Indianapolis, Ind. Saws for all purposes; metal cutting saws, circular metal saws, metal band saws, hacksaw blades, hacksaw frames, machine knives, band saws, circular saws, saw fitting tools, power hacksaw machines.

Automatic Transportation Co., Buffalo, N. Y. Electric trucks built and used exclusively for interior trucking; electric trucks equipped with lifting platform, intended for machine shop work and equipped to raise a load from four to five feet, converting the truck into a tiering machine.

Baird Equipment Co., Chicago, Ill. Time stamps and electric clocks.

Baker Bros., Toledo, Ohio. High-speed, high-power drilling machine with compound table, motor driven; gear box showing arrangement of gears and method of shifting for high speed; high-power drill, motor driven; and keyseater for internal keyseating, motor driven.

Barnes Drill Co., Rockford, Ill. All-geared drill, complete with motor drive; sliding-head all-geared drill and tapper, with motor drive, self-oiled; all-steel geared manufacturing drill with motor drive.

Benjamin Electric Mfg. Co., Chicago, Ill. Benjamin safety devices for punch presses, installed on press in operation.

Charles H. Besly & Co., Chicago, Ill. Besly horizontal disk grinders; Besly disk grinders; direct-connected patternmaker's disk grinder; "Helmet" spiral circles; oil, taps, etc.

Bullard Machine Tool Co., Bridgeport, Conn. Bullard vertical turret lathe, "New Era" type, complete with cutting lubricant system, motor drive, etc., in operation on various classes of work.

Carborundum Co., Niagara Falls, N. Y. Carborundum and

wheel presses; roll sanding machine; ball bearing polishing lathes; ring wheel chucks; complete line of disk grinder supplies.

General Electric Co., Schenectady, N. Y. Induction motor-driven and turbine-driven centrifugal air compressors.

Gisholt Machine Co., Madison, Wis. "Periodograph" (time registering system).

Goldschmidt Thermit Co., New York City. Samples of roll repairs; samples of work done, with equipment for doing same; demonstration showing intense heat produced by the chemical reaction of thermit.

Gould & Eberhardt, Newark, N. J. Twenty-eight-inch "Invincible" type shaper with direct-current variable-speed motor drive with automatic starter and dynamic brake; twelve-inch gear hobber with direct-current motor drive, and automatic starter.

Greaves, Klusman & Co., Cincinnati, Ohio. Greaves-Klusman all-geared head, heavy, quick-change screw cutting engine lathe and heavy standard screw cutting engine lathe.

Hannifin Mfg. Co., Chicago, Ill. Air-operated chucks; countershafts; clamping fixtures; vises and mandrels; air-operated firedoors; collapsing taps.

Hoskins Mfg. Co., Detroit, Mich. Hoskins electric furnaces; Hoskins thermo-electric pyrometers including portable, wall, illuminated-scale and recording types; Hoskins electric hot plates for laboratories.

Hunter Saw & Machine Co., Pittsburg, Pa. Inserted tooth saw grinder; saw sharpening and beveling machine; inserted tooth saw blades; high-speed friction saw.

Independent Pneumatic Tool Co., Chicago, Ill. "Thor" pneumatic chipping hammers; calking hammers; flue beading hammers; riveting hammers; sand rammers; piston air drills; reversible wood boring machines; flue rolling machines; tapping machines; pneumatic grinders; and electric drills.

Ingersoll Rand Co., New York City. Air compressors, single and two-stage, electric driven; pneumatic chipping hammers; pneumatic riveting hammers; pneumatic scaling hammers; pneumatic motor hoists; stationary motors; piston drills; sand rammers.

International Machine Tool Co., Indianapolis, Ind. "Libby" heavy-duty turret lathe with tool equipment for gear blanks.

Kempsmith Mfg. Co., Milwaukee, Wis.

Landis Machine Co., Inc., Waynesboro, Pa. Double-head bolt cutters; stationary pipe die heads; automatic die heads; solid adjustable die heads.

La Salle Machine & Tool Co., La Salle, Ill. La Salle No. 1 plain and surface grinder with micrometer adjustment.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Eighteen-inch by eight-foot selective head engine lathe; sixteen-inch by six-foot universal new model tool-room lathe with selective head.

Manufacturers' Equipment Co., Chicago, Ill. Turret lathe in operation demonstrating "Aero" chuck and collapsible tap; complete line of "Aero" chucks and collapsible taps.

Modern Machine Tool Co., Cincinnati, Ohio. "Modern" turret lathes.

Norma Company of America, New York City. Norma annular ball thrust, roller and combination bearings, Hirth minimeters.

Norton Co., Worcester, Mass. Grinding demonstrations on swing frame grinding machine, on flexible shaft grinding machine and on new model two-inch Norton floor stand; exhibit of Norton alundum and crystolon grinding wheels.

Oliver Machinery Co., Grand Rapids, Mich. Full equipment of patternshop machinery, including universal wood milling machine; saw bench; jointer; band saw; sander, oilstone grinder; lathes; comb; surfacer; knife grinder, band saw filer; band saw setter; circular saw sharpener; fitting-up wheels; brazer; circular saw set; knife balance; etc.

Oxweld Acetylene Co., Chicago, Ill. Oxweld cutting and welding apparatus; supplies for oxy-acetylene welding.

E. O. Partridge, Chicago, Ill. Emery grinders.

Pawling & Harnischfeger Co., Milwaukee, Wis. Five-ton electric crane; three-ton hoist and single-line grab bucket in operation; crane motors; controllers; I-beam trolleys.

Rockford Drilling Machine Co., Rockford, Ill. Four-spindle vertical chucking gang drilling machine, complete with jigs and special tools for machining pinions.

Rock Island Mfg. Co., Rock Island, Ill. Vises for machine shop and foundry use.

William Sellers & Co., Inc., Philadelphia, Pa. Universal tool grinding and shaping machine; improved drill grinding machine; centrifugal sand mixing machine, all motor driven; centrifugal sand mixing machine, belt driven.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Cage controlled monorail electric hoist; pulpit-controlled single I-beam electric hoist; crane trolleys; foundry controllers.

Springfield Machine Tool Co., Springfield, Ohio. "Ideal" engine lathe with friction geared head; rapid change gear device; Fox monitor turret lathe with friction geared head, chasing bar and taper attachment.

Tabor Mfg. Co., Philadelphia, Pa. Molding machines.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Ferro carbon-titanium and titanium alloys for use in ferrous and non-ferrous metals.

United States Electrical Tool Co., Cincinnati, Ohio. Electric drills and grinders.

Vulcan Engineering Sales Co., Chicago, Ill. Pneumatic jolt rammers with pattern drawing mechanism; electric jolt rammers; power and hand squeezers; split pattern machines and vibrators; pneumatic riveters; shakers and electric riddles and oscillators; pneumatic punches; mold dryers; cold metal saws; shop saws; hacksaws; etc.

Warner & Swasey Co., Cleveland, Ohio. Screw machines and turret lathes.

West Haven Mfg. Co., New Haven, Conn. "Acme" high-speed power hacksaw machine; "universal" hacksaw frames; "universal" hacksaw blades.

Willard Machine & Tool Co., Cincinnati, Ohio. Gap bed lathe; tool-room lathe with compound geared taper attachment and draw-in collet attachment, hexagon turret on carriage and square turret on carriage.

Wilmarth & Morman Co., Grand Rapids, Mich. Wilmarth & Morman wet surface grinder and "New Yankee" drill grinders, motor driven; combination cutter, reamer and drill grinder, motor driven; "New Yankee" drill grinders, belt driven; lathe center grinder; water tool and drill grinder.

Wright Mfg. Co., Lisbon, Ohio. Chain hoists, electric hoists, trolleys and traveling cranes.

All machines shown in the exhibit in operation were motor-driven and of the latest design. Several of the machines exhibited were strictly new and incorporated some radical improvements in machine design and construction. The general feeling among the exhibitors and visitors was that the convention was a pronounced success. An even better and more largely attended exhibition is expected next year.

* * *

NEW YORK ELECTRICAL SHOW

The Electrical Exposition and Motor Show of 1913 was held in the Grand Central Palace, New York City October 15 to 25 inclusive. A great variety of exhibits showed something of the part that electricity now plays in the activities of modern industry and home life. They ranged from an electric cow-milker to a full-sized section of one of the Consolidated Telegraph and Electrical Subway Co.'s electric underground cable conduits including manhole and vault. The U. S. Government exhibited a working model of a section of the Mint, all machines, furnaces, presses, etc., required for coining, being in operation. The process of coining $20 gold pieces was illustrated, the coins produced being bronze medals of the exact size of double-eagles. The Government also showed Agriculture, Panama Canal, Navy and Army exhibits. Electro-therapeutical apparatus claimed considerable space, but the commercial and industrial exhibits, of course, were the most important. The variety of office appliances and domestic machines now furnished with electric motors would surprise anyone who had not kept closely in touch with the applications of electric drive during the past few years. Among the many concerns exhibiting were the Bell Electric Motor Co., General Electric Co., H. W. Johns-Manville Co., New York Edison Co., Rhineland Machine Works, Twinvolute Pump & Mfg. Co., and Westinghouse Electric & Mfg. Co. The educational value of the show was appreciated by many students who embraced the opportunity to see the latest electrical apparatus and applications, and something of the activities of the Government department with which comparatively few are familiar.

* * *

A. S. M. E. MEETING IN WORCESTER

About two hundred members of the Boston branch of the American Society of Mechanical Engineers met with the Worcester branch of the society in Worcester October 17. After partaking of luncheon at the Worcester Institute of Technology, tours of inspection of engineering work and local industries were made to Holden where the hydraulic laboratories of the W. P. I. are located, to the Quinsigamond Works of the American Steel & Wire Co., to Worcester Electric Light Co., to Reed & Prince Mfg. Co., Graton & Knight Mfg. Co., Crompton & Knowles loom works, United States Envelope Co., etc. Prof. David L. Gallup read a paper on aeroplane propellers at the W. P. I. hydraulic laboratories, and a demonstration on an electrically-driven aeroplane propeller mounted on a revolving boom was made.

The party then reassembled at the Norton Co.'s works where the following papers were read: "Modern Abrasives, Their Manufacture and Use" by Aldus C. Higgins; "How the Best Abrasive Wheels are Made" by Carl F. Dietz; "Efficiency Grinding" by Charles H. Norton. The engineers then inspected the works of the Norton Co. and the Norton Grinding Co. The inspection was followed by a banquet at the new Hotel Bancroft, President Hollis acting as toastmaster.

* * *

TARIFF LAW OF 1913

The so-called Underwood-Simmons tariff bill was passed by Congress and became a law October 4. Substantial changes and reductions were made in all schedules. The free list was added to; the tariff on machine tools was reduced from thirty per cent to fifteen per cent; wool will be admitted free beginning December 1, 1913; and new rates on woolen manufactures will apply January 1, 1914. Sugar and molasses will be admitted free beginning May 1, 1916. The loss of revenue collected on imports will, in a measure, be made up by an income tax which provides for taxing the incomes of individuals, companies, corporations, associations, etc. The law provides for taxing all incomes more than $3000 annually except those of married persons which are exempted up to $4000.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

POND THIRTY-INCH RAPID REDUCTION LATHE

The illustrations show a new lathe which has recently been developed at the Pond Works of the Niles-Bement-Pond Co., 111 Broadway, New York City. This machine is intended for handling the heaviest roughing work of the kind met with in steel and forge shops. To adapt it for such severe classes of service, the machine is of particularly massive construction and steel gears are used throughout. The spindle is driven by a direct-connected 35-horsepower, variable-speed motor, which is capable of supplying a pressure of 26,000 pounds to the tool when it is working at a speed of 50 feet per minute. The motor pinion and the gear which it drives have herringbone teeth, which insure quiet operation. Two mechanical changes of speed can be made in the headstock by means of a convenient lever. The lower speeds of the faceplate are obtained by means of a pinion which drives the faceplate gear. The design is such that any tendency for the resistance of the tool or the power applied to the pinion to lift the main spindle in its bearings is eliminated. The higher speeds are obtained by driving direct through the faceplate spindle, thus obviating the necessity of running the faceplate pinion at an excessively high speed. The end thrust on the main spindle is taken on hardened steel and bronze washers.

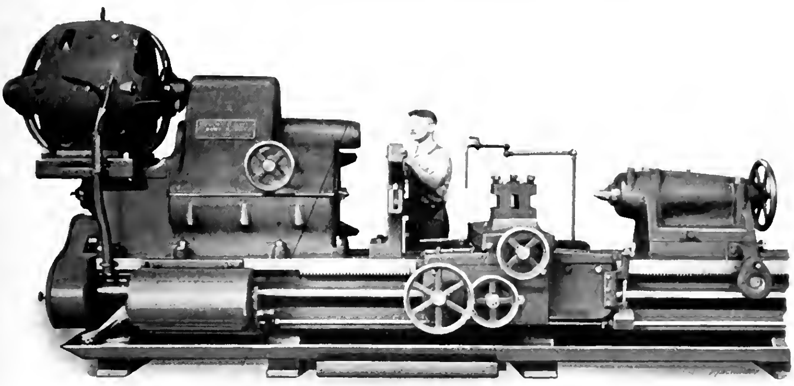


Fig. 1. Front View of Pond Rapid Reduction Lathe

The gearing in the headstock, in connection with the variable-speed motor, gives forty faceplate speeds ranging from 13 to 174 revolutions per minute. By means of a handle on the carriage, the faceplate may be started, stopped or reversed, and any of the motor speeds may be obtained without requiring the operator to leave his position at the front of the machine. The faceplate is made of steel and fitted with radially adjustable drivers. All the rotating shafts in the headstock are mounted in bronze lined self-oiling bearings provided with large oil reservoirs. All of the bearings and gears are entirely enclosed and furnished with a continuous supply of oil from a tank in the headstock. This tank is kept filled by a geared pump which draws oil from a tank located in the bed of the machine. All surplus oil drains back into this tank, the oil being filtered before it is used a second time.

The tool carriage has a bearing on the bed for its full length at both the front and back. It is gibbed underneath the track on both the inside and outside. The edges of the carriage are raised, drains being provided to prevent the lubricant from running onto the floor, and as the drainage surface is below the tool-slide guides, the latter are protected from chips and water. The tool-slide travels on a wide bridge, which is of such length that the sliding surface on the carriage is not exposed when the largest diameters for which the lathe is adapted are being turned. The tool-block or carrier is secured to the top of the tool-slide by means of four heavy bolts and a cross-key. It has two open-side slots and one closed central slot, which are large enough to receive tools 1¼ by 2½ inches in size. Each slot is provided with a hardened, serrated plate and three clamping screws. Cutting lubricant is supplied to the tool by means of a geared pump located at the headstock, and telescopic piping at the back of the bed conducts the lubricant to the tool carriage, from which it is returned to a tank at the head end of the lathe. The apron is of ribbed box construction, and the feed gear shafts are supported at both ends, all rotating shafts running in bronze bearings. The center-rest is of heavy construction, and provided with three adjustable jaws with large wearing surfaces.

The tailstock is especially heavy, but may be readily moved by gearing engaging with the steel feed rack. A graduated set-over is provided for turning small tapers. The tailstock can be rigidly clamped to the bed of the lathe by four large bolts, and a tail-brace engages a rack in the bed, thus preventing the possibility of the tailstock slipping under heavy loads. The bed is wide and deep, and has flat tracks tied together at short intervals by heavy box section ties. The bed is mounted on short legs in a deep steel pan which entirely surrounds the machine and extends beyond the sides a sufficient distance to prevent the cutting fluid from dripping onto the floor. The pan is also mounted on legs, thus providing space underneath it for a wheeled tank which is placed at the head end to collect the lubricant.

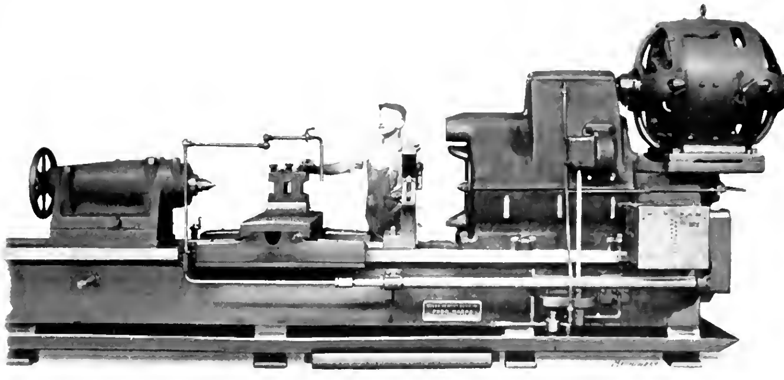
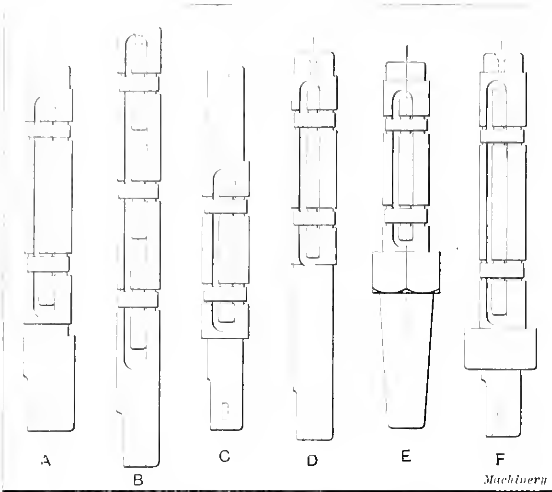


Fig. 2. Rear View of Pond Rapid Reduction Lathe

ALERT ROLLER MANDRELS

Six styles of roller mandrels which are now being manufactured by the Alert Tool Co., 221-223 N. 23 St., Philadelphia, Pa., are illustrated herewith. These mandrels are particularly suited for various classes of second-operation work, and their use enables the work to be set up with the greatest possible dispatch. Referring to the illustration, it will be seen that a

longitudinal groove is milled in each mandrel, the position of this groove being slightly off center. One or more hardened rollers—according to the style of mandrel—are carried in this groove. By having the groove off center the roller drops below the circumference of the mandrel at one side of the groove, but when the mandrel is turned to the left the roller moves over and binds the work securely in place. From the preceding description it will be evident that the principle upon which this type of mandrel operates is similar to that of the roller clutch. Transverse grooves are machined around the mandrel, and spring collars fit in these grooves to hold the rollers in place.



Six Different Types of Alert Roller Mandrels

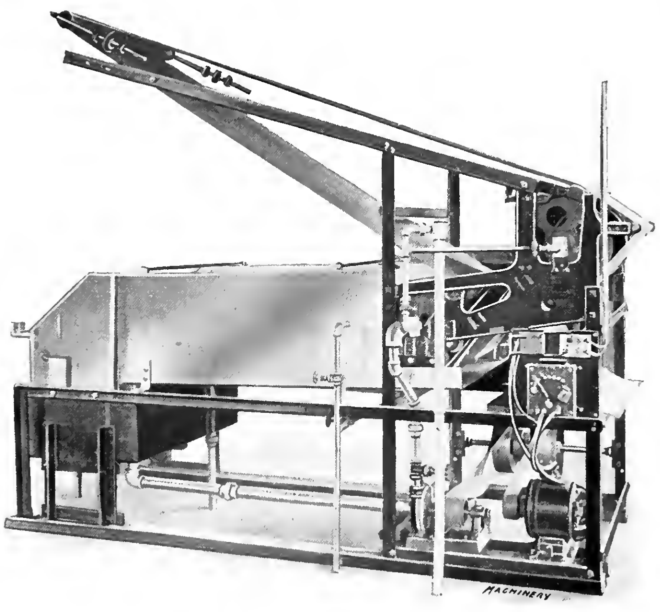
The following gives a brief description of the classes of work for which the different styles of mandrels shown in the illustration are intended: The mandrel shown at *A* is the standard type which is intended for the work of the tool-room, jobbing shop and similar purposes. A multiple roll type of mandrel is shown at *B*. This is intended for grinding or turning more than one piece of work at a single setting. Mandrels of this kind are made with any required number of rolls that is consistent with good practice, and effect a great saving of time in the production of duplicate work. The double facing type of mandrel is shown at *C*. This mandrel is intended for turning, facing, grinding or forming operations, and both faces of the work can be finished without requiring it to be removed from the machine. A double facing tool can be used to advantage with this mandrel. A single facing type of mandrel is illustrated at *D*; this is similar to the double facing type except that it is made shorter. It is used for facing one end of a piece of work at a setting and can also be used for turning, forming or grinding. The taper shank stub type of mandrel shown at *E* is intended for use in a turret lathe, engine lathe, milling machine or any other type of machine having a taper spindle. It is adapted for turning, facing and grinding operations. A special turning and facing type of roller mandrel is shown at *F*. This mandrel has a stop for locating the work longitudinally, and is particularly convenient for turning and facing duplicate parts, without altering the position of the tool. It will be noted by referring to the illustration that five of these mandrels have a flat ground on them to provide for the use of a driving dog, while the taper shank mandrel is driven in the usual way. It will be readily appreciated that the facility with which work can be set up on these mandrels effects a material saving in the cost of machining.

AUTOMATIC BLUEPRINT FINISHER

The automatic blueprint finisher illustrated herewith is a recent production of the Technical Supply Co., of Scranton, Pa. This machine facilitates the speed with which blueprints can be dried, and also turns out the prints perfectly smooth so that they occupy less space in the filing cabinets. In using this machine, the blueprint, as it comes from the printing frame, is placed upon a traveling belt which carries it under a series of pipes that spray water upon it. In this way the print is washed and made ready to be passed on to the drier. The wash water is delivered by a series of pipes which run the entire length of the belt. These pipes are equipped with spray nozzles which deliver water over the entire width of the belt, and after flowing over the blueprint, the water runs down into the tank, from which it is pumped back to the pipes. Before leaving the wet belt, fresh water is sprayed onto the blueprint. About fifteen or twenty gallons of fresh water is used per hour.

After being washed according to the method described in the preceding paragraph, the blueprint is taken up by a dry belt, which carries it over a stationary drier where the preliminary drying takes place. The print is then transferred to a heavy canvas belt which holds it in contact with a revolving drum that is heated by gas or electricity, as desired. The print remains in contact with this drum during one complete revolution and is then passed out of the machine onto a table or stand placed in position to receive it. The contact with the drum has completely dried the print, and also "ironed" it, so that it emerges from the machine perfectly smooth. The only manual labor connected with the operation of this machine is to place the print in position on the first belt; after this has been done the operation is entirely automatic.

An idea of the rapidity with which blueprints may be finished on this machine may be gathered by the following.: A print 15 by 20 inches in size can be passed through at the slowest speed of the machine and completely washed, dried and ironed in about two minutes and twenty seconds. With the machine operating at its highest speed, the same print would be completely washed, dried and ironed in one minute and ten seconds. Prints may be finished at the rate of $4\frac{1}{2}$ to $7\frac{3}{4}$ square feet per minute, and in a ten-hour working day a 42-inch machine will wash, dry and iron 7000 square feet of blueprints. The machine is of simple construction and the design is very compact. It is manufactured by Benjamin Levi, 355 West Broadway, New York City.



Automatic Machine for washing and drying Blueprints

PRATT & WHITNEY DISK GRINDER

There are certain classes of work finished by grinding, in which it is preferable to have the finish lines circumferential, instead of having the radial lines which result from the use of a cupwheel. To meet the requirements of such work, and especially for circular grinding where the surfaces to be ground are at various heights, the Pratt & Whitney Co., Hartford, Conn., has brought out a new grinder, front and rear views

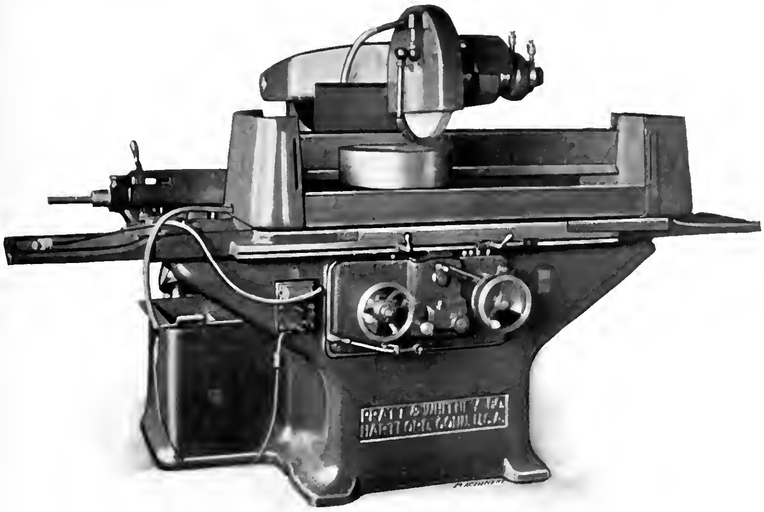


Fig. 1. Front View of Pratt & Whitney Disk Grinder showing Control Mechanism

of which are illustrated in Figs. 1 and 2. This machine has also been found very satisfactory for grinding thin hardened disks, as there is relatively little heat generated during the grinding processes, so that the work may be finished without distortion. Another application is the grinding of large piston rings and similar classes of work, the large wheel used on this machine handling such pieces without perceptible wear.

The bed, table and table feed mechanism are similar in design to the 14-inch vertical surface grinder of this company's manufacture. The machine is adapted for using a large size wheel, which is adequately supported and powerfully driven. Referring to the illustrations, it will be seen that the wheel is mounted at right angles to the work and provision is made for delivering a liberal supply of water during the grinding operation. The bed is massively proportioned and internally braced in a manner that insures ample rigidity and permanent alignment; it is of compact design, and the various units are located in a way that makes them easily accessible. Wide bearing surfaces of the vee and flat types are provided, and oil reservoirs for automatically oiling the ways are located in the bed. The pan which surrounds the rear of the bed for collecting the water and chips is of liberal proportions and easily accessible for cleaning.

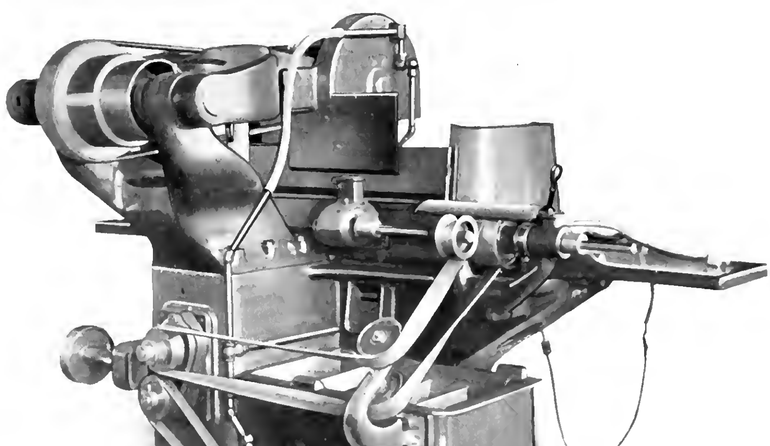


Fig. 2. Rear View of Pratt & Whitney Disk Grinder showing Wheel Support and Arrangement of Drive

The table is of heavy construction and powerfully ribbed to prevent warping and resist torsional strains. Both the bed and table are finished to masters, which insures perfect accuracy; the table is slightly longer than the bed and the traveling action keeps the bearings perfectly true. Guards are provided at each end of the table, which cover the bearings and protect them from injury. A pan is cast integral with the table for controlling the water. The work-holding problem is simplified by the use of a rotary magnetic chuck which forms part of the equipment of this machine. The features of these chucks were discussed in connection with the description of this company's 22-inch vertical surface grinder, which was published in the September number of MACHINERY. At this point it may be stated that they combine accuracy, durability and a low power consumption; they are also absolutely waterproof, the drive units being located outside of the water guard, thus making it impossible for water to get into the chuck. Lubrication is effected by means of large self-feeding reservoirs.

The table is provided with an automatic reciprocating motion, the desired length of stroke being obtained by means of adjustable table dogs. The table feed mechanism is designed as a simple and compact unit, which is easily accessible. Two table feeds are provided, both of which are instantly controlled by means of a lever located at the front of the machine. When adjusted to the central station, this lever serves as a means for stopping the table; when placed in the upper position, the slow feed is engaged; and when located at the lower station, the fast feed is brought into action. The table is driven through a vertically located rack and pinion, the construction being such that the possibility of vibrations commonly called "tooth marks" showing in the work is eliminated.

One of the important features of this machine is mounting the wheel on an arm, which entirely eliminates the use of a slide construction. The arm is accurately fitted on an arbor, which, in turn, is supported by an upright at the rear of the machine. Both the arm and arbor are of ample proportions to insure absolute strength and rigidity. With this construction, the wheel is supported without overhang, and the control of the vertical wheel feed is also made a simple matter. Referring to the rear view of the machine, shown in Fig. 2, the arrangement of this method of supporting the wheel will be readily apparent, and it will also be seen that the arm has a liberal bearing upon the arbor, the bearing surfaces being dust- and water-proof. Both hand and power vertical wheel feeds are provided. The feed mechanism operates a screw, which engages the under side of the arm upon which the

wheel is mounted, thus adjusting its position as desired. Both the elevating screw and nut are of liberal proportions and made easily accessible; the power feed is obtained by means of a ratchet wheel and pawl which act in connection with the elevating screw. Provision is made for automatically disengaging the power feed and the feed may be accurately gaged by means of a large dial, the periphery of which is graduated to thousandths of an inch. The feed operates at the end of each stroke when the wheel is entirely clear of the work.

The wheel spindle is made of tool steel and is first carefully heat treated, and then ground and lapped to obtain the highest possible efficiency for this important member. The bearings are bronze bushed and mounted in conical seats; they are mad · and located in such a way that they are easily accessible for adjustment and absolutely dust- and water-proof. Particular care has been taken to obtain proper lubrication, large self-feeding oilers being provided for this purpose. The wheel-mount is self-contained and constructed in a way that insures having the wheel held securely and perfectly true. The end of the spindle is made conical to receive the wheel-mount, which is positively driven by means of a key. The machine is designed to use wheels up to 18 inches in diameter by 2 inches in width, but suitable packing rings are provided to permit the use of wheels down to a face width of 1 inch. The wheel spindle drive is of liberal proportions so that there is no question as to whether the wheel will have power for the most severe classes of service for which the machine is intended. Two speeds are provided by means of a two-step cone pulley so that when the diameter of the wheel is reduced by wear, its speed may be proportionally increased.

It is well known that in order to keep a grinding wheel cutting freely and to prevent the work from heating, a liberal supply of water is absolutely necessary. This point has been given careful attention and the pump that is used is made and located in a such a way that it entirely dispenses with the use of the customary type of idler pulleys. The pump is capable of delivering an abundant supply of water, which is drawn from a tank located at the back of the machine, where it is readily accessible for cleaning. The arrangement is such that the water is returned to the tank without being carried through pipes. This is characteristic of the design of the machine throughout, care having been taken to guard against the possibility of dirt or grit collecting in inaccessible places.

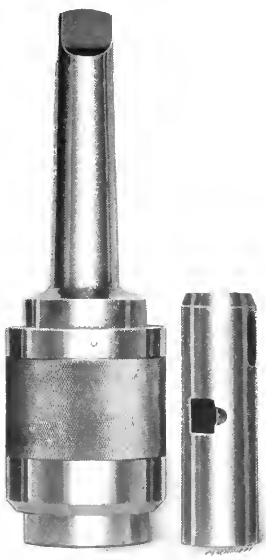


Fig. 2. The Wiard Chuck

The pipe through which the water is conveyed to the wheel, is attached to the guard and may be quickly adjusted or removed according to the requirements of different classes of work. Both the table and wheel are provided with guards to prevent water from being thrown onto the floor.

WIARD CHUCK

The Wiard chuck was originally made for the use of the Wiard Mfg. Co. This firm is engaged in contract work on automobile parts and the chuck was designed with the view of reducing the cost of various machining operations so that a profit could be made on contracts taken at a low price. The chuck proved to be so satisfactory that Mr. F. Wiard, 724 Ford Building, Detroit, Mich., recently decided to place it on the market. One of the larger sized chucks is illustrated in Fig. 2; the parts of the chuck are shown in Fig. 3, and Fig. 1 shows a cross-sectional view from which the construction will be readily apparent.

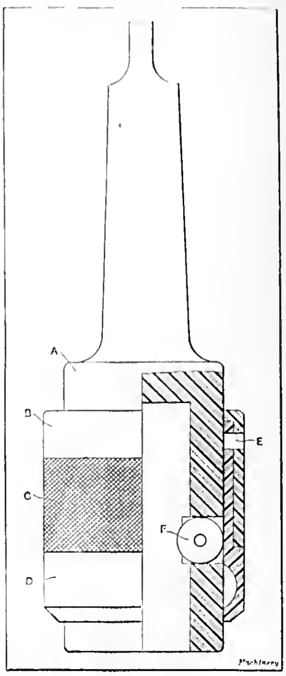


Fig. 1. Sectional View of the Wiard Chuck

Referring to the cross-sectional view, it will be seen that the body of the chuck *A* has a taper shank which fits into the drill press spindle. Surrounding this body is a sliding sleeve which is held in position by means of a pin in the body of the chuck which extends into a slot in the sleeve. The sliding sleeve is built up of three members, *B*, *C* and *D*; the parts *B* and *D* are secured together by means of a pin *E* while the knurled collar *C* is free to rotate around the chuck body. Two hardened steel disks *F* are held in place in the body of the chuck by means of pins which slide in transverse slots. This arrangement will be better understood by referring to the detail of the chuck body which is shown in Fig. 3. The purpose of these disks is to hold the collet in which the drill or other tool is mounted in position in the chuck and also to afford a positive drive. In order to set up a tool in the chuck, the operator takes hold of the knurled ring *C* with his thumb and finger and raises the sliding sleeve

Fig. 3. Parts of the Wiard Chuck

so that the hardened disks *F* are free to move back into the recesses in the sleeve. The collet is then pushed up into the socket in the chuck and when the sliding sleeve is pushed down, the disks *F* are forced into the recesses which are machined in the collet, thus providing a positive drive.

The chuck and collet are numbered according to the taper number of the drill. For instance, the No. 2 chuck takes drills up to 29/32 inch, which is the No. 2 taper limit. The shank of the No. 2 chuck is a No. 3 taper or one size larger than that of the drill; this standard is adhered to in all different sizes of the Wiard chuck. All of the wearing parts of the chuck and collet are hardened and ground to special gages. During a recent test, twenty-five holes were drilled in a cast-iron block 2¾ inches square by 1 inch thick. Two ¾-inch drills were mounted in collets and the operator used alternate drills for drilling successive holes. The twenty-five holes were finished in four minutes and 21½ seconds which shows the rapidity with which tools may be changed in this chuck.

WATSON-STILLMAN HYDRAULIC SHEAR

A horizontal hydraulic shear with a capacity for cutting 4½-inch steel cables has recently been placed on the market by the Watson-Stillman Co., 192 Fulton St., New York City. The machine is also capable of shearing a variety of large sizes of rolled steel, and its general arrangement will be readily understood by referring to the accompanying illustration.

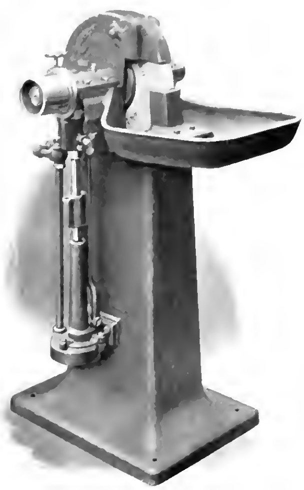
Watson-Stillman 175-ton Hydraulic Shear

It will be seen that the shear is mounted on a truck, upon which it may be conveniently moved about the shop to any position where shearing operations are to be performed.

The pump is entirely independent of the cylinder, and the valves and pump parts are easily accessible. In shops equipped with a hydraulic system, the hand pump may be eliminated and direct connection made with the high pressure pipe line. The ram and cutter are guided by a slide which runs in a groove machined in the frame of the shear. After the ram has completed its cutting stroke, the pressure is released by turning the handwheel on the pump, after which the ram is returned by a rack and pinion. The lever which actuates this rack and pinion movement is seen in the illustration extending out to the left. A spring is provided which absorbs the shock of the sudden jump forward which the ram makes at the instant of rupture, and thus protects the teeth of the rack and pinion from excessive strains. A gage is connected with the pipe line which supplies the machine in order to indicate the operating pressure at all times.

BLOUNT WET TOOL GRINDER

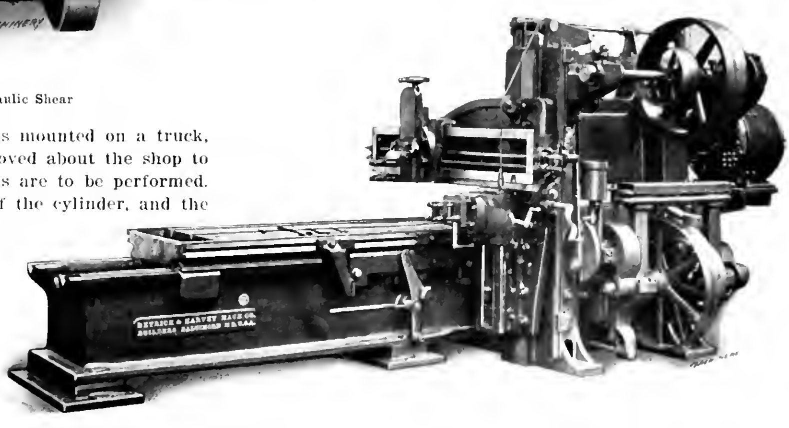
The accompanying illustration shows a 14-inch wet tool grinder, the design of which is similar to the machine equipped with a 30 by 3-inch wheel which was referred to in the July 1912 number of MACHINERY. The present machine, however, is of lighter construction and is intended to meet the requirements of shops having work for a smaller sized machine. It will be seen that a vertical centrifugal pump is provided which furnishes a constant supply of water the volume of which may be regulated to meet the requirements of different classes of work. The pump is driven by a friction pulley which engages a flange on the inner side of the main driving pulley. A sleeve covers the pump and encircles the pump shaft, extending above the water line. The purpose of this sleeve is to prevent water from leaking onto the floor without requiring the use of packing. The tank is located in the column of the machine and holds an ample supply of water; an opening is provided through which the tank may be cleaned if necessary. This grinder is a recent product of the J. G. Blount Co., Everett, Mass.



Blount 14-inch Wet Tool Grinder

DETRICK & HARVEY OPEN-SIDE PLANER

A 36-inch by 24-inch by 8-foot open-side planer which was recently built by the Detrick & Harvey Machine Co., Baltimore, Md., for use on the U. S. repair ships *Vestal*, *Panther* and *Culgoa*, is shown in the accompanying illustration. It will be seen that this planer is driven by an individual motor, a Morse silent chain being used for connecting the motor to the machine. The cross-rail is provided with one head which has horizontal, vertical or angular feeds by hand or power. A side head is also provided which has vertical hand and power feeds, and horizontal hand adjustment.



Detrick & Harvey 36-inch by 24-inch by 8 foot Open-side Planer

The bed is provided with substantial cross girts at frequent intervals and suitable lubricating devices for oiling the table vees. The vees are 21 inches between centers and each vee is 1½ inches wide at the top. The included angle of the vees is

90 degrees. The bed is 12 feet 8 inches long between the end pockets, and the bearings for the driving shaft are cast integral with the bed and provided with bronze bushings. The table is 32 inches wide by 8 feet long between the end pockets. Three T-slots are planed in it and a number of rectangular cored stop holes are also provided to facilitate securing the work in place. The table is gibbed down on both sides to prevent the possibility of its lifting.

The post is of box section and reinforced by extensions at the front and rear which extend to the full height of the post. The cross-rail is an L-shaped casting with the leg bearing on the face of the post, 11 1/4 inches wide by 51 inches long. The length of this vertical support of the cross-rail is about 1 1/3 times the length of the overhanging arm in order to give the necessary rigidity, and the horizontal portion of the cross-rail is cast integral with the vertical leg. The cross-rail is further supported by a triangular brace secured to the rear surface of the overhanging arm and extending to the inner face at the rear of the post. That part of the vertical leg of the cross-rail which projects downward from the horizontal slide-way, has a slide-way on its front face upon which the side-head is mounted. This reduces the distance from the cutting tool to the ultimate point of support, and does away with the use of a sliding saddle, when the side-head is mounted directly upon the post.

The feed mechanism is of the positive friction type, and only consumes power when in use. The drive is of the Sellers worm-gear type, the machine being driven by a 10 horsepower constant-speed motor which is direct-connected to the countershaft on the planer post by a silent chain drive. The countershaft revolves in a line parallel to the line of travel of the table and is belted to the planer pulleys. Power is transmitted through a pair of bevel gears to a diagonal shaft on which the multiple threaded worm is mounted, which engages the rack under the table. The cutting speed is 50 feet per minute and the return speed 90 feet per minute. The planer occupies a floor space not over 9 feet wide by 20 feet long, and weighs 21,000 pounds.

PAWLING & HARNISCHFEGER HOIST

The intensive methods of manufacturing that are used in modern industrial plants make efficient methods of handling material and product a matter of the greatest importance. Various systems have been developed for this purpose, among which different forms of cranes, hoists and trucks may be mentioned.

The accompanying illustrations show three forms of hoists which have recently been brought out by the Pawling & Harnischfeger Co., Milwaukee, Wis. Referring to these illustrations, it will be seen that the hoist shown in Fig. 1 is arranged for hook suspension; Fig. 3 illustrates a hoist with the truck operated by a hand chain; and Fig. 2 shows a hoist which is motor-driven and provided with controllers which may be operated from the floor. The frame of these hoists is of symmetrical design, the drum being located at the center and surrounded by a frame of cast steel. The motor of the hoist shown in Fig. 2 is secured to one side of the frame and the gear case is located at the opposite side.

The wire rope is of plow steel and proportioned to give a factor of safety of 5. The drum is flanged and provided with grooves of a depth equal to the diameter of the rope, so that the rope is not apt to jump out of the grooves even if the pull is in a sidewise direction. The standard lift of these hoists is 15 feet. The load brake runs at a moderate speed and is located so that a minimum number of parts is interposed between it and the drum. The load is automatically held at all times and cannot be dropped through carelessness of the operator or the interruption of current. In order to let the load down, the motor must be reversed.

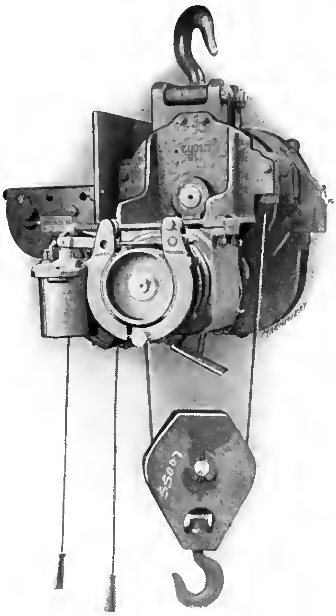


Fig. 1. Pawling & Harnischfeger Hoist arranged for Hook Suspension

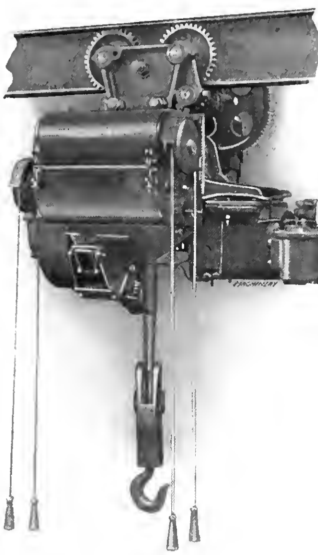


Fig. 2. Motor-driven Pawling & Harnischfeger Hoist

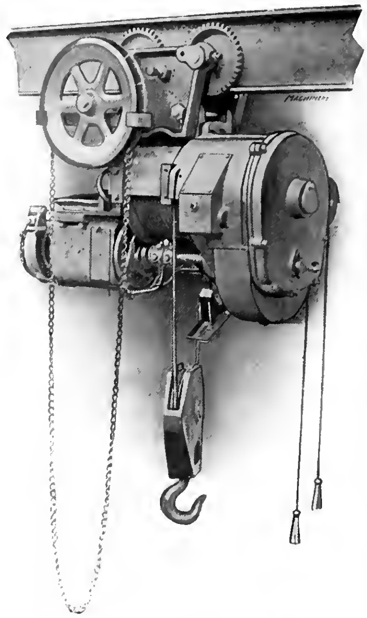


Fig. 3. Pawling & Harnischfeger Hoist operated by a Hand Chain

All of the gears are of cast steel and the pinions are of forged steel, both gears and pinions being hardened. The hoist gears and the load brake are enclosed in a dust- and oil-proof case and thoroughly lubricated by the splash system which gives them a high transmission efficiency and long life. Spur gears are used exclusively, as experience has shown them to be the most satisfactory for this class of service.

The truck is bolted to the cast-steel drum frame and the truck wheels are drop-forgings. The chain wheel, which is used on the hand-driven truck, is provided with a chain guard; and on the motor-driven truck the four truck wheels are driven to facilitate running over short curves. The motor used on the hoist shown in Fig. 2 is provided with a substantial asbestos lined solenoid brake, which will stop the motor promptly after the controller has been moved to the off-position. When the bottom block reaches the highest position, it strikes a limit switch which shuts off the current and brings the motor to a stop by means of the motor brake. A load cannot be hoisted any higher but it can be lowered in the usual way, and as soon as the load is let down, the limit switch re-sets itself automatically. Direct-current motors manufactured by the Pawling & Harnischfeger Co. are used on these hoists. These motors are especially designed for crane

service and run at a moderate speed. Alternating-current motors can be furnished if so desired.

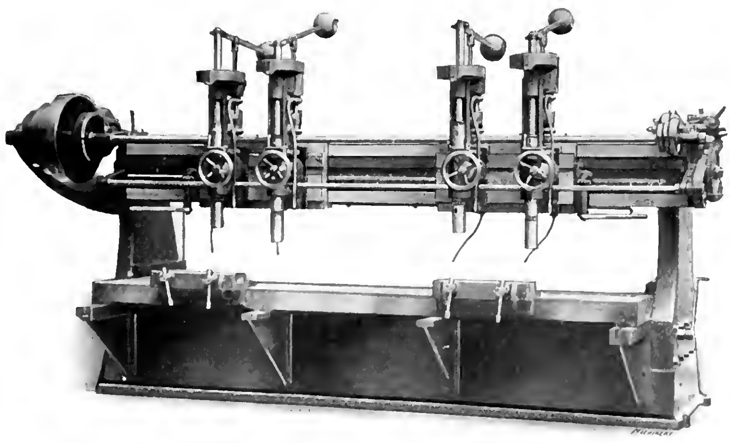
The controller used on these hoists is of the drum type and is provided with a large number of speed points. The use of single-speed controllers is not recommended as they do not permit of any speed regulation and are out of the question where any degree of precision in handling the load is required. They have the further draw-back that the contact points burn off rapidly, and in the long run repairs and renewals cost more than the original cost of a multi-speed controller.

The combination of a multi-speed controller, a substantial solenoid motor brake and a liberally proportioned load brake gives an efficient speed control to these hoists. Particular care has been taken throughout the design, to make all parts of the mechanism readily accessible for adjustment. The motor, gear case and controller are separate units and can be removed independently. The load brake or any of the gears can be removed without disturbing other parts of the hoist.

FOOTE-BURT FLUE SHEET DRILL

The four-spindle drilling machine illustrated herewith is an addition to the line of machines manufactured by the Foote-Burt Co., Cleveland, Ohio. This machine is styled a No. 2 mud-ring and flue-sheet drill and is particularly suited for the requirements of railroad locomotive boiler shops and general boiler shops, for use in drilling the rivet holes around a mud ring or for cutting out the flue holes in a flue sheet. The spindles are of the independent feed type, each spindle being provided with an automatic knock-off for the power feed and quick return of the spindle by a handwheel located at the front of the head. Each spindle is also provided with a clutch for starting and stopping, and an interlocking mechanism, so that the feed cannot be thrown in with the spindle stopped or *vice versa*. With this independent feed mechanism it is possible to have some of the spindles drilling while the operator is setting the other spindles so that a high efficiency of both the machine and operator is obtained.

The spindles are arranged in pairs which are mounted on auxiliary cross-rails, and the spindles are adjustable on these cross-rails to a minimum center distance of 8 inches. The advantage of this feature is that it is possible to set the spindles to the proper spacing of the rivet or flue holes and then adjust two spindles along the main rail of the machine, thus maintaining the proper spacing and eliminating the

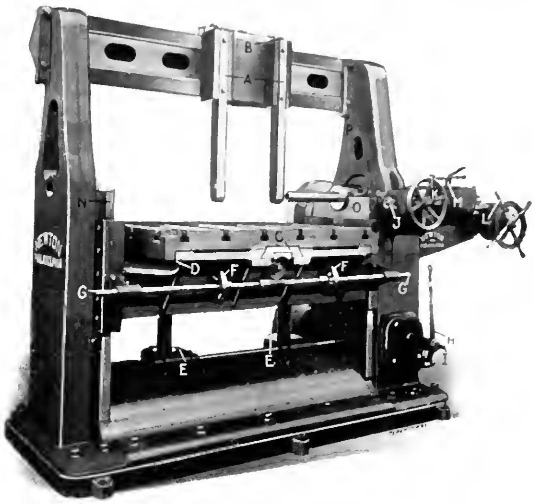


Foote-Burt No. 2 Mud-ring and Flue-sheet Drill

necessity of spacing each spindle individually. The spindles overhang the front edge of the base 8 inches to take care of the mud ring work, and the table is provided with chucks for holding the mud rings. The table has an in and out movement of 36 inches and is supported under the spindles by bracket slides on the front of the base. Three changes of power feed are provided, any one of which is instantly available by simply shifting a lever at the right-hand end of the machine. Six changes of speed are provided by means of the three-step cone and throw-out back gears. The weight of the machine is approximately 21,000 pounds.

NEWTON TOOL-ROOM BORING MACHINE

The accompanying illustration shows what is known as a tool-room boring machine, which has recently been added to the line of the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine is intended for boring operations on jigs and fixtures, and for other classes of work where a high degree



Newton Tool-room Boring Machine

of accuracy is required. One of the noteworthy features of the design is the "aerial" cross-rail which is provided with an adjustable slide on which the boring bar supports *A* are mounted. These supports are interchangeable, and they are made in a number of irregular shapes to provide for supporting the bar in positions which would otherwise be inaccessible. In addition to the side bearings in the slide, an end stop is provided to insure accurate alignment.

The cross adjustment of the table is provided by a narrow guide *C* which has a double taper bearing in the saddle, and end locking gibs *D* are employed to hold the work table securely to the saddle. The knee is raised or lowered by screws *E*, and the bearings for these screws are exceptionally long to provide the necessary rigidity. The cross movement of the table is obtained through a worm and worm-wheel and a fine pitch screw controlled by means of handwheels *F*, while a more rapid adjustment is obtained with a wrench on the square ends of the spline shaft *G*.

Power elevation of the knee is controlled by the lever *H* and hand elevation and fine hand adjustments are obtained by a wrench on the square end of the shaft *I*. The feed motion of the spindle is engaged by the arm *J*; slow hand adjustment of the spindle is obtained by means of wheel *K* and fast hand adjustment through the wheel *L*. The gear feed changes are controlled by the latch lever *M*, which operates the movable sleeves on which the gears are mounted and gives the changes without requiring the removal of gears. The alignment of the knee supporting the table is insured by four side bearings on the uprights, one of which is shown at *N*, and the end thrust is taken on bearings *O* on the upright. It is, of course, understood that the rail support *P* is independent of the spindle cap.

The following gives a brief description of the mechanical features of this machine: The spindle is 3 inches in diameter

and has a No. 5 Morse taper. it is driven by a sleeve having a bearing on each side of the driving worm-wheel, and is arranged to drive cutters or a boring bar with a broad faced key. The length of the boring bar is 6 feet 8 inches and the length of the continuous feed which may be obtained is 24 inches. The spindle sleeve is driven by a steep pitch bronze worm-wheel provided with ball thrust bearings. The spindle speeds vary from 12 to 120 revolutions per minute. Power is supplied by a General Electric $5\frac{1}{2}$ horsepower motor running at from 375 to 1125 revolutions per minute. A double step cone pulley for a 4 inch belt is used to transmit the power to the machine. The work table is 60 by 48 inches in size and provided with the customary T-slots to facilitate clamping and to accommodate parallels. In addition to the T-slots shown in the illustration, there are four additional T-slots in the table running parallel with the spindle of the machine. The maximum distance from the end of the spindle to the outer upright is 72 inches; the minimum distance from center of the spindle to the top of the table is $1\frac{3}{4}$ inch and the maximum distance is 24 inches. The net weight of the machine is 22,000 pounds.

ACME FLAT TURRET LATHE

The illustrations show what is known as a combination flat turret lathe, that is a recent product of the Acme Machine Tool Co., Cincinnati, Ohio. The term "combination" is applied to this machine because it is adaptable to both bar and chucking work. A complete view of the machine arranged for chucking operations is shown in Fig. 1, while Fig. 2 shows the head end of the machine provided with a collet chuck to adapt it for bar work. The maximum capacity for bar stock is $3\frac{1}{4}$ inches in diameter by 36 inches in length, while all classes of chucking work up to 16 inches in diameter can be handled. The actual swing over the bed of the lathe is 22 inches. The bed is of deep and heavy section and is strongly ribbed to withstand the cutting strains when the maximum pulling power of the all-geared head is being utilized. The pan blocks and tank are cast integral with the pan, which is of unusual depth and capacity. A perforated cover serves as a strainer which allows the oil to drain off the chips and flow back into the tank. A geared pump provides an ample supply of oil when the machine is running.

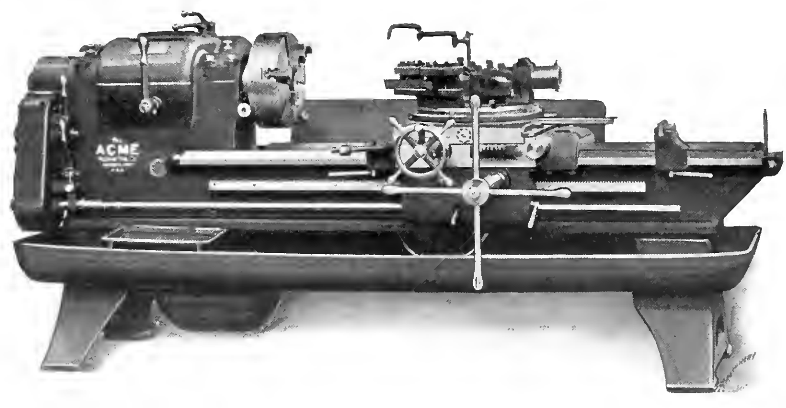


Fig. 1. Acme Flat Turret Lathe arranged for Chucking Operations

Nine changes of speed are provided by the geared head which is of simple construction. The available speed range is from 14 to 285 revolutions per minute, the changes being quickly obtained by means of two levers located at the front of the head. The head is cast integral with the bed which simplifies the construction and also insures the permanency of the alignment of the spindle with the vees upon which the carriage travels. The spindle is made of high carbon crucible steel and may be instantly started, stopped or reversed by means of a double cone friction operated by a lever at the front of the head. The drive is taken from a single pulley 12 inches in diameter, which runs at 600 revolutions per minute and carries a $3\frac{1}{2}$ inch belt. The positive automatic chuck for holding bar work is illustrated in Fig. 2; it can be opened and closed while the machine is running, by means of the long lever at the front of the head. The distinctive feature of this chuck is that the work does not have end motion while the chuck is being closed so that accurate shoulder lengths can be produced. The master collet parts which hold the jaws are secured against the closing ring, which prevents dirt or chips from getting between them. The jaws do not collapse and extremely short work can be held

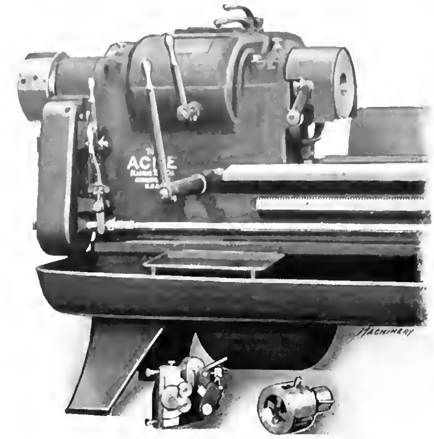


Fig. 2. Acme Flat Turret Lathe for Bar Work

without tilting; adjustment for variations in diameter 1/16 inch larger or smaller are provided. The jaws can be easily removed without dismantling the chuck, and to insure accuracy and long life all working parts of the chuck are hardened and ground. The simplex roller feed is extremely simple in design and operation, only one adjustment being necessary. By adjusting the jaws to the required size with a spanner wrench and then releasing them slightly, the rollers will be given the proper tension. The roller feed is operated by the same lever which actuates the automatic chuck.

The cross-sliding turret revolves on a hardened and ground stem of large diameter and is automatically locked in position by a hardened and ground taper plunger located directly underneath the cutting tool. This plunger enters hardened taper bushings in the turret, and the turret is further held down at the extreme outer edge by means of circular clamps. The oiling arrangement is such that lubricant can be delivered to each individual tool. The cross-slide moves on a long narrow dovetailed guide with flat bearing surfaces on each side and has an adjustable gib to compensate for wear. A hardened center stop is also provided. The cross-feed, which is operated by hand or power in either direction, is provided with a graduated pilot handwheel to facilitate the production of duplicate work. The saddle has a continuous bearing on two vees of the bed and the swinging stock stop is attached at the front of it. One independent stop is provided for each turret face and there are also six auxiliary stops which are operated by a knob on the front of the saddle. These can be used in any desired combination with the independent stops. Eight stops are provided for the cross-feed, which are controlled by a knob on the front of the slide; these can be used to advantage in conjunction with the graduated pilot wheel. The stops are arranged to trip the power feed in either direction and when chuck work is being handled, as many as seven different lengths can be turned without indexing the turret. Safety stops are provided to trip the power

feeds in all directions and all working parts are protected from dirt and chips. The feed for both the longitudinal and cross movements is of the all-geared type; and all feed changes are instantly obtainable by means of the lower lever on the head-stock, while the upper lever provides for reversing the feeds. The feeds can be changed or reversed without stopping the machine.

The apron is of the double-wall construction, with all shafts and studs supported at both ends. It is securely bolted and keyed to the bottom of the saddle and provides a double bearing support for the feed-rod which is driven by a knuckle-joint coupling at the head end. By referring to the illustrations in connection with the preceding description, it will be readily seen that all of the operating levers on this lathe are located in positions where they may be conveniently reached by the operator. In this way, the time between operations is reduced to a minimum. Similarly, all oil holes are easily accessible and of a type which makes it impossible for dirt to find its way into the bearings. The machine is driven by a 5 H. P. constant speed motor which is operated at from 1200 to 1800 revolutions per minute. A convenient arrangement is to mount the motor on a sliding base on the floor and belt it directly to the driving pulley on the machine.

BRADFORD EIGHTEEN-INCH LATHE

In the March, 1912, number of MACHINERY, a motor-driven lathe built by the Bradford Machine Tool Co., Cincinnati, Ohio, was illustrated and described. The accompanying illustrations show a lathe of similar design which has been brought out by this company, the distinctive feature of the present machine being the application of single pulley drive through the geared head. Where the lineshaft is suitably located, a single pulley on this shaft affords a satisfactory arrangement for transmitting power to the machine. The regular equipment, however, consists of the usual double friction countershaft having both belts driving forward, or if more convenient having one belt for reversing. In some cases, a triple friction countershaft is used which affords sixteen forward and eight reversing speeds for the machine.

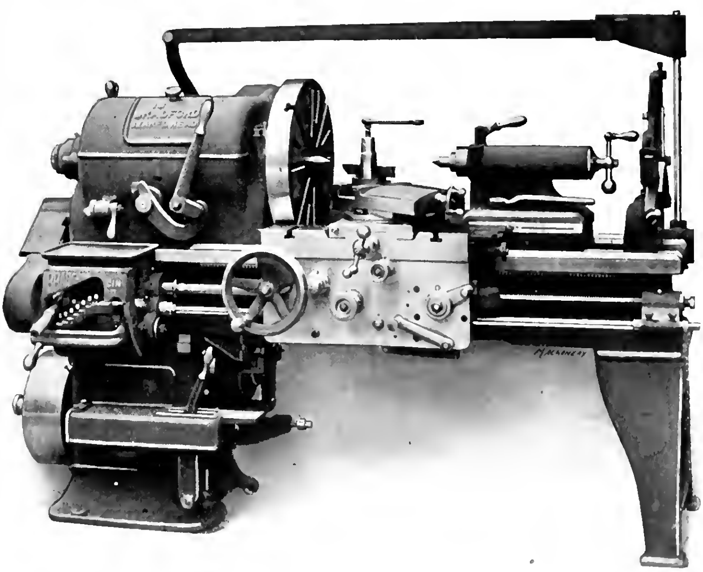


Fig. 1. Bradford 18-inch Lathe with Single Pulley Drive through Geared Head

An end view of the lathe is shown in Fig. 2, in which the arrangement of the single pulley drive is clearly shown. Referring to this illustration, it will be seen that the driving pulley is provided with a friction clutch which is controlled by a shifter pole running the full length of the lathe. This affords a convenient means of releasing or engaging the clutch on the initial driving pulley when making changes. A lever on the head is used for stopping or starting the lathe when it is required to make inspections or remove the work. The idler pulleys are mounted on a frame which may be adjusted downward and this adjustment provides for regulating the tension of the endless driving belt which is employed.

A selective type of speed box is used which consists es-

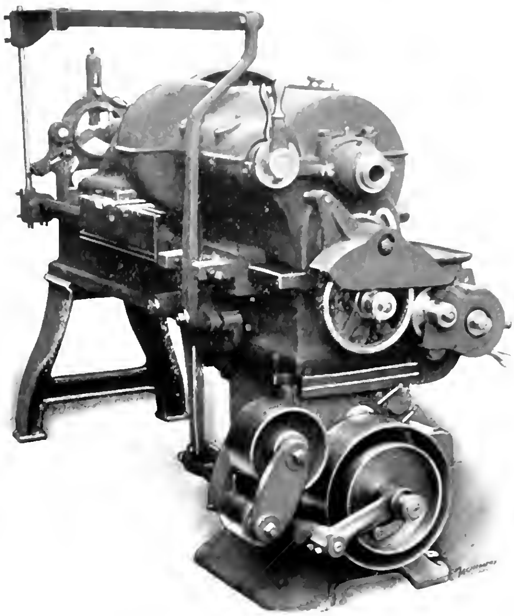


Fig. 2. End View of Bradford Lathe showing Arrangement of Single Pulley Drive

sentially of two shafts and eight gears, so that four changes are provided. Four gears are mounted on each shaft, those on the lower shaft being arranged in two groups, each containing two gears. Each of these pairs is made to slide independently of the other pair, by means of a single lever and two shifting forks. The shifting lever is so arranged that it is impossible for two gears to be engaged at the same time, and the gear shifting mechanism is positively and automatically locked when the lathe is running. This makes it impossible for the gearing to be damaged by a careless or inexperienced operator. The lower speed box shaft is extended to the left to carry the initial driving pulley, while the upper shaft in the speed box extends to the right and has a Morse silent-chain wheel mounted on it for transmitting power to the lathe head. The available spindle speeds are clearly marked on the speed plate opposite the four positions of the speed box lever. These four changes in connection with the right- and left-hand positions of the lever on the head, give all of the spindle speeds that may be obtained.

The lathe head is illustrated in Fig. 3 with the cover removed in order to show the arrangement of the gearing. It has already been stated that power is transmitted from the speed box to the head by means of a Morse silent chain drive. The Morse chain wheel is mounted on a short shaft upon which there is a gear which transmits the power to a friction driven gear on the main spindle. This spindle gear meshes with the first gear on the back shaft and the second back shaft gear transmits power to a positive clutch driven gear on the spindle. A lever on the head controls both the friction and positive clutches which engage the high and low speed gears on the spindle.

The change gears are of the standard Bradford type and give an ample range of feeds. All standard and pipe threads

can be cut and only one lever is required for making the changes. When not in use, the worm-wheel on the chasing dial may be swung out from the lead-screw to an inoperative position, so that unnecessary wear is avoided. The feeds are all positive geared through the feed-rod and any desired feed can be instantly engaged. The lathe has friction cross feed and also friction transverse feed for the carriage. An automatic stop is provided which may be placed in any position on the feed-rod. When required, a lead-screw and change gears to conform to the metric system may be provided on this lathe. The lead-screw is cut from a master-screw and is not splined, as a feed-rod is employed to save wear on the lead-screw and nut. The nut is made of phosphor-bronze and is tapped in a way which provides a high degree of accuracy.

The spindle is made of high-carbon crucible steel and is bored straight through from one end. The outside of the spindle is then turned parallel with the hole, after which it is finished by grinding. The tailstock is of the overhanging pattern which permits the use of the compound rest at right angles when turning between short centers. The tailstock can be set over for taper turning and the clamping arrangement is of a design which insures ample rigidity. The base of the compound rest is graduated in degrees and the wearing

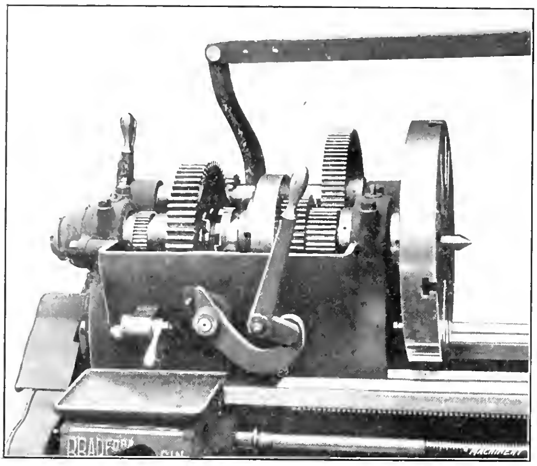


Fig. 3. Head of Bradford Lathe with Cover removed to show Arrangement of Gears

surfaces are liberally proportioned. The carriage has a full bearing on the vees for its entire length and is gibbed front and back. The apron is of the double-plate pattern and is provided with a non-interfering device so that the feed-rod and lead-screw cannot be engaged simultaneously.

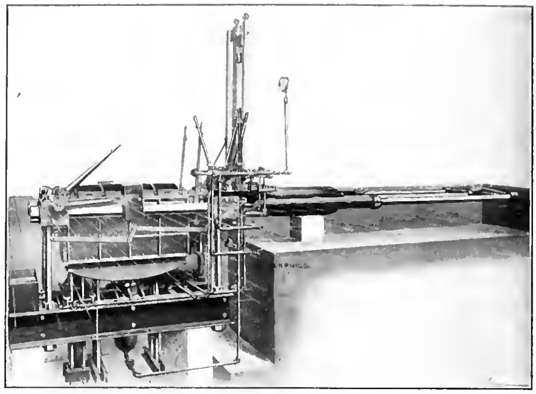
HYDRAULIC BALING PRESS

The horizontal baling press shown in the accompanying illustration constitutes a recent addition to the line of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. It will be seen that this press is hydraulically operated; the machine is intended for baling scrap sheet metal and is capable of exerting pressures up to 200 tons. It can be used on scrap metal up to No. 10 gage.

The press is installed so that the top of the box is flush with the floor line. This makes it an easy matter to fork the scrap into the press without having to lift it. The box is 60 inches long by 20 inches wide by 30 inches deep, and the normal size of the bales produced in the press is 10 by 12 by 20 inches. The cast-steel door which forms the top of the box is counterbalanced and can be easily moved with the hand lever provided for that purpose.

The press is equipped with two hydraulic cylinders for pressure purposes, one of these cylinders being used for compressing the material against the top of the box and the other for compressing it against the end of the box. Two auxiliary cylinders are connected with the horizontal pressure cylinder for use in returning the horizontal ram. After the platen which constitutes the bottom of the box has completed its forward movement, it is locked in position by two hydraulically operated bolts which enter each end of the platen. These bolts prevent the platen from tilting while the horizontal pressure platen travels across it to compress material against the end of the box.

In the head end of the lower platen which forms the bottom of the box, there is a small ejecting platen operated by a 4-inch ram. The ram works in an ejecting cylinder located on the sills in the head end of the press. As the lower platen



Horizontal Hydraulic Press for baling Sheet Metal Scrap

travels upward, it carries the ejecting platen and ram with it. This permits the 4-inch cylinder to fill from the pump reservoir by gravity. As soon as the scrap metal has been pressed into a bale, the door constituting the top of the box opens automatically and pressure is then applied to the ejecting cylinder. This causes its ram and platen to rise and lifts the bale out of the box to the level of the floor line so that it can be easily moved.

The valve equipment required for operating all of the members of this hydraulic baling press is controlled by an interlocking device which compels the operator to throw each lever in its proper order. It is impossible to operate the machine in any other way. There is also a "tell-tale" board with an indicator governed by cables attached to the moving part of the press, which enables the operator to see the positions of the vertical and horizontal pressure platens at any moment during the period of operation.

ONEIDA DRILL CHUCK

Two styles of ball bearing drill chucks which have recently been added to the line of the Oneida National Chuck Co., Oneida, N. Y., are illustrated in Figs. 1 and 2. The general arrangement of these chucks is similar to that of a chuck which

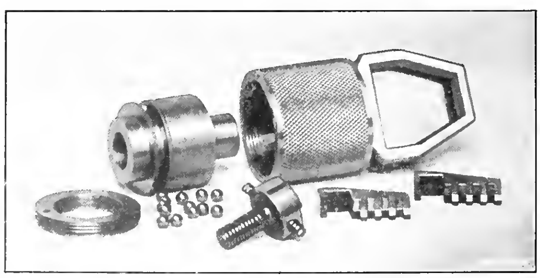


Fig. 1. Parts of the Oneida Ball Bearing Drill Chuck

this company has been manufacturing for several years. The improvements in the present design consist of having the jaws tightened on the shank of the drill through the resistance of the cut, instead of using a wrench for this purpose; and in having a ball bearing between the chuck body and the outer sleeve, so that the chuck may be readily opened by hand. Fig. 2 shows the style of chuck which is made for handling 1/4, 3/8 and 1/2-inch drills, while the parts of the open-body type of chuck for handling 3/4 and 1-inch drills are illustrated in

Fig. 1. Both the open- and closed-body chucks operate on the same principle.

In mounting a drill in this chuck, the drill is slipped into place between the jaws, and the knurled sleeve is then turned to bring the jaws into contact with the shank. A loose grip is secured in this way and the drill press is then started. As the drill begins to cut, the resistance continues the tightening of the jaws so that an adequate grip is secured. One of the features of this arrangement is that the grip on the drill increases with the resistance offered by the cut, so that the grip is proportional to the severity of the service. The chuck is opened by turning a knurled sleeve in the reverse direction.

Fig. 2. Oneida Drill Chuck

It will be evident from the illustration that the operation of the chuck jaws is effected by turning a screw which fits in the chuck body. The flange at the lower end of this screw fits into slots at the upper ends of the chuck jaws, and raises or lowers them in contact with the tapered surfaces of the chuck body. In tightening the chuck, the flange is lowered and the jaws forced down on the taper, causing them to close on the shank of the drill. When the knurled sleeve is turned in the reverse direction, the flange and chuck jaws are raised and at the same time forced out of contact with the drill by means of the two coiled springs shown in Fig. 1.

LANDIS STATIONARY PIPE DIE-HEAD

A stationary pipe die-head which is made in 4- and 8-inch sizes by the Landis Machine Co., Inc., Waynesboro, Pa., is shown in the accompanying illustration. This die-head consists of four essential parts which are: the body or the head that carries the chaser-slides; the chaser-slides; the operating ring which imparts the oscillatory movement of the handle to the chaser-slides to give the chasers a radial movement to or from the center; and the chasers.

It will be seen that six chasers are employed which are inclined to the work to agree with the pitch of the thread that is required. The chasers are milled from flat bar steel

Landis Stationary Die-head made in 4- and 8-inch Sizes

and are hardened for their entire length. They have line contact with the work which reduces friction to a minimum and permits the use of high cutting speeds. When dull, the chasers are ground on their front ends and then moved forward in their holders the necessary amount, the correct cutting position being determined by means of a small hook gage. The rake can be ground to suit the nature of the material that is being threaded. The throat is permanent, allowing close shoulder work to be handled.

Each chaser is gripped in its holder by a clamp that engages the upper side of the dovetail on the back of the tool and draws it down onto a solid seat. The chasers are removed for grinding by loosening the two screws which tighten each of the clamps. The head is manually operated by means of a bell-crank lever which moves the chaser holders to or from th center on radial lines. The holders are incorporated in the head, thus limiting their use for either right- or left-hand threading. The head is made of steel and graduated for all sizes of pipe within its range.

During a recent test of one of these die-heads, a cutting speed of 40 feet per minute was maintained on pip s varying in size from ¾ inch to 2 inches. An important feature of this die-head is that one set of chasers covers the entire range of pipe sizes for a given pitch, so that it is unnecessary to remove the chasers from their holders except for the purpose of grinding. Another feature which tends toward economy is that one or more chasers can be replaced without requiring an entirely new set to be purchased. This die-head is suitable for threading all kinds of pipe such as iron, brass, steel or copper.

DAVIS-BOURNONVILLE RAILAGRAPH

The Davis-Bournonville Co., 30 Church St., New York City, has added to its line, the oxy-acetylene rail cutting machine shown in the accompanying illustrations. This equipment is known as the "railagraph" and is made for cutting different forms of electric traction and steam railroad rails. It can be used on a rail in position in the road bed.

The machine consists of a stand which is clamped on the rail to be cut by means of a hand lever that actuates an eccentric binder. On each side of the rail, a bracket is provided in

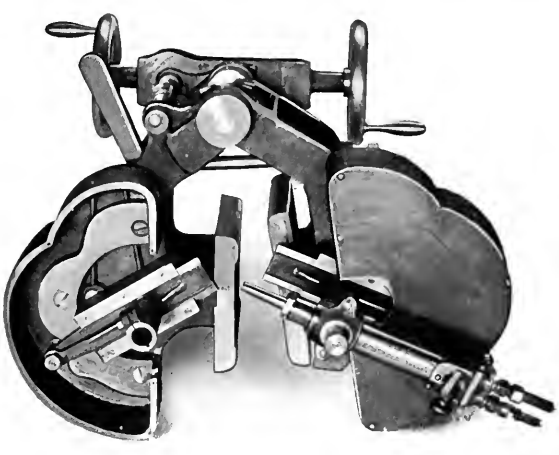


Fig. 1. Davis-Bournonville Rail Cutting Machine

which the cutting torch can be mounted. This bracket is secured to a slide which has a roller attached to it; and the roller is held in contact with a cam by means of a tension spring. Different forms of cams are provided for cutting different styles of rails, the purpose of the cam being to regulate the position of the slide so that the point of the torch is held at a distance of about ⅛ inch from the work while it is being fed over the line on which the rail is to be cut off.

The machine is driven by hand, the small handwheels at the top being used for this purpose. The power is transmitted through a pair of bevel gears, a worm and wheel, a second pair of bevel gears and then through a pair of spur gears to the shaft upon which the torch-slide is mounted. By rotating the handwheel, the torch is made to travel over the rail and as previously stated, the cam and slide arrangement holds the ends of the torch at the required distance from the work.

In operation, the torch is first applied at one side of the rail and fed over the line on which it is to be cut, one half of the base, the entire web and one half of the rail surface being cut by this operation. The torch is next removed from the holder and mounted at the opposite side of the rail; it is then passed over the work the second time in order to cut the remaining halves of the base and rail surface. An idea

of the rapidity with which this cutting-off machine operates may be gathered from the fact that during a recent exhibition, a 9-inch electric traction rail was cut off in a few seconds over three minutes, with a consumption of 2 cubic feet of acetylene and 5½ cubic feet of oxygen. A comparison between this time and the time required to cut off such a rail with a hand hack-saw will readily show the desirability of using an

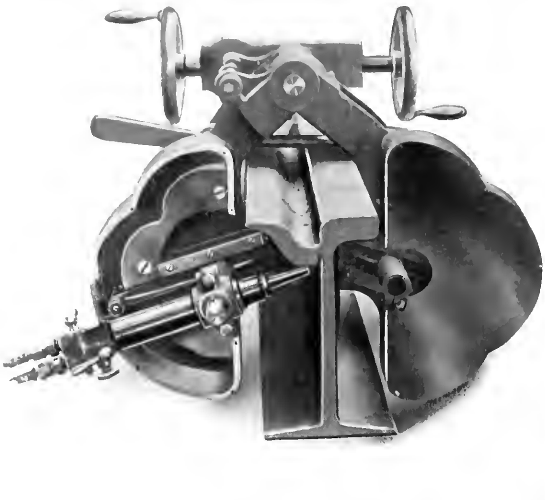
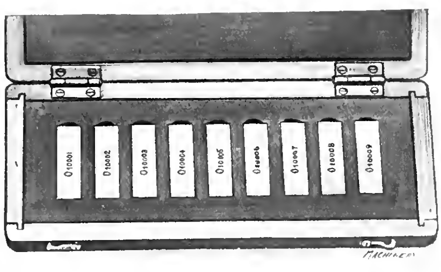


Fig. 2. Davis-Bournonville Machine in Position for Cutting

oxy-acetylene equipment for work of this kind. The standard Davis-Bournonville machine cutting torch is used on this machine, except that for rail cutting the torch is made about 2 inches shorter than the standard dimension. In using this equipment, the oxygen is used at a pressure of 50 pounds per square inch.

JOHANSSON GAGES

The Johansson Swedish gages are widely used in this country as a standard for use in tool-rooms and for other classes of work where accuracy is required. As most mechanics know, these gages are made in series, the sizes of which differ by ten thousandths, thousandths and hundredths of an inch. A new set of gages has just been brought out, consisting of a series of nine blocks ranging in size from 0.0201 to 0.0209 inch;



Special Set of Johansson Gages varying in Size by 0.00001 inch

a series of nine blocks, ranging in size from 0.021 to 0.029 inch; and a series of nine blocks ranging in size from 0.010 to 0.090 inch. By using different combinations of blocks, every size from 0.03 inch can be obtained.

The extreme accuracy with which these gages are finished by the processes which Mr. Johansson developed for their manufacture is shown by the fact that several special sets of gages have recently been made with a variation of 0.00001 inch between each of the nine blocks in the series. It has been stated by Mr. Johansson that these blocks were accurate within 0.000001 inch of the required dimension. Such a degree of accuracy is not required in most shops where Johansson gages are used, but it illustrates the perfection of the method by which all of these gages are finished and is consequently a strong recommendation for their use in cases where the greatest accuracy is required. The Johansson gages are being distributed in the United States by the Gronkvist Drill Chuck Co., 20 Morris St., Jersey City, N. J.

PORTER-CABLE UNIVERSAL MILLING ATTACHMENT

For several years, the Porter-Cable Machine Co., Syracuse, N. Y., has been manufacturing a No. 3 belt-driven universal milling attachment. The results obtained with this tool have been entirely satisfactory, but for heavier classes of work a positive driven attachment is required. To meet the requirements of such classes of service, a No. 4 gear-driven attachment, shown in the accompanying illustrations, has recently been placed on the market. The attachment is shown set in vertical and horizontal positions in Figs. 1 and 2 and a partial cross-sectional view is shown in Fig. 3, from which the arrangement will be readily understood.

The attachment is mounted on the milling machine by means of a driving arbor inserted in the spindle. This arbor

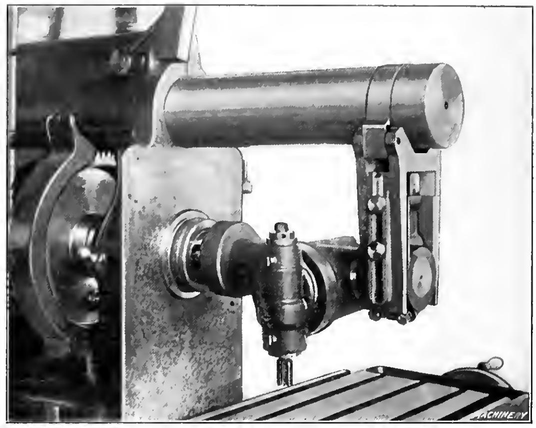


Fig. 1. Porter-Cable Universal Milling Attachment set in Vertical Position

has either No. 9, 10 or 11 B. & S. taper as desired. The driving gear is mounted on the arbor and meshes with a pinion on the countershaft contained in the frame of the attachment. This arrangement is shown in the partial sectional view. After the arbor has been placed in the spindle of the milling machine, the outer end is supported and held in place by means of a telescoping clamp and flexible steel strap which passes around the overhanging arm. This clamping mechanism is made ad-

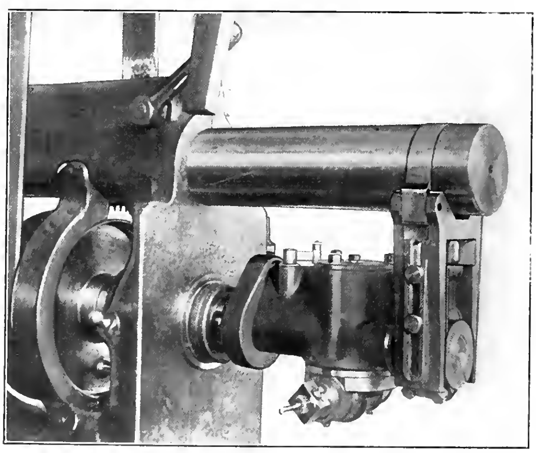


Fig. 2. Universal Milling Attachment set in Horizontal Position

justable to provide for the varying distances between the centers of the spindle and overhanging arm of different sizes of milling machines, so that the attachment can be used on more than one size. This means a considerable economy, as

one attachment may be used on several machines which may have an occasional job for which it is required.

Referring to the illustrations, it will be seen that the attachment is universal in that it may be operated at any angle in any plane. The required setting is obtained by means of graduated dials on the spindle housing and main frame, which read to 90 degrees on either side of the zero mark. Bosses or lugs are also located on the front of the spindle housing; these bosses are accurately machined in line with the center of the spindle and by using a square or protractor, a very accurate setting may be obtained.

A particularly valuable feature of this attachment is the reversing mechanism which is clearly shown in Fig. 3. The

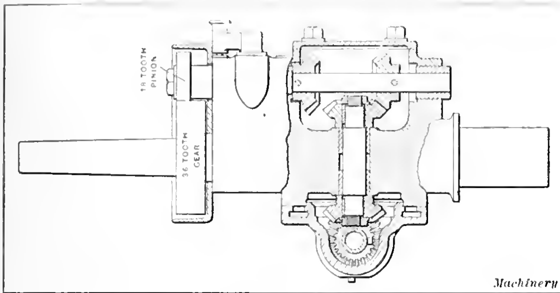
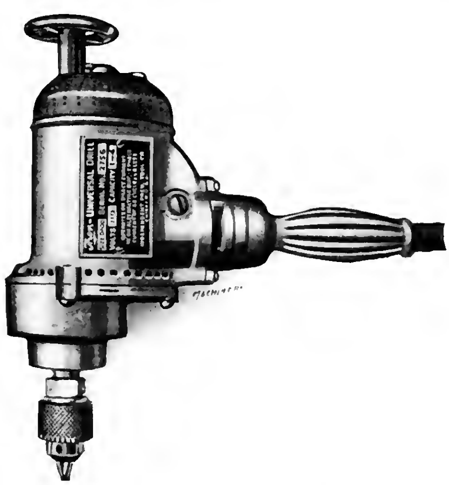


Fig. 3. Partial Sectional View of Porter-Cable Universal Milling Attachment

control of the position of the shaft is effected by a bronze sleeve which forms the inner bearing for the shaft. This sleeve has rack teeth cut on its upper side which mesh with a pinion that is integral with the stem of a small locking lever shown in the illustration. By this means, either of the bevel gears may be engaged to adapt the attachment for using either right- or left-hand mills, without regard to the direction in which the milling machine is running. All of the gears in the attachment are of steel and the miter gears which operate the cross shaft and spindle have planed teeth. The countershafts and spindle are hardened and ground and the spindle bearings are carefully scraped to an accurate fit. This attachment has a capacity for end mills up to $1\frac{1}{4}$ inch in diameter.

THOR PORTABLE ELECTRIC DRILLS

The Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill., has recently brought out two sizes of portable electric drills, one of which is shown in the accompanying illustration. The principal feature of these drills is that they are equipped with universal motors so that they can be attached to an



Thor Portable Electric Drill made with a Grip Handle

ordinary incandescent lamp socket of 110 or 220 volts, direct current, or single phase alternating current of 60 cycles or less. The drills are made with a hand grip of the type shown in the illustration or with a breast plate.

The spindle and armature shaft is supported on roller and ball bearings and the revolving parts are carefully balanced so that there is no vibration at the high speed for which the tools are designed. The brush holders are self adjusting and the commutator may be easily removed for cleaning by simply unscrewing one nut. The motor is air cooled by a fan which draws air in through the holes in the cover. The air passes around the motor and is ejected through the small holes which will be seen at the bottom of the case. Drills of this type are made in two sizes which have capacities for drilling holes up to $\frac{1}{4}$ and 5/16 inch in steel.

SMITH & MILLS CRANK SHAPER

In the issue of MACHINERY for February, 1909, a crank shaper built by the Smith & Mills Co., Cincinnati, Ohio was illustrated and described. The machine shown in the accompanying illustration is a more recent product of the same company and is constructed along the general lines of the preceding type of shaper referred to, the improvement consisting of a single pulley drive and change gears which have been applied in place of the cone pulley. This speed changing mechanism is simple and efficient, the control being located within convenient reach of the operator who is able to make any required changes without moving from his position at the front of the machine. The changes in cutting strokes are obtained by four pairs of gears, which are thrown into mesh by the aid of suitable shifting levers. The four changes

Smith & Mills Crank Shaper with Single Pulley Drive and Change Gears

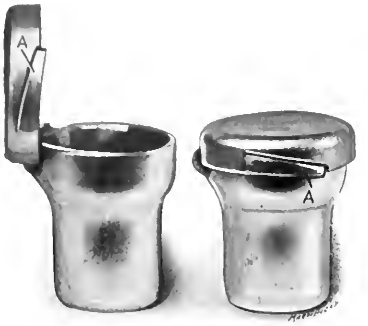
obtained in this way are supplemented by the back gears located inside the column of the machine. The back gears are engaged or disengaged by a conveniently located handle, and in connection with the change gears give a total of eight changes to meet the requirements of different classes of work.

The main driving shaft runs in a bearing which is bolted to the back of the column of the machine, as shown in the illustration, and the friction driving pulley is located at the opposite end of this shaft from the change gear box, where it is out of the operator's way. The speed box has three shafts, two of which carry sliding gears that are shifted by the levers shown in the illustration, one at the back and the other to the left of the handwheel. The handwheel provides for revolving the gears by hand when making changes. The gears run in oil so that both the gears and bearings in the speed box are thoroughly lubricated at all times. This speed box arrangement makes the machine particularly well suited for motor drive. The motor may be either bolted to the floor behind the machine and belted to the friction pulley, or a pad can be attached to the base of the machine, upon which

the motor is mounted and connected to a gear on the driving shaft by means of a rawhide pinion. Plain crank shapers of this type are built in 12, 14 and 16-inch sizes, while back-geared crank shapers—one of which is shown in the illustration—are built in 16, 20 and 25 inch sizes.

CONUS OIL CUP

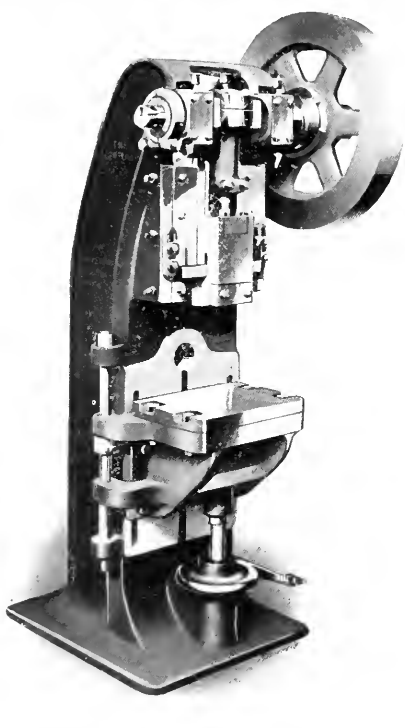
A simple form of oil cup manufactured by G. A. Lindstedt & Co., Stockholm, Sweden, and distributed in the United States by the Buckeye Churn Co., Sidney, Ohio, is shown in the accompanying illustration. The body and cover of this cup are stamped from sheet steel. The body is not threaded, but is simply driven into the oil hole, and as there is no obstruction of any sort on the inside of the cup, it has the maximum capacity for lubricant. In order to adapt these cups for use on rotating parts, the flange on the cover is split, as shown at *A*, in order to provide a spring lock for keeping the cover closed. These cups are easily kept clean and the flanged cover effectually prevents dirt from getting into the oil channels.



The Conus Oil Cup

CLEVELAND HORNING AND WIRING PRESS

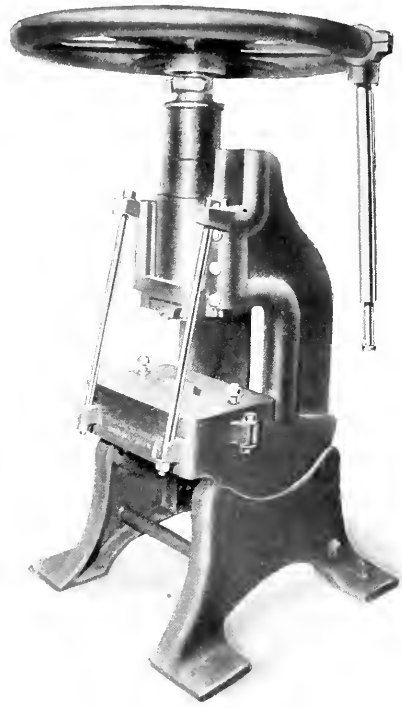
The horning and wiring press illustrated herewith is a recent product of the Cleveland Machine & Mfg. Co., 4938 to 4952 Hamilton Ave., Cleveland, Ohio. The construction of this machine embodies the following features: bronze bushings for the shaft bearings are provided in the frame of the machine; there is a safety latch on the clutch pin; the crank pin is of ample proportions; a hinged brake band is provided that has a compensating spring for wear and expansion; and the machine is equipped with a quick-adjusting knock-out device.


Cleveland Horning and Wiring Press

The machine is intended for the operation of wiring dies that are used for wiring the edges of pails, cups, reflectors and similar classes of work. Referring to the illustration, it will be seen that the frame of the press is bored for a horn. A plain horn for holding piercing or riveting dies or a horn of duplex construction for folding and locking the side seams of pails, tubs, furnace pipe and other articles made out of sheet steel, may be used on this press. The screw adjustment under the knee provides for setting it to any desired height so that the machine may be adapted for wiring dies of different depths. In using the press with a horn, the screw is lowered and the knee is swung around to a position where it is out of the operator's way. Machines of this type are made in four sizes. The machine shown in the illustration will close seams in a length up to 12 inches or in a diameter up to 24 inches; it will wire work up to 10 inches in diameter or 12 inches in length; the floor space occupied is 38 by 30 inches and the weight of the machine is 1850 pounds.

STANDARD SCREW PRESS

The hand screw press illustrated herewith is a recent product of the Standard Machinery Co., 7 Beverly St., Providence, R. I. The machine is designed for various operations on sheet metal and is capable of operating blanking dies up to 16 inches in diameter. It was built for operating dies used for punching armature disks, but is capable of application on a variety of other classes of work. The machine is operated by a quadruple threaded screw of $1\frac{3}{4}$ inch lead. This screw is $3\frac{1}{2}$ inches in diameter and made from a steel forging; it is turned by a handwheel 4 feet in diameter which has 500 pounds of metal in its rim.


Standard Hand-operated Screw Press

The machine is fitted with tie-rods to provide accurate alignment and the nut in which the operating screw turns is secured to the lower part of the frame by four bolts. The screw is held in the ram by means of a split collar. It will be seen that the frame is set on legs in such a way that the press can be inclined. The principal dimensions of this machine are as follows: thickness of bolster plate, $2\frac{1}{2}$ inches; maximum

distance from ram to bolster plate, 14½ inches; distance from lower end of ways to bed, 12 inches; distance between gibs, 10¾ inches; distance between uprights at rear of machine, 14½ inches; distance from the center of ram to back of rod, 6½ inches; weight of machine, 3000 pounds.

HJORTH DRILL GAGE

In shops where it is the practice to grind drills by hand, satisfactory results cannot be expected from the drill unless both of its lips are ground equally, so that each does its proper share of the work. Figs. 1 and 2 show two styles of

Fig. 1. Hjorth Gage for Drills up to 1 Inch in Diameter

gages which are made by the Hjorth Lathe & Tool Co., 27 School St., Boston, Mass., for testing the accuracy of a drill after it has been ground. The gage shown in Fig. 1 has a capacity for drills up to 1 inch in diameter, while the gage shown in Fig. 2 will take up to 2-inch drills.

It will be seen that the general arrangement of both gages is similar except that the larger one is provided with a stand.

Fig. 2. Hjorth Gage for Drills up 2 Inches in Diameter

Both gages have a V-slot in the handle in which the drill to be tested is laid. The gage proper has a 59-degree angle and may be adjusted vertically to bring it in line with the axis of different sizes of drills. In using such a gage, the drill is held firmly in place in the V-slot; the gage is next adjusted to bring it to the proper height; and the operator then observes whether the lips of the drill are parallel with the edges of the gage. If any discrepancy is found, further grinding must be resorted to until satisfactory results are obtained.

NEW MACHINERY AND TOOLS NOTES

Dividers: Welles Caliper Co., Milwaukee, Wis. A pair of dividers with inserted steel points which are held in place by binding screws.

Offset Bench Shear: Welles Caliper Co., Milwaukee, Wis. A machine designed for use on sheet steel up to 3/16 inch in thickness. The weight of the machine is 35 pounds.

Oil Heater: Hauck Mfg. Co., Brooklyn, N. Y. A portable steel tire-heating outfit for use in roundhouses. Crude petroleum, fuel oil or kerosene may be burned in this heater.

Double Spindle Engine Lathe: J. J. McCabe, New York City. This machine has been provided with improvements and special features which make it especially well adapted for use in street railway and other repair shops.

Die-stock: Nye Tool & Machine Co., Chicago, Ill. A taper-threading die-stock with long pipe handles for turning the die. The chasers fit into guiding slots and are kept from dropping out by the pressure of spring backed pins.

Hydraulic Press: United Engineering & Foundry Co., Pittsburg, Pa. A high-speed, hydraulic forging press for use on gun forgings. The machine was built for installation at the Watertown Arsenal and is capable of exerting pressures up to 800 tons.

Ring and Tire Welders: Toledo Electric Welder Co., Cincinnati, Ohio. One of these machines is designed for butt-welding harness rings and similar classes of work; the other is a similar machine except that it is designed for welding heavier work such as tires.

Steel Belting: Flexible Steel Belting Co., Bridgeport, Conn. A flexible steel belting of unit construction, designed as a substitute for double leather belting. Each unit is composed of four sheet metal parts and a pin. These belts may be taken apart and assembled in new lengths, if so desired.

Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A machine for finishing gas-engine liners or bushings which has a capacity for boring bars up to 9½ inches in diameter by 6 feet long. The machine is provided with clamps which are adjustable to enable bushings of various diameters to be held.

Cold Saw: Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine was designed to meet the requirements of a shop where 1⅜-inch heat-treated stock was to be cut off at the rate of 900 pieces in ten hours. Ten bars are held at a time in a special work-holder. The machine is motor-driven.

Electrical Welder Switch: Toledo Electric Welder Co., Cincinnati, Ohio. A hand switch for use on spot welders. The use of this switch adds materially to the convenience with which the machine can be operated, making it possible for one man to handle large sheets and control the machine without assistance.

Power Press: Cleveland Machine & Mfg. Co., Cleveland, Ohio. A line of straight sided, single crank geared power presses. These machines are designed for blanking, forming and drawing light and heavy sheet metal parts. All sizes can be fitted with drawing attachments and also a bar knock-out in the slide.

Machinists' Hammer: Westfield Plate Co., Thompsonville, Conn. A machinists' hammer with a composition metal head for use on machine tool and automobile work. The head of the hammer is made of a mixture of lead and antimony, and may be readily removed from the handle which is made of tinned, malleable iron.

Combination Punch and Shear: Henry Pels & Co., 90 West St., New York City. This machine has a capacity for punching holes 3 inches in diameter in a 2-inch steel plate, and it will shear a 2½ inch plate 60 inches in width. The machine has this company's steel plate frame construction and is operated by a Cameron steel lever.

Hacksaw: Racine Tool & Machine Co., Racine, Wis. A hacksaw adapted for cutting structural steel and various materials used in the machine shop. An automatic mechanism lifts the saw on the return stroke and the machine is equipped with a quick change vise. Work can be cut off either square or at an angle.

Wire Straightening Machine: Sleeper & Hartley Co., 98 Beacon St., Worcester, Mass. A wire straightening machine, especially adapted for straightening piano wire. This wire is rolled in relatively small coils and a machine of special design is necessary to straighten it ready for feeding to an automatic wire-forming machine.

Die Handling Crane: Toledo Bridge & Crane Co., Toledo, Ohio. A special crane, especially adapted for handling work in drop-forge plants. The hook of this crane is at the end of a counterbalanced arm and swings into a vertical position when the load is removed from it. An auxiliary hook is provided which enables the crane to be used for a variety of other classes of service.

Power Hammer: Fairbanks Co., New York City. This hammer is arranged so that it can be driven with either a slanting belt from above or with a horizontal belt from either side. This makes it possible to set the hammer up in places where there is very little overhead space. These hammers are made in sizes ranging from 25 to 300 pounds capacity and are equipped with either belt or motor drive.

Automatic Turret Lathe: Gisholt Machine Co., Madison, Wis. The design of this machine has been carefully worked out to provide for the safety of the operator. It is easily adjusted and of rigid construction to adapt it for severe service. All of the operations are automatic except the setting up and removal of the work, and in some cases the work may be automatically removed from the machine by an air chuck. This machine is built in two sizes of 15 and 20 inches.

SELLING GUARANTEES WHAT ARE SAFE LIMITATIONS?*

BY G. O. GRIDLEY†

In presenting an article on the subject of "Selling Guarantees, What are Safe Limitations?" I have considered that "safe limitations" means limiting the guarantee in favor of the seller, or stating it in another way, the title might be "How Broad a Guarantee is it Safe for the Manufacturer to make to a Prospective Customer?"

This question of guarantees has troubled mankind for many generations, in fact for ages, and to-day it costs us not an inconsiderable amount of money as well as time and trouble to maintain our guarantees, notwithstanding our endeavors to put in "safe limitations." Why is this? Why have we gone on and on, generation after generation, making guarantees that have cost us so much money and trouble? Is it because we have deliberately misrepresented our machines? Is it through a misunderstanding of the language used in our guarantees? Is it from the lack of good judgment on our part as to what we can perform? Or is it from a desire on our part to so word our guarantee that the purchaser must keep the machine even though he does not want to do so?

Let us consider what the object is in making a guarantee. Is it to help us make a sale? Is it to safeguard the interests of both the manufacturer and the purchaser? Is it to assure the purchaser he will get that which he thinks he is buying? Or is it to assure him he is to get that which will best serve his purpose? I believe it should be the latter.

No transaction between seller and buyer is satisfactory, and no business is, nor can it be, successful if the relation between the seller and buyer is not satisfactory to both. Neither is any guarantee satisfactory unless it safeguards the interests of both parties to the transaction. Therefore we must draw our guarantee carefully and see that its language is such that it means to the one to whom we are giving it the same that it means to us.

In the case of the builder of a machine which is designed especially for the purchaser, your guarantee should be drawn very clearly and definitely so as to safeguard both parties, because there are many elements over which the other has no control that enter into and influence the decision of the purchaser as to whether he will accept or reject the machine. With the manufacturer of a standard line of tools which he builds in lots and which are not built especially for each individual customer it is different, and it is not necessary to have the guarantee so definite as in the case of the builder of the special machine, because if one customer does not want the machine the maker can sell it to another.

There are, of course, cases where a definite guarantee of performance is necessary, and it should be given, as, for instance, where the question of costs of a new product is being considered or where a change of methods is being taken up; but where only an increase in product is to be made without change of method, the limited guarantee should not be given. *Make your guarantee broad and short and without limitations.* It is better for your customer and for yourself, because it will cost you less to maintain such a guarantee than any in which there are limitations so drawn that you may feel that you have met your guarantee and that your customer should keep the machine even though he does not want to do so.

Your guarantee should be such as to assure your customer that he is getting that machine which will best serve his purpose.

This does not necessarily mean that he is getting the best machine of its kind, because the most accurately made machine and the one which will do more work than others, and necessarily cost more than others, might not be best for the purchaser, as he might perhaps need and could use to better advantage that extra money which the best machine would cost; therefore, we should not try to force onto him this high-priced machine. In fact, we should not try to sell it to him, because a cheaper machine would be better for him to purchase. If, however, you have been so fortunate or so unfortunate as to have taken his order for the high-priced machine, and after getting it into his shop, he realizes that there is only a little work for it, and that the work need not be accurate and that a cheaper machine would have been better for him to buy, what do you do if he comes to you and states the case clearly and honestly; do you take it back or not? If you take it back your guarantee with safe limitations has not been of any financial benefit. If you do not allow him to return it what happens? If he is honest with himself, he pays the account when it is due, and then when he requires more machinery he will probably go to your competitor and place his order with him.

Can your loss on this order placed with your competitor under these conditions be charged to anything other than the cost of maintaining your limited guarantee? I say it cannot and that it can be and should be charged against that account. Open an account in your books under the heading "Cost of Maintaining Limited Guarantees" also one under the heading "Cost of Maintaining Unlimited Guarantees" and see which costs you the more. You will find that the unlimited guarantee costs less than the other.

The company with whom I am associated has made a great many limited guarantees, as well as broad ones, and I am frank to state that the limited guarantees cost us the more to maintain. It costs us less to secure an order with the limited guarantee than one with the broad and unlimited one. This is because it takes a higher degree of salesmanship to get an order that way, although it seems on first consideration that it should be the opposite. To secure an order with the broad unlimited guarantee you must first convince your prospective customer that you have the best machine for his purposes. When you have done that, your guarantee of performance, which is a limitation, is of secondary consideration, and the question of whether or not the machine will make four or forty-four pieces in a given unit of time is not made the main issue, as it should not be, but consideration is given to the question of whether or not the machine is the best machine for the purpose. If it is the best for the buyer, all things considered, your guarantee has not cost you anything to maintain; neither will it cost you anything on future sales. The cost of getting future sales will be greatly reduced, and you can, therefore, credit the saving in securing these sales to the "Cost of Maintaining Unlimited Guarantees."

It will cost the manufacturer a considerable sum to make a limited guarantee of performance, as one with experience and judgment must give his most careful attention to each proposition if the guarantee is anything more than perfunctory, and even with the most careful attention given to a detailed guarantee mistakes will happen—mistakes that will cost considerable money either through overestimating the capabilities of your machines or through underestimating them and thereby losing the order. In this case you should make another charge against the "Cost of Limited Guarantees." This, however, is not the greatest objection to guarantees of performance.

The greatest objection in my mind to making guarantees of performance is that your customer too often loses sight of everything except the stated guarantee of performance and does not give due consideration to the machine—that is whether it is the best for his purpose—whether it will continue to perform that which it was guaranteed to do after having accepted it, or whether or not it will be useful in the future, if his work changes.

There is a big advantage in using the broad unlimited guarantee, in addition to its primary advantage. It will make you improve your machines faster than you otherwise would; it will make your representatives more careful in their statements of performance, and thus create a reputation for your machines, your ability to perform and your honesty, all of which reduce the cost of maintaining selling guarantees.

What are the objections to an unlimited guarantee other than that the purchaser can, if he is so disposed, take advantage of you and return the machine without just cause? On the other hand, if he wishes to do so, he can question this or

* Paper read at the National Machine Tool Builders' Association Convention, New York City, October 22

† General Manager, Windsor Machine Co., Windsor, Vt.

that, justly or not—it matters not which—and make you a great deal of trouble and expense, usually ending by your taking the machine back. However, during a period covering about ten years and many broad unlimited guarantees, our company has not had such an advantage taken of it except in two cases, and I believe others who have sold those two parties machines on limited guarantees have had fully as much trouble and been to greater expense and then had their machines returned. Therefore, that need not be given serious consideration, as few of your customers are dishonest.

Do not make guarantees with "safe limitations" because you are working in the wrong direction and because it will cost you more to maintain such guarantees. Start on the basis of the right machine for your customer, and then make your guarantee broad and short and without limitations, such as: "We guarantee this machine satisfactory to you."

* * *

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The twelfth annual convention of the National Machine Tool Builders Association was held in New York City October 22, 23 and 24 at the Hotel Astor, E. P. Bullard, Jr., presiding. In his opening remarks, Mr. Bullard referred to the need of greater efficiency in building machine tools. The production of the tariff had made better methods imperative. The textile manufacturers had already taken steps to meet foreign competition. There was no reason in his opinion why our makers could not maintain the supremacy of American machine tools. Improvements all along the line, a broader outlook, closer cooperation in committee work would put them on more than an even footing in the world's markets.

C. L. Taylor, chairman of the patent committee, in his report referred to the dangerously broad scope of a law passed by Congress to protect foreign manufacturers at the Panama-Pacific Exposition. This law imposes a fine of $1000 or one year's imprisonment for imitating a foreign maker's patented machine or his copyright, without providing that the foreign patent or copyright shall be legitimate. The practical effect might be to prevent some American makers from building their own machines for four years, because of the notorious practice abroad of copying American models. Steps are to be taken to so amend the legislation as to prevent such an outrageous outcome.

D. M. Wright offered a resolution in regard to the nomenclature of machine tools to change the name of the National Machine Tool Builders Association to the Metal Working Machine Makers' Association. Action on the resolution was put over until the next meeting. Mr. Wright also reported on the standardization of machine tools and accessories, stating that little progress had been made. He recommended the appointment of sub-committees composed of men competent to exhaustively investigate those details with which they are thoroughly familiar with the view of bringing about agreement on vital essentials which could not be handled effectively by the general committee.

C. H. Alvord reported on the Panama-Pacific Exposition, stating that the railroads have promised every facility for the transportation and care of machine tools, etc., to be exhibited. The exposition management has offered various inducements, but the machine tool builders have evinced little interest, so far, in the exposition.

The association now numbers 175 members; no new members were admitted at this meeting.

The following excellent papers were read but available space at this date will not permit reproducing them in full in this number:

"Cost Accounting Practice with Special Reference to Machine Hour Rate," by Clinton H. Scovell of the Clinton H. Scovell Co., Boston, Mass.

"Selling Guarantees—What are Safe Limitations?" by George O. Gridley of the Windsor Machine Co., Windsor, Vt.

"Automatic Features on Machine Tools—To What Extent Are They Commercially Profitable?" by Edson R. Norris, director of the manufacturing operations at the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

"The Development of Cutting Tools," by B. F. Waterman of Brown & Sharpe Mfg. Co., Providence, R. I.

"The Use of Heat-treated Gears in Machine Tools—From the Standpoint of the Machine Tool Manufacturer," by Andrew C. Gleason of the Gleason Works, Rochester, N. Y.

"The Use of Heat-treated Gears in Machine Tools—From the Standpoint of the Material Manufacturer," by J. Heber Parker, metallurgist of the Carpenter Steel Co., Reading, Pa.

"Carbonizing and Heat-treating of Shafting—Methods and Materials Used," by J. G. Weiss, works manager of the Hyatt Roller Bearing Co., Newark, N. J.

The following officers were elected: President, William A. Viall, Brown & Sharpe Mfg. Co., Providence, R. I.; first vice-president, J. B. Doan, American Tool Works, Cincinnati, Ohio; second vice-president, D. M. Wright, Henry & Wright Mfg. Co., Hartford, Conn.; treasurer, A. E. Newton, Reed-Prentice Co., Worcester, Mass.; secretary, C. L. Taylor, Taylor & Fenn Co., Hartford, Conn.

The question of abandoning the semi-annual or spring meeting was taken up and decided in favor of continuing to have two meetings a year. The place of the next meeting was not fixed. Three cities were suggested, namely, Buffalo, Atlantic City and Worcester. A letter ballot will be taken to decide in which city the spring meeting will be held.

* * *

STABILITY IN FLYING MACHINES

Prof. Albert A. Merrill, founder of the Boston Aeronautical Society and lecturer on the subject of aeronautics, presented a paper "Stability in Flying Machines" at the monthly meeting of the American Society of Mechanical Engineers Tuesday evening October 14, in New York City. Prof. Merrill analyzed the forces acting on an aeroplane in flight. The movements are translation and rotations about the center of gravity. The rotations are about the three axes of the machine, *viz.*, vertical, longitudinal and lateral. He showed that existing machines are for the most part badly designed and have little or no inherent stability. A strong plea was made to mechanical engineers to take up the design of flying machines and correct the present faults. Prof. Merrill intimated that cut-and-try methods had been the rule and rational design an exception. He saw little commercial future for the flying machine until the faults of existing design had been corrected and machines built having inherent stability.

Elmer E. Sperry, the designer of gyroscopes for U. S. naval vessels and Curtiss aeroplanes, denied that great inherent stability was desirable in flying machines. He pointed out that the great modern ocean steamers like the *Olympic* and *Imperator* had very low metacentric heights, that of the former being only sixteen inches. In other words, if the center of gravity of the *Olympic* were raised only sixteen inches, the vessel would roll over. The inference was that marine designers have discovered that a low metacentric height was favorable to speed and fuel efficiency. Mr. Sperry referred to the very satisfactory results following the application of his gyroscopes to Curtiss aeroplanes and showed lantern slides illustrating the mechanism.

The members of the society and members of the two New York aeronautical societies present displayed keen interest in the paper and discussion. A comparatively new scientific field has been opened, worthy of the best thought of the physicist and mechanical engineer.

* * *

AMERICAN MACHINIST THEATER PARTY

The *American Machinist* gave a theater party at Cohan's Theater to the members of the National Machine Tool Builders Association and their friends, Thursday evening, October 23. The play was "Potash and Perlmutter" adapted from the stories by Montague Glass, published in the *Saturday Evening Post*. It is advertised as "trimmed with a thousand laughs," and judging from the effect produced on the machine tool builders, this is in no sense an exaggeration. The play depicts Jewish characteristics in a broad, sympathetic and amusing manner not, however, without pathos and glimpses of the high ideals which may inspire the Jew in great crises.

AUTOMATIC FEATURES ON MACHINE TOOLS*

TO WHAT EXTENT ARE AUTOMATIC FUNCTIONS COMMERCIALLY PROFITABLE?

BY EDSON R. NORRIS†

In recent years machine tool builders have been active in taking advantage of the many improvements that have been suggested in the way of special devices, attachments and accessories for machine tools for the purpose of increasing the usefulness of the tools, lessening the cost of production and in some cases reducing the skill necessary to operate. It is the object of this article to consider some of these special features from the standpoint of the large user of machine tools, yet giving due consideration to the demands of others whose requirements are different and whose lines of work are also often diversified in nature. The subject cannot be discussed without taking into account to some extent the designs of the tools; and what might appear as adverse comment in the illustrations of apparently faulty designs is merely offered in the way of constructive criticism.

It may be said that ordinarily the following reasons and conditions prompt the machine tool user to purchase equipment:

1. To take care of an immediate increase in business.
2. To provide for anticipated increase in business and at the same time to reduce the cost of manufacture by replacing existing tools with more efficient ones.
3. To replace worn-out tools with tools of the same design.

All large progressive concerns expect to and generally do expand, either by increasing their business along existing lines of manufacture or along similar lines, and frequently this increase occurs so suddenly that immediate action must be taken in purchasing the necessary tools to take care of the extra requirements. When this condition arises the purchaser must quickly decide what machines will be required, and endeavor to purchase those that can be delivered promptly and which will do the work intended in an efficient and economical manner.

It is often found, however, that while the machines offered for prompt delivery will perform the work desired in a satisfactory manner from a time standpoint, they are also designed and equipped to do a still larger class of work, and if installed the investment is greater than it should and would be for the work intended, if time would permit the installation of special machines. The fact that the fully-equipped general-purpose tools are valuable and a good investment both for the large and small manufacturer, when the work is brought through in small quantities and the machining requirements vary, has no doubt a tendency to encourage the machine tool builders in some cases to carry only as their standards fully-equipped tools (or nearly so) capable of doing a wide range of work, feeling that as long as this situation exists the demand will warrant such a policy and that it would not pay to carry a line of cheaper and simpler tools.

When machines are considered to take care of an anticipated increase in business and to improve manufacturing conditions by replacing existing tools, the purchaser generally has the time to give the proper attention to the design and character of the machines needed and it is almost unnecessary to say that he frequently decides to install special or single-purpose tools when the machine tool builders have nothing else to offer but expensive general-purpose tools.

The history of the automobile business in regard to machine tool requirements, if reviewed, will show that when the business first started machine tool builders had no difficulty in selling standard tools for this service, but as the business reached a sounder footing and time permitted giving more attention to the methods of manufacture, it was found advisable in a great many cases to demand machines capable simply of performing particular operations or similar operations to those for which they were intended.

* Paper read at the National Machine Tool Builders' Association convention, New York City, October 22.

† Director of manufacturing operations, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

This has prompted some machine tool builders so to design their tools that they can now supply not only this demand but also the demands made upon them for tools equipped to do a wider range of work. The attention of the writer was recently called to an instance where this had been done in the re-designing of a horizontal boring and drilling machine so that it could be offered simply for boring operations, and not as a high-class precision tool. The machine was arranged with a reasonable number of changes in feeds and speeds, and as a jig would be depended upon for accuracy of the work and duplication of parts the spindle of the machine merely acted as a driver and feeder. The machine was designed for either belt or motor drive.

What has been said regarding the tendency of automobile builders in ordering tools, is also true of other large manufacturing companies, but possibly not to so marked a degree, because their products are not so well standardized or defined. This condition was very apparent in placing about $100,000 worth of medium sized machine tools in a new factory for a line of work which is manufactured in large quantities. It was advisable for several reasons to provide direct motor drive for all of these tools, and an effort was made to do so, but it was soon found that this could not be accomplished with all the machines that were considered desirable to use on the work and could be supplied promptly. For instance some of the engine lathe and milling machine operations necessary in this work are of a light and simple nature, which can be done economically on stud lathes or cone type millers; in most cases, therefore, the standard lines of motor-driven engine lathes and high-power milling machines were considered too expensive to install, which, of course, prevented carrying out the idea of motor driving all of the tools as originally desired.

It can readily be seen that it is not generally considered desirable or profitable to use so-called "standard or fully-equipped tools" on a line of standard apparatus. While it is appreciated that it is to the machine tool builders' interests to make their standard lines of tools serviceable for as many purposes as possible, in order to be able to meet the different requirements of a majority of their customers, they should also aim to make the designs so that the tools can be sold without the attachments and special features if not required for the work intended. They should either do this or else they should carry a line of machines of simpler design, which can be used on the general run of commercial work.

Machine tool builders very often show machine tool users by time studies or actual demonstrations in connection with a special piece of work that the time taken can be lessened by the use of their particular tools, and in such cases from the machine tool builders' standpoint, there is no reason why advantage should not be taken of this gain. With the user, however, this is not the entire proposition, especially if his production will permit him to use the machine in question continuously on such a line of work, which is very often the case. Under this condition any special features or attachments other than those actually needed for the work in question are of no value to the user and on account of the high purchase value, the saving in time does not warrant the extra investment. Cases of this sort are very common and are discouraging to those endeavoring to be progressive by aiming to take advantage of some of the new machine tools offered, and while machine tool builders deserve a great deal of credit for the great advancement made in the designs of their tools for the purpose of producing work rapidly and accurately, it seems that in their efforts to do this they have overlooked the fact that in some lines of manufacture these tools are too expensive to use. Simpler designs embracing some of the modern features will often do just as well.

These points can probably be made clearer by referring to a certain machine the Westinghouse Electric & Mfg. Co. has

found very useful for its needs, and of which it has about two hundred in operation. The builder of this tool has, however, more recently developed a fully-equipped tool with all of the modern attachments, making it very advantageous in some instances, but which naturally is higher priced. He intends to discontinue the manufacture of the old machine, yet it is very evident that on certain classes of work the older type is just as desirable, and on other classes the advantage of the new tool is negligible, because of the difference in purchase price of the two machines. It would be to the interest of the user to have this old design of tool improved to some extent and it would likewise be profitable to the manufacturer, without in any way discrediting the value to both parties of the new type of tool.

In another case the machine tool builder in his effort to produce a simple tool for a certain line of work did not take advantage of some of the modern attachments which would have improved his tool from an operating standpoint. The changes in feeds were cut down to what was considered the required amount for the service intended, but to change the feed it is necessary to remove and replace change gears. It can readily be seen that a modern change feed attachment would have been far more desirable. The value of this machine to the user also could be increased if it were equipped with a rapid traverse for the carriage. Another tool recently installed to improve the quality of work and reduce the cost, lacks a certain modern feature, which makes the machine more laborious and more expensive to operate, and it will have to be equipped with this attachment to meet the cost of doing the operation under the old method.

These examples tend to show that attachments are valuable, and that a greater effort should be made to apply them to the simple line of machines, when they can be used to advantage.

The demand for motor-driven tools, especially by the larger manufacturers, is increasing as the value of the motor drive is becoming more fully recognized, but some tool builders do not seem to realize this fact, or to take it into account in their designs. Machine tools so designed that the only possible way to apply motor drive is by ceiling mounting and belting down to them, or by placing the motors on the floor some distance from the tools, are very unsatisfactory, and it is safe to assume that this type would not be considered if it were possible to find other machine tools to do the work which were better arranged for motor drive.

While this fault can be found with some machine tools of recent design, most of them, however, have been on the market for years, and in place of making them more suitable for motor application some builders have designed new lines of machines which are satisfactory as far as motor application is concerned, but which cost considerably more to install on account of the greater number of parts or attachments and higher power features. These new types of machines have a broad field of usefulness and are profitable on certain classes of work, but they do not entirely replace the old type; it is obvious therefore that users whose policy it is to motor drive must either drive some of their equipment with belts, or else do work on expensive tools which could be done as economically on cheaper and simpler tools.

To show what may be accomplished by a combined effort on the part of the machine tool builder and user an instance may be given of a small hand milling machine which has been arranged for adjustable speed motor drive in a very satisfactory manner by widening the column of the standard machine to receive the motor, and driving direct to the spindle by means of a sprocket chain. Ventilation is secured through suitable openings in the column. A semi-dustproof condition is obtained by covering these openings with a fine mesh wire screen. Saving in operating time and changes in speed are obtained by the use of a starting and speed adjusting rheostat so placed on the side of the machine that the operator does not have to change his position to start, change the speeds or stop the machine. This application requires no extra floor space, and it makes a self-contained portable unit which can be readily shifted from one location to another, making the tool available and desirable to those wishing motor application.

In making the change the tool builder was put to some additional expense and the purchaser was charged accordingly for the first machines, but on later purchases the price was about the same as the regular charge for the standard cone type. This is very uncommon, however, as machines sold for motor drive generally cost more, regardless of the fact that the full value of the parts not required seems more than those added for motor application.

A few years ago it was not considered advantageous to motor drive planers, but now the adjustable speed reversing motor drive for planers is generally accepted as a decided improvement over the usual method of belt drive. This is merely mentioned to call attention to the possibility of eliminating some of the mechanical speed changing features of other equally important machine tools by the use of the adjustable speed motor, and in so doing, of obtaining a more satisfactory range of speeds. On some types of machines the speed-changing features can be omitted without altering the designs to any great extent, but this is not true in all cases, clearly showing that adjustable speed drive was not considered when designing them.

In conclusion it may be said that on commercial lines of work the operations and methods are so planned that the operators are only required to perform a single operation, and can therefore be graded accordingly. It is not good policy consequently to use highly improved machine tools capable of doing a wider range of work than the operators are called upon to do, but the machines should be equipped with any automatic features which will decrease the skill necessary to operate them, or which will reduce the cost of performing the required operations.

* * *

CABLEWAY SEVENTY-FIVE MILES LONG

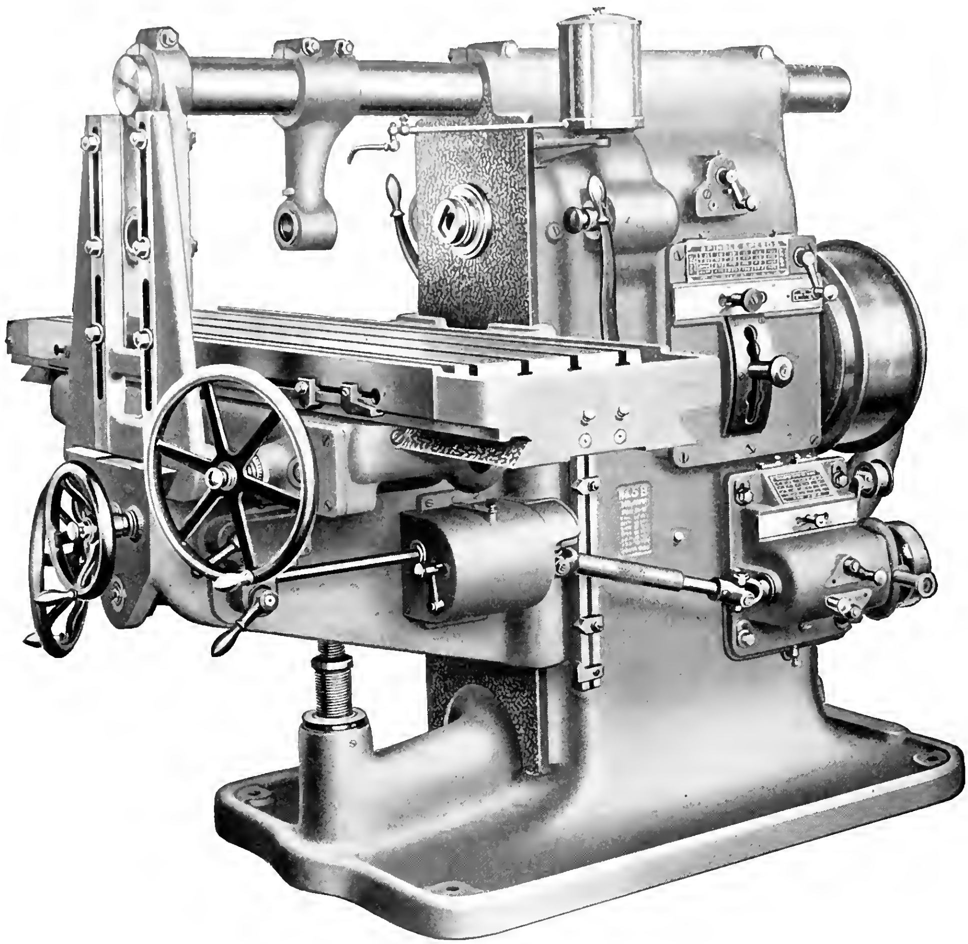
Henry D. Baker, on special commercial service in India, writes in the U. S. *Daily Consular Reports* that work will probably begin in 1914 on the longest aerial cableway in the world. It will be seventy-five miles long and will be built across the Himalaya Mountains from the plains of Punjab to the "Vale of Kashmir." The project is considered to be the only feasible means of providing rail communication over this mountainous district. Owing to the loose conglomerate soil which causes disastrous slips and falls of huge boulders whenever there is unusual rainfall, engineers who have studied the situation deem it impracticable to build even a light electric railway. The cableway will be constructed in spans of about 800 yards, each upheld by steel towers, some of which will be 100 feet high. In some places the spans will bridge gorges 1200 feet deep.

* * *

In a paper read by Mr. Thomas D. West before the American Foundrymen's Association at Chicago in October, Mr. West emphasized the importance of making notes of everything about the plant that might cause an accident. The supervisors of a plant should regularly make notes of everything they see or think of that might cause injury to employes. The recent expansion of accident liability in many states has increased the insurance rate of those works in which the hazards, on account of the indifference of the supervisors, are high. If the practice of recording all memoranda bearing on accident causes and prevention is followed, a great change will be noticed in the extra-hazardous plant.

* * *

The great Zeppelin dirigible L-2 exploded near Johannsthal, Germany, October 17, at a height of 3000 feet, and twenty-eight of the passengers and crew were killed. Only one escaped. This is the ninth serious accident that has befallen the Zeppelins, the eighth occurring September 9 in a storm. Fifteen lost their lives in this disaster. The huge bulk, the inflammability of the gas-holder and the close proximity of gasoline engines and electrical apparatus constitute a hazard that seems beyond the power of the German engineers to cope with. Storms and fire have wrecked these great costly structures, but until the last two were destroyed there had been no loss of life.



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PERSONALS

D. De Vries, manager of the technical department of Stokvis & Zonen, Rotterdam, Belgium, arrived in the United States in October, having made a trip around the world. Mr. De Vries will leave for Rotterdam about November 10.

Thomas D. West read a paper before the American Foundrymen's Association in Chicago, October 15: "Recording Memoranda on Accident Prevention," prepared with special reference to the conditions of foundry practice.

S. O. Livingston, secretary and sales manager of the Wilmarth & Morman Co., Grand Rapids, Mich., manufacturer of grinding machines, sailed on the *Olympic*, October 25, for a business tour of England and the Continent.

Walter Deakin, managing director of H. W. Ward & Co., Ltd., machine tool builders, Birmingham, England, arrived in America on the *Mauretania* October 17. Mr. Deakin will spend about six weeks visiting American manufacturing plants.

The degree of Doctor of Laws was conferred upon Mansfield Merriman at the annual celebration of Founder's Day, Lehigh University. Dr. Merriman, who is well known as an author and teacher, was head of the civil engineering course at Lehigh for nearly thirty years.

The Worcester manufacturers are feeling very proud, and justly so, of their new hotel, the Bancroft. A good hotel has been needed for a long time in Worcester, and some of the public-spirited citizens, headed by Mr. C. L. Allen of the Norton Co., raised $800,000, and put one up that everybody says is equal to the best anywhere.

Joseph A. Anglada, consulting engineer with offices at 1790 Broadway, New York City, has sold his interests in the Anglada Co., Detroit, manufacturer of demountable rims and automobile accessories, and has resigned the presidency of the company. Mr. Anglada will devote his energies to a company which will manufacture a small motor car of his design.

The Technology Club of Syracuse, N. Y., on the occasion of its eleventh annual meeting, October 8, honored Prof. John E. Sweet, one of its founders and the first president, by establishing the John E. Sweet Lecture Fund. The fund is to be used in the maintenance of a lecture course in which distinguished speakers on both technical and popular subjects will be brought to Syracuse.

William L. Garcia, who has been with the Fairbanks Co., for the past eight years, as manager of the engineering and power transmission department, has resigned to take a similar position with Flint & Chester, Inc., New York City, beginning October 6. A complete engineering and power transmission department has been equipped and Mr. Garcia will have full charge of same.

Melville W. Mix, president of the Dodge Mfg. Co., has been nominated on the Democratic ticket for mayor of Mishawaka, Ind. This is the third time the honor has been conferred on Mr. Mix. He has been twice elected mayor by a large majority. Aside from being president of the Dodge Mfg. Co., Mr. Mix is also the head of the National Veneer Products Co., a large concern making trunks, traveling bags and leather novelties, and is interested in other local and national business activities.

* * *

OBITUARIES

Dr. Rudolph Diesel, the inventor of the Diesel internal combustion engine, was drowned September 30 by falling overboard from the steamer *Dresden*, sailing from Antwerp.

Heinrich Dreyer, a well-known machine tool dealer of Berlin, Germany, died September 14, in Neckargemünd, near Heidelberg. Mr. Dreyer was only thirty-nine years old, but during the last ten years had built up a large and successful machine tool business, handling American tools exclusively. For nearly two years he was incapacitated from business by illness, but the interests of his clients have been well taken care of by his brother-in-law, Mr. Schumann, an experienced Berlin banker, and also by Mr. Franz Böhm, who previously had a number of years' experience in the machine tool field with Messrs. Schuchardt & Schütte.

Edwin T. Moore, secretary and treasurer of the Coatesville Boiler Works, Coatesville, Pa., and director of the executive board of the Coatesville Foundry & Machine Co., died at his home in Coatesville, September 25, from a complication of ailments brought on by overwork, aged forty-six years. Mr. Moore entered the employ of the Coatesville Boiler Works at the age of twenty-one as a clerk, and ten years later he was made secretary and treasurer. His unusual grasp of the details of the business received recognition when he was made general manager about two years later. Under the able supervision of Mr. Moore, the company grew and developed into a very important industry. He was instrumental in organizing the Coatesville Foundry & Machine Co., which in five years has also grown into an important industry. He was prominently connected with several other local enterprises.

JAMES MILLS

James Mills, president and general manager of the Smith & Mills Co., Cincinnati, Ohio, died October 17, aged seventy-four years. He had been suffering from heart trouble for the past six months, but his death was unexpected. Mr. Mills was born in Oldham, England, and came to America in 1861. He settled in New York and later served in the Civil War. After the war was over, Mr. Mills located in Savannah, Ga., and moved from there to Cincinnati in 1868. He became associated with the John Steptoe Shaper Co., and was shortly afterward made superintendent. In 1888, Mr. Mills and Albert S. Smith organized the firm of Smith & Mills with a very small capital. The business prospered, but no capital was ever borrowed to expand it. The policy was to be free of all financial entanglements and to conduct a safe, conservative business of constantly growing volume. Contrary to the policy of many machine tool concerns, the plan of Smith & Mills was to carry a large stock of machines ready for shipment. Mr. Smith withdrew from the firm some time ago, when the business was reorganized as the Smith & Mills Co. Mr. Mills is survived by a widow, two sons and three daughters. The sons, Ernest and James E., are active in the management.

COMING EVENTS

December 3-6.—Annual meeting of the American Society of Mechanical Engineers. Headquarters Engineers Bldg., 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty one museums of safety in Europe, and all these will contribute to the American Exposition.

NEW BOOKS AND PAMPHLETS

Registration of Vital Statistics and Good Business. By Louis I. Dublin. 15 pages, 6 by 9 inches. Published by the Metropolitan Life Insurance Co., New York City.

List of Works Relating to the Development and Manufacture of Typewriting Machines. 18 pages, 7¼ by 10¼ inches. Published by the New York Public Library, New York City.

Technical Control of the Colloidal Matter of Clays. By H. E. Ashley. 118 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards, No. 23.

The Silver Voltameter—Part III. By E. B. Rosa, G. W. Vinal and A. S. McDaniel. 60 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Reprint, No. 201.

The Function of Time in the Vitrification of Clays. By G. H. Brown and G. A. Murray. 26 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards, No. 17.

Effect of Overfiring upon the Structure of Clays. By A. V. Bleininger and E. T. Montgomery. 23 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards, No. 22.

Analysis of Coals in the United States Part II. By N. W. Lord, J. A. Holmes, F. M. Stanton, A. C. Fieldner and Samuel Sanford. 1200 pages, 6 by 9 inches. Published by the Department of Interior, Bureau of Mines, Washington, D. C., as Bulletin 22.

Melting Points of the Refractory Elements—I. Elements of Atomic Weight from 48 to 50. By G. K. Burgess and R. G. Waltenberg. 14 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Reprint No. 205.

Diagram Giving Stresses in Beams. By H. R. Thayer. 9 by 12 inches. Published by D. Van Nostrand Co., New York City. Price 20 cents.

With the diagram, the designer can find a beam for given loads and stresses; a beam for given moments and stresses; the section modulus required for given loadings and stresses; the stresses caused in a given beam by a given load; and the stresses caused in a given beam by a given moment.

Laboratory Manual of Testing Materials. By William Kendrick Hatt, and H. H. Scofield. 135 pages, 5 by 7½ inches. Published by McGraw-Hill Book Co., New York City. Price $2 net.

The manual is the outcome of the operation through eighteen years of the laboratory for testing materials of Purdue University. It treats of materials stressed beyond the elastic limit, testing and testing machines, list of experiments, instructions for performing experiments, common formulas, specifications for steel and iron, standard forms of test pieces, strength tables, etc. The work is one that should be appreciated by students, engineers and others who have to conduct experiments in the strength of materials of all kinds.

Cranes and Hoists. By Hermann Wilda. Translated from the German and adapted to British practice by Charles Salter. 168 pages, 4½ by 6¼ inches. 399 illustrations. Published by Scott, Greenwood & Son, Ludgate, E. C., England, and D. Van Nostrand Co., New York City. Price $1.

The work treats on the elements of lifting tackle, comprising hemp and wire ropes; chains, rope and chain pulleys; rope and chain drums; grooved chain wheels and sprockets; capstans; hooks; holding gears; brakes; gearing; couplings; etc. The second chapter is on types of cranes and hoists, comprising pulleys and pulley connections; fixed and movable pulleys; block and pulley tackle; differential pulleys; screw or worm pulleys; winches; traveling crabs with electric drive; lifting jacks; wall swings, pillar and traveling cranes; derrick cranes, etc. The book contains a great deal of valuable information and condensed data.

Farm Gas Engines. By C. F. Hirshfeld and T. C. Ulbricht. 239 pages, 5¼ by 7½ inches. 188 illustrations. Published by John Wiley & Sons, Inc., New York City. Price $1.50 net.

This work differs from other works on the operation and care of farm gas engines in that it may be used as a guide by those contemplating the purchase of a farm gas engine. The author discusses the power problems, fuels, the internal-combustion engine, the construction of the engine, principles of operation, indicator diagrams, power of gas engines, cooling systems, valve systems, com-

parison of two- [illegible] four-cycle operation, carbureters, electric [illegible] apparatus, the governing systems, lubricat[illegible], desirable and undesirable features of construct[illegible], mufflers, power rates and speed and types of farm engines. The work is one that can be recommended not only to farmers but to [illegible] purchasers and users of small internal combustion engines.

Strength of I-Beams in Flexure. By Herbert F. Moore. 40 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin 68.

The formulas commonly used by architects and structural engineers for determining the carrying capacity of structural steel shapes are, in general, based on the common theory of elasticity and the tensile strength of structural steel. In figuring the strength of I-beams under transverse loads, it is the usual practice to consider only the direct flexural action. Transverse tests of I-beams have not been numerous and the results of such tests have not been widely used. It is known that besides direct flexural action of I-beams there are also sidewise buckling action and stresses in the web. In this bulletin these secondary effects are discussed and tabulated summaries given of the results of tests of I-beams. From the results of tests, the conclusion is drawn that in considering direct flexural action of I-beams the yield point strength of the material must be regarded as the ultimate fiber stress for the beam.

Principles of Industrial Organization. By Dexter S. Kimball. 272 pages, 6 by 9 inches. Published by McGraw Hill Book Co., New York City. Price $2.50 net.

The author points out that as the industrial enterprises have grown in magnitude, the simple administrative methods formerly in use have long since been outgrown in modern plants. He discusses fundamental principles, factory systems, systems preceding present methods, the effects of the great inventions, etc. One of the effects of great inventions has been to separate the worker from the tools and to degrade labor. In order that national property may not suffer and the degradation of labor may not be allowed to go on, a discussion of means for elevating labor, providing for welfare work, etc., is given. The author takes up modern industrial tendencies, forms of industrial ownership, principles of organization, planning departments, principles of cost-keeping, the depreciation of wasting assets, the compensation of labor, purchasing, storing and inspection of materials, the location, arrangement and construction of industrial plants, and theories of management, etc.

The Science of Burning Liquid Fuel. By W. N. Best. 159 pages, 6½ by 9½ inches. Illustrated. Published by W. N. Best, 11 Broadway, New York City. Price $2.

This work is a treatise for practical men; it gives some of the twenty-five years' experience of a man who was among the first to use liquid fuel on locomotives and for industrial purposes. The contents comprise: Liquid Fuel, its Origin, Production and Analysis; Atomization; Oil Systems; Refractory Material; Locomotive Equipment; Stationary and Marine Boilers; Oven; and Furnaces. The chapter on furnaces is of the utmost direct and suggestive value to foremen of forge shops, etc. Various types of oil feed furnaces are illustrated, showing the construction in detail. The author refers to the fact that the fuel oils used in America are now being refined and are distilled by new processes which produce higher percentages of kerosene, gasoline, etc., and that therefore it has become necessary to utilize the heavy crude oils from California and Mexico. These fuels necessitate many changes in oil systems heretofore used, and practical hints as to these troubles are given. The author being a maker of oil-burning apparatus, is in close touch with the developments of oil-burning apparatus in all fields.

Hendricks' Commercial Register of the United States. 1668 pages, 7¼ by 10 inches. Published by the S. E. Hendricks Co., 74 Lafayette St., New York City. Price $10.

This well-known directory of manufacturers has just been issued in the twenty-second annual revised edition. It was established in 1891 and has been published annually since. It is one of the most complete works of its kind published. Its aim is to furnish complete lists of manufacturers for the benefit of those who wish to buy as well as those who have something to sell. It covers very completely the architectural, engineering, electrical, mechanical, railroad, mining, manufacturing and kindred trades and professions. The present edition is the largest so far issued. The twenty-first edition required 122 pages to index its contents while the twenty-second edition requires 138, or 16 additional pages. As there are upward of 400 classifications to the page, the 16 additional pages represent over 6000 additional classifications, none of which appeared in previous editions. The total number of classifications is over 55,000 representing the manufacturers or dealers of machines, tools, specialties or materials required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries. An important feature of the register is the simplicity of its classifications. They are so arranged that the book may be used for either purchasing or mailing purposes. As an illustration, all manufacturers of a particular trade are classified under a general heading for mailing purposes. They are then sub-divided, each firm and corporation being placed under as many classifications as every variety of their products call for. The value of this arrangement for all classes of users is obvious. The work also gives information with the names of firms of value to the buyer. The trade names of products are included with the manufacturer's name whenever the product of a manufacturer is sold under a trade name. These trade names appear in parentheses between the names and addresses, under the classifications where they appear.

NEW CATALOGUES AND CIRCULARS

Mesta Machine Co., Pittsburg, Pa. Bulletin I on Mesta gas engines.

J. T. Slocomb Co., Providence, R. I. Leaflet on the Slocomb micrometer No. 26, with friction thimble.

Charter Gas Engine Co., Sterling, Ill. Catalogue No. 12 of "Charter" type "R" oil engines.

Industrial Instrument Co., Foxboro, Mass. Bulletin 81 on "Foxboro" electric pyrometers.

Pawling & Harnischfeger Co., Milwaukee, Wis. Bulletin 301 on the "P. & H." type "T" electric hoist.

Loew Mfg. Co., Cleveland, Ohio. Circular on the "Loew Victor" lathe bed pipe threading and nipple machine.

Schutte & Koerting Co., Philadelphia, Pa. Catalogue 6, Section C on Koerting air jet chimney ventilators.

General Electric Co., Schenectady, N. Y. Bulletin No. A4142 on the importance of operating lamps at the proper efficiency.

National Tube Co., Frick Bldg., Pittsburg, Pa. Circular of the "National" spring plug cock, suitable for working pressures up to 125 pounds.

Newall Engineering Co., Blackhorse Lane, Walthamstow, London, E., England. Catalogue of Newall gages, micrometers and measuring machines.

Oneida National Chuck Co., Oneida, N. Y. Circular of the "National" ball bearing drill chuck in which the jaws automatically tighten on the drill.

Charles H. Besly & Co., 118-124 North Clinton St., Chicago, Ill. Circular on the Besly patternmakers' disk grinder, illustrating its use on typical pattern work.

Electric Furnace Co. of America, Alliance, Ohio. Circular of the Baily electric furnace for heat-treating metal and for annealing, tempering and casehardening.

C. U. Scott, Davenport, Iowa. Folder illustrating Mr. Scott's plant for casehardening, carbonizing, heat-treating, brazing, blueprinting, tinning, galvanizing, etc.

Eugene Dietzgen Co., 218 E. 23 St., New York City. Circular of the Dietzgen economy box for storing blueprints, sketching, tracing and drawing paper, tracing cloth, etc.

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 225 on air washers for removing dust and soluble impurities from air supplied to plants where absolute purity of the atmosphere is required.

Sleeper & Hartley, Worcester, Mass. Bulletin 270 on torsion spring winding machines; bulletin 272 on music wire straightening and bundling machine; and bulletin 275 on No. 1 wire flattening mill.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1017 on automatic controllers for motor-driven machines, direct current; bulletin 1036 on the Youngstown safety limit stop for direct current motors.

Clinton Wire Cloth Co., Clinton, Mass. Report of a fire, load and water test made upon cinder, concrete, terra cotta and gypsum floor slabs at the Columbia Fire Testing Station, Greenpoint, Brooklyn, N. Y.

Lumen Bearing Co., Buffalo, N. Y. Booklets on machine tool and machinery bronzes and high tensile strength bronze. These little booklets, which are sent free to any address, contain valuable information on bearing metals.

Shaw Electric Crane Co.—Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City. Bulletins 82, 91 and 109 on portable electric single drum drag, type M trolley for steel mill service and crane motor, type Z.

National Tube Co., Frick Bldg., Pittsburg, Pa. Circular of the "Kewanee" air pump union which is largely used on the air lines of locomotives. The union is tested with 125 pounds compressed air under water before leaving the factory.

Covel Mfg. Co., Benton Harbor, Mich. Circular on automatic band-saw sharpener having a capacity for saws from 1 inch to 6 inches. This machine automatically sharpens all kinds of band-saws with any shape of tooth, within its capacity.

Alston Saw & Steel Co., Folcroft, Pa. Circular on the Alston process improved hacksaw blades for all purposes. The blade is made with a hardened edge and back and a soft center, a combination which is said to produce an extremely flexible saw.

General Electric Co., Schenectady, N. Y. Bulletin No. 4972 describing the KR system of voltage regulation which can be successfully employed on systems having such large fluctuations of voltage that the standard method is ineffective.

Porter-Cable Machine Co., 501 East Water St., Syracuse, N. Y. Circulars of No. 3 sensitive high-speed universal milling attachment for standard milling machines, and No. 4 positive drive universal milling attachment for standard milling machines.

F. Wiard, 724 Ford Bldg., Detroit, Mich. Circular on the Wiard drill chuck for rapid drilling, reaming, counterboring, etc. The chuck is made for use with collets fitting the Morse standard taper. Drills can be changed with the spindle in motion.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin No. 8011 showing new line of "Little David" riveting hammers, sizes 50, 60 and 80, which are suitable for structural work, tank, steel or other similar work up to 1¼ inch diameter rivets.

Gisholt Machine Co., Madison, Wis. Catalogue of Gisholt adjustable reamers manufactured by the small tools department of the company. The manufacture of these reamers is the outcome of the demand for tool equipment by users of Gisholt turret lathes.

Metropolitan Museum of Art, New York City. Supplement to the bulletin on the relation of the Metropolitan Museum of Art to the public schools, showing how valuable an educational adjunct the museum may be made by teachers with their classes.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin No. 16 on "National" stationary and marine boiler tubes, containing illustrations showing the severe tests to which boiler tubes are subjected and which they must endure in order to be passed by the inspectors.

C. H. Cowdrey Machine Works, Fitchburg, Mass. Descriptive leaflet of the company's equipment for building special machinery. It is prepared to build textile machinery, celluloid machinery, shoe machines, paper bag machines, printing press feeders, jigs, fixtures, tools, etc., to order.

Raymond Foundry & Machine Co., Raymond, Wash. Circular on the Selby gearless reverse clutch for motor boats driven by gas engines. The claims are made that this clutch gives full speed in reverse direction, that its efficiency is 96 per cent in reverse and that it is noiseless in operation.

Davis-Bournonville Co., 30 Church St., New York City. Special price list No. 4 of oxy-acetylene welding and cutting supplies, comprising "Atlas" cast-iron welding rods, "Ajax" welding wire, "Atlas" sealing powder, "Marvel" flux powder for brass and bronze, "Peerless" aluminum welding powder, etc.

Toledo Bridge & Crane Co., Toledo, Ohio. Clearance dimension sheet for standard cranes, giving the dimensions for cranes of 3 tons to 150 tons capacity, inclusive, and having from 40 to 80 feet span. This list will be sent to consulting, contracting or mechanical engineers and plant superintendents, on request.

Curtis & Co. Mfg. Co., 1568 Kienlen Ave., St. Louis, Mo. Catalogue No. 61 on air compressors, air hoists, air cranes, pneumatic and hydro-pneumatic elevators, trolleys, trolley systems and sand blasts. The catalogue illustrates a wide variety of pneumatic appliances for manufacturing plants.

E. Horton & Son Co., Windsor Locks, Conn. Catalogue No. 12 of lathe chucks, faceplate jaws and drill chucks, including the Morrow ball-bearing self-tightening drill chuck. The catalogue lists the new lines of the S. E. Horton Machine Co. with those of E. Horton & Son Co., thus forming a complete line of chucks for all purposes.

General Electric Co., Schenectady, N. Y. Bulletin No. A4137 illustrating and describing Curtis steam turbines of 100 to 2500 K.W. capacity for driving 60-cycle generators at 3600 R.P.M. These generating sets are of the horizontal shaft rigid frame type, and either two or four impulse wheels are used, depending upon the capacity of the generator.

Universal Boring Machine Co., Hudson, Mass. Catalogue of No. 3-A "Universal" horizontal boring machine, containing illustrations showing head, post and operating levers; machine fitted with special table and equipment. The manufacturer makes a point of the fact that the "Universal" is "a right-hand machine for right-handed operators."

General Electric Co., Schenectady, N. Y. Bulletin A4115 entitled "Electricity on the Farm" constituting the most complete treatise on the subject that has yet been issued by any manufacturer. The bulletin treats of lighting systems for the farm and the uses of electricity in the farm home and contains a dissertation on the general advantages of electric drive.

James Clark, Jr. Electric Co., Louisville, Ky. Catalogue No. 22 of "Willey" electrically-driven portable drills in a large variety of styles, center grinders and hand grinders and buffers, surface and internal grinders, toolpost grinders, bench grinders, combined wet and dry grinders, jewelers' sensitive bench drills, electrically-driven hacksaws, friction-driven sensitive drills, notching presses, winding machines, locomotive turntable motors, etc.

Hollands Mfg. Co., Erie, Pa. Catalogue No. 22 of vises and tools comprising machinists' solid jaw parallel vises, filers' solid jaw parallel vises, machinists' offset jaw vises, machinists' swivel jaw vises, Penn woodworkers' vises, woodworkers' offset jaw vises, Walworth pipe vises, standard combination vises, Keystone woodworkers' vises, Keystone malleable pipe vises, Penn malleable hinged pipe vises, three-wheel pipe cutters, pipe reamers, taper reamers, pipe taps, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin No. 17 on the manufacture and use of Shelby seamless steel tubing, containing extracts from an address to the U. S. Naval School of Marine Engineers by J. H. Nicholson and Emil Holinger. The article is illustrated with many drawings to show principles of operation. The bulletin should be of unusual interest to all concerned with the use of seamless tubing, seamless cylinders, hydraulic forgings, projectiles, etc.

New York Central Lines, Grand Central Station, New York City. Reprint from the "Outlook" of "A Nation's Neglect" by Marcus A. Dow, general safety agent New York Central Lines. The writer urges educational and legislative measures to prevent the unnecessary killing and maiming of thou-

MACHINERY

DECEMBER, 1913

RE-BLADING A PARSONS STEAM TURBINE

TOOLS, DEVICES AND METHODS EMPLOYED IN REPLACING BLADES OF A TURBINE ROTOR

BY N. I. MOSHER*

In a machine shop where the writer was a foreman, a Parsons steam turbine from one of the United States Navy destroyers came in to be rebladed. After dismantling the unit the first step was to test the cases and rotor, to determine if they had taken any permanent "set" or distortion from the

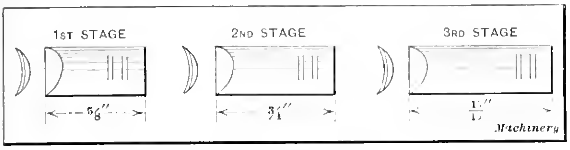

Fig. 1. Results of Successive Operations in forming the Turbine Blades

heat. A careful test showed the cases to be perfectly accurate, but it was found that the rotor had taken a permanent set that threw it 0.030 inch off center. This figure refers to the error that existed at the middle of the rotor, the error gradually diminishing until it was nil at each end. After careful consideration it was decided not to attempt to remedy this error until after the new blades had been set in the rotor. This line of action was adopted, because it was felt that

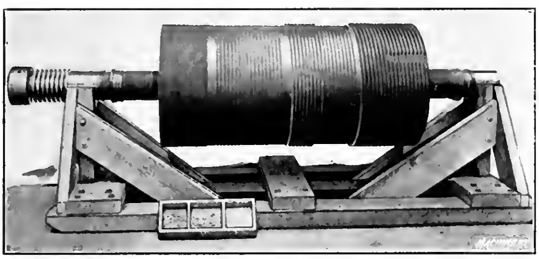

Fig. 2. Cradle in which the Rotor was supported to remove the Old Blades

further distortion would be sure to result from calking the blades in the grooves in the rotor. The method by which the error was finally eliminated will be described in a subsequent paragraph.

The next operation was to remove the old blades from the rotor and cases. In order to facilitate matters the rotor was mounted in a cradle of the form illustrated in Fig. 2, and the blades were removed with a hand chisel. A similar method

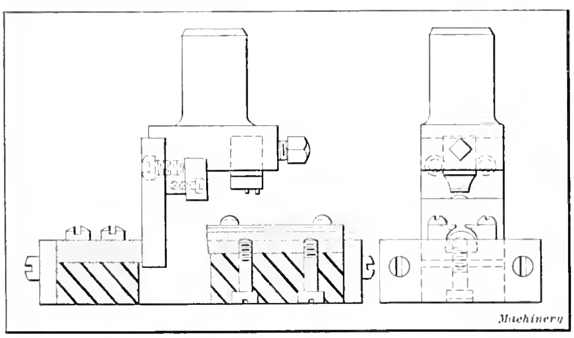

Fig. 3. Shear, Punch and Die used for cutting off and forming the New Blades

of procedure was adopted in removing the blades from the turbine cases. An idea of the magnitude of this task may be gathered from the fact that the total number of blades was in the neighborhood of 60,000.

The first step in preparing to re-blade the rotor and cases was to cut the blades and calking strips from the bar stock. This stock was purchased in lengths of 10 feet, and of the required form for the blades and calking strips. In preparing the blades the operations performed on the stock were as follows: First, pieces of the required length were cut off from the bar. Second, notches were stamped in one end of these blanks to provide for securing them in place in the turbine

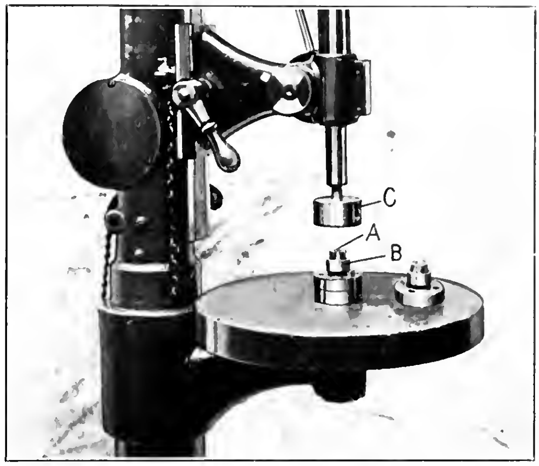

Fig. 4. Method used for milling the Ends of the New Turbine Blades

rotor and cases. Third, the opposite ends of the blades were then milled to the required form. The first and second operations were performed by the combination shear and die illustrated in Fig. 3. This die was used in a No. 18 Bliss power press operated at 90 revolutions per minute. At this speed

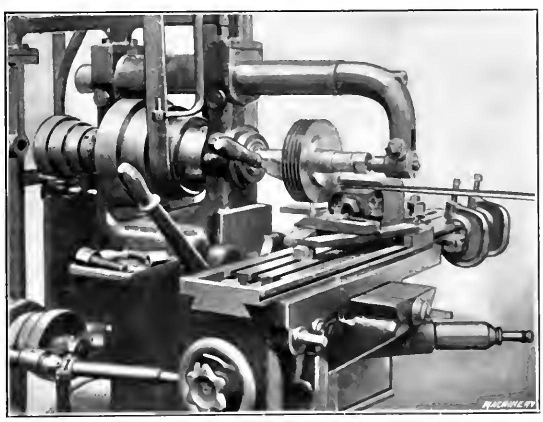

Fig. 5. Milling Machine Fixture used for cutting off Calking Strips

3600 blades could be cut off and grooved in an hour, and the total time required to perform these two operations on 60,000 blades was 18 hours. This does not include the time occupied in adjusting the die.

The ends of the blades were next milled to the required form by means of an end mill mounted in the drill press shown in Fig. 4. The workholder consisted of a pin *A*, 5/8 inch in diameter, around which five blades were held by means of a collar *B*. The hollow mill *C* was fed down over the ends

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of the blades, and about ten seconds was required to complete the operation. The blades were quickly removed from the holder by simply turning it upside down. Two work-holders were employed and two boys were engaged upon this work. One boy operated the machine and the other removed the finished blades from the holder and filled it with fresh blanks, while the milling operation was being performed on

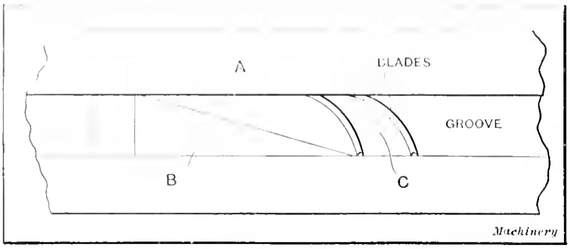


Fig. 6. View of a Groove in the Turbine Rotor showing Method of starting to replace the Blades

work held in the other holder. By this method, it was possible to mill about nine hundred blades per hour, and as long as the milling cutter was kept sharp, a perfectly smooth surface was produced. After washing these blades with gasoline, they were ready to be calked into the cases and rotor of the turbine.

The next operation consisted of cutting up the calking strips into pieces of the proper length. This material, like the stock

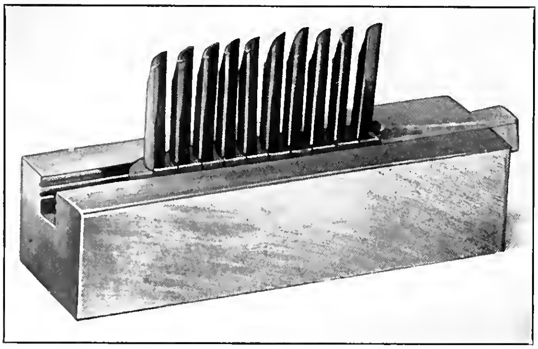


Fig. 7. Model of a Section of the Rotor Groove, showing Blades, Calking Strips and Wedges in place

from which the turbine blades were made, was purchased in 10-foot lengths and cut up by means of gang saws secured on the arbor of a Fox hand milling machine illustrated in Fig. 5. The saws were spaced on the arbor to cut off pieces of the required length and a stop was provided at the end of the fixture to enable the bar stock to be properly located in relation to the saw blades. By this means, six pieces were cut off at once and about 2400 pieces could be cut per hour.

With the blades and calking strips prepared, the work of installing the blades in the turbine was started. In order to make a start in filling a groove, two wedges *A* and *B* were driven into place as shown in Fig. 6. One end of the wedge *A* is formed to the required angle and shaped to enable the first blade to be properly located against it. A calking strip *C* is next placed in the groove and calked sidewise to secure it in small grooves cut in the sides of the grooves in which the blades are mounted. These small grooves may be seen in Fig. 7. Alternate blades and calking strips were then put in place and calked until the opposite side of the starting wedges was reached. The wedges were then removed and the remaining blades and calking strips put into place. A certain amount of manipulation was necessary to get the last few blades in, but after a little experience this part of the work was easily performed; and with one man putting the blades in place and the other calking them, it was possible to set five hundred blades per hour. After a groove had been filled in this way, it was necessary to go back over the same blades a second time and set the calking strips endwise to expand them into the small notches that were stamped in the blades in a preceding operation. A third man performed this work and was able to proceed with about the same rapidity as the two men who set the blades in place. Fig. 8 shows the tools used for

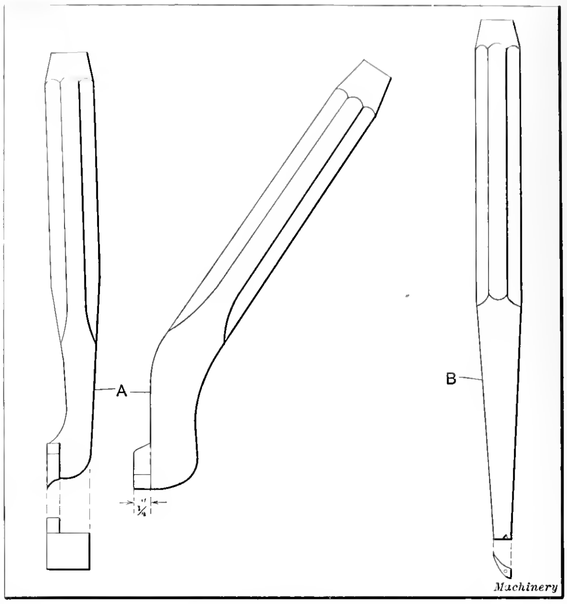


Fig. 8. Tools used for expanding the Calking Strips Sidewise and Endwise

calking. The tool shown at *A* was used for expanding the calking strips sidewise and a tool of the form *B* was used for setting the strips endwise. It will be seen that there is a small hole in the end of the calking tool *B*. This leaves a mark on the calking strip and shows at a glance whether the strip has been set. The blades were mounted in the grooves in the cases in the same manner, but owing to the awkwardness of the position much more time was required for this part of the work.

After both the rotor and cases had been re-bladed, the next operation was to true up the rotor and turn the blades down to a length that would give the desired clearance. The blades

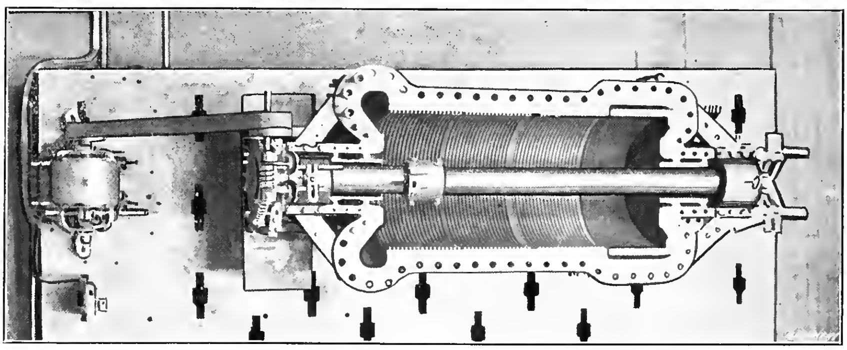


Fig. 9. Arrangement of the Boring-bar for machining the Ends of the Blades in the Cases

were turned in a lathe provided with a special tool which cut the ends off clean without leaving any burr. The journals were next ground, and it was then necessary to balance the rotor. For this purpose the rotor was set up in a lathe and trued between the blades, *i. e.*, the part that revolved close to the fixed blades in the cases. Truing up the drum in this way left one side 0.030 inch thicker than the other side—ac-

cording to previous measurements—and this naturally threw the rotor out of balance. To correct this error, the rotor was mounted on hardened steel knife-edges and allowed to roll until the thick part of the metal—the heavy side—reached the lowest point. The necessary amount of putty to exactly balance the rotor was then placed on the thin side of the drum. The weight of this putty was then determined and its weight in steel secured to the light side of the drum by means of screws. In this way, an accurate balance was secured.

The blades in the cases were finished to the required length in practically the same way that the cylinders of a reciprocating engine are bored. Fig. 9 shows the lower half of the case set up on a surface plate with a 6-inch boring bar fitted in the bearings and driven by an electric motor and belt. A special tool was fitted in the cutter head, the tool being set to about 0.010 inch smaller radius than the cases should have

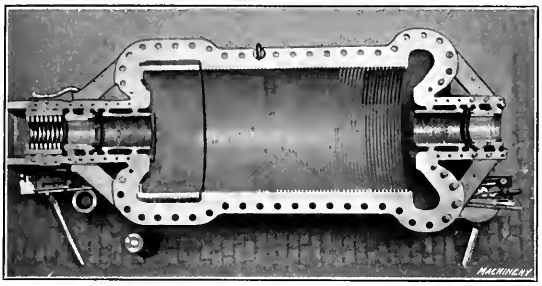


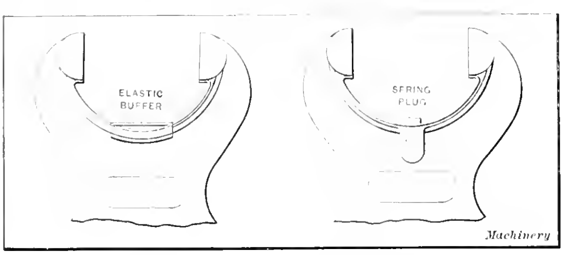
Fig. 10. Upper Half of the Turbine Case ready to be bolted in place for boring the Blades

when finished. The upper half of the case, shown in Fig. 10, was then lowered into place and securely bolted. In this way, the cases were in exactly the same condition as they would be if the turbine were in operation. After running the first cut through, the cutter head was drawn back to the starting point and a second cut was then taken with the boring bar expanded 0.010 inch, which machined the blades down to exactly the required length. The adjustment of the tool and the calipering of the bore was accomplished by reaching through the exhaust nozzle. The time required to bore the rotor cases was eight hours. About the same length of time was required to turn the blades in the rotor to the required length. A clearance of about 0.030 inch was left between the cases and the blades of the rotor. After the cases had been bored out, the bar was removed and the chips and dirt blown out. The bearings were then adjusted, after which the rotor was lowered into place and the cases bolted together.

* * *

IMPROVED LIMIT GAGES

An improvement in snap limit gages of some interest has been patented by Ludwig Loewe & Co. and Otto Moratz of Berlin, Germany. The improvement is intended to give snap gages longer life. The claim is made that when gaging work, the effect of many pieces passed through the jaws is to peen



Ludwig Loewe & Co.'s Improved Limit Gages

the metal at the bottom of the slot of the "go" gage because of the slight shock caused when the part strikes it. The effect is to open the jaws and thus the wear on the jaw faces themselves is accelerated. The inventors interpose an elastic material or a spring plug in the center, which takes the impact of the work piece and thus stops the peening action.

CLUSTER DOUBLE-ACTION PUNCHES AND DIES*

BY BENJAMIN W. HURD†

The cluster double-action punches and dies shown in Fig. 1, although of a type familiar to many readers, should be of interest to others who have not had experience in this style of die construction. While this type of die has many advantages over the single construction, it is open to the objection that extreme care has to be taken in laying out the punch-block. The holes in the die-block are reamed approximately 0.005 inch larger than the collets and are transferred to the die-block through bushings fitted into the punch-block when the two members are clamped together. If the holes for the die-holders are not laid out accurately the tie or web between the blanked holes will be cut out as the metal feeds through, any error in spacing, of course, being multiplied as the work progresses. However, if the die-holder is properly laid out, it is possible to cut very close on scrap. On thin metal, in actual running, it has been found that the scrap averaged 18 per cent, while the estimated scrap was 18¼ per cent. These test runs were made on 0.017-inch metal, 90 Cu 102 N mixture, sixty- and sixty-five-pound rolls, averaging two strips to the roll. The difference between the actual and estimated scrap was due to the slight amount that the feed rolls squeezed the scrap back, making the webs slightly less than that estimated.

As a general rule, the punch- and die-block for this type of die is made from steel, and while this is not necessary as a matter of strength, it does away with the chances of striking a blow-hole in cast iron. The collets, sleeves and nuts, forming the members for holding the dies, are also made from tool steel hardened and ground. The blanking dies *A* are made from a high-carbon steel heated to the recalescent point, cooled in brine, at 62 degrees F., and then placed in an oil bath at 225 degrees F., after which they are ground. Each blanking die is good for approximately 1,000,000 blanks before grinding on the top face, which can be done, as a rule, about ten times, if necessary on account of wear and not due to chipping. It can be seen by referring to Fig. 1, from the way in which the blanking die is held, that if the die is cracked from any cause, after it is ground to size, it still can be used without detriment to the blank. The sleeve holding it is tapered, and in this way as it is drawn up by the nut under the bolster, the die is securely held in place, and if cracked would be closed up.

The cupping dies *B* and *C* are made from "Intra" steel, which is used because of the extremely hard surface obtained when it is heated to the proper temperature and "spouted." It is also extremely tough when heated in this way, and the combination of hardness and toughness is ideal for cupping dies. The small size of these dies makes it necessary to use a steel of great tensile strength, as well as one that will harden well, and "Intra" steel fills these requirements better than any that has thus far been used for this purpose.

The cupping dies are heated to the recalescent point, which is found by using the testing fixture shown in Fig. 2. The die to be tested is placed under the magnet *A* from time to time, as the heating progresses, and when the point is reached where the steel has no attraction for the magnet, the heat is noted on a temperature pyrometer, and all dies made from this grade of steel are heated to that point. If a temperature pyrometer alone is used, without the magnet, readings are taken at stated intervals of approximately one minute apart, and then a chart is laid out by taking the readings as obtained from the pyrometer. This chart, if properly laid out, will show at the recalescent point a horizontal line. When the cupping dies have reached the proper temperature they are "spouted" with brine by holding them under a funnel which hardens the hole and leaves the outside circumference soft. They are then placed in oil, heated to 225 degrees F., and allowed to remain until they reach the temperature of the oil. One noticeable feature of cupping dies made from

* For further information on punch and die work, see "Drawing and Forming an Automobile Clutch Cone," published in the November, 1913, number of MACHINERY, and other articles there referred to.

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"Intra" steel is that they have a longer life—more cups per die—when the press is operated at from 125 to 135 R. P. M. than they do on lower speeds of from 90 to 100 R. P. M.; also the cups come square with less trouble.

In making the blanking punches and dies, care should be taken at all times to have the bottoms of the blanking punches and the tops of the cupping dies parallel. If they are not, it will be impossible to get a square cup, as the punch will bear harder on one side than on the other. In reaming out the hole in the cupping die, care should be taken to see that it is perfectly round and square with the top and bottom faces. A good method of determining if such a requirement has been obtained is to wring the plug gage into the die; this leaves a ring around the hole in the die parallel with the top face when the hole has been properly machined. That is to say, after swabbing out the die and cleaning the gage, a slight oil film is left on both parts; then when the gage is wrung into the die the liquid constituents of the oil are squeezed out, leaving a small carbon deposit. This should show heaviest just at the point where the drawing portion of the die commences to round off into the straight or sizing portion. On the lower or stripping die it is necessary to have the line show heaviest on the bottom, as a slight bell-mouth on the bottom will make the cup strip hard. If this line left by wringing the gage into the die is not parallel with the top face, the cup produced will not be perfectly straight, but will have an irregular top edge. This undesirable condition generally results from a chip clinging to the cutting edge of the reamer for a portion of a revolution when reaming out the die. It is also often caused by poor lapping, but more generally by reaming, as previously mentioned. If more attention were paid to this point there would be less trimming with its attendant scrap on re-draw work, as it is practically impossible to get a floating die to draw square unless it has a perfect "ring" bearing.

The blanking punches *D*, one of which is shown to the right in Fig. 1, are held in the punch-block by the split sleeve

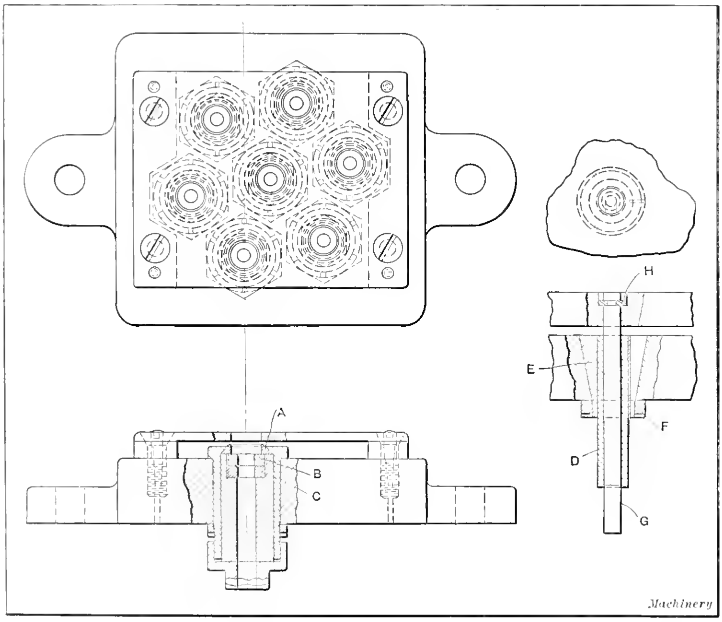


Fig. 1. Cluster Double-action Punches and Dies

E, which, in turn, is drawn down by the nut *F*. This makes it possible for the punch *D* to slip up if more than one blank gets under it, which sometimes happens when a poor piece of metal gets into the press and the drawing punch *G* punches out the bottom of the cup instead of drawing it through the dies. Both the blanking and drawing punches are made from high-carbon steel, heated slowly to the recalescent point in a muffle furnace and rolled around from time to time to get an even heat. They are then plunged in water that has previously been heated to 80 degrees F. This is done slowly with a tank which is so deep that the punch will turn black before being withdrawn. That is to say, the tank should have sufficient depth so that the punch when dipped straight will not touch the bottom before it has been cooled sufficiently to harden; it is also withdrawn straight from the tank. After hardening, the punches are then dipped in oil, heated to 225 degrees F., and allowed to remain in the tank for from ten to fifteen minutes. Afterwards they are ready for grinding.

The drawing punch is made with a taper on the end of from

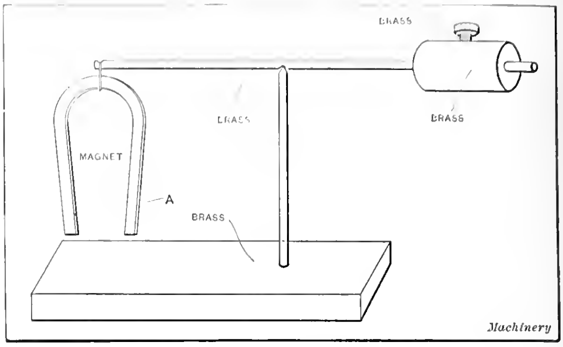


Fig. 2. Magnetic Device for determining Recalescent Point of Dies when heating for hardening

0.004 to 0.005 inch to the inch of length, and is ground to this taper for approximately one inch. When the tapered ends of the punches have worn down below the required size, they are cut off on the end and re-ground, the slide of the press being lowered to compensate for the reduction in length. The upper ends of the drawing punches are held by slotted washers *H* which are fitted into counterbored holes in the punch-block.

The cluster double-action punches and dies shown in Fig. 1 are used in double-action crank and double-action cam presses, but for work using metal thinner than 1/32 inch the cam press is preferable on account of the dwell which it is possible to obtain at the lower end of the stroke while the drawing punches are doing their work. With a strong, well designed and well built press, no trouble should be experienced in cutting with a minimum amount of scrap, when the tools and feeding device have once been properly adjusted.

* * *

Managers, superintendents and foremen sometimes forget in talking with outsiders that their workmen are human beings and have the feelings and instincts common to the race. We have heard superintendents speak in very caustic terms of the characteristics of workmen in general, within hearing of the workmen themselves. This is extremely bad policy. Even if the statements were true, it is not always wise to let the men know how the management feels about them, especially if contemptuous. "Give a dog a bad name and hang him" is an old saying expressing as much truth to-day as when it originated. A better policy is to convey the impression that the management respects workmen as a class and all individuals who merit respect. Thus mutual respect will be engendered, where under the other condition suspicion, hatred and malice are fostered.

* * *

A cement that will resist white heat may be made, according to the *Mechanical World*, from four parts pulverized fire-clay, one part plumbago, two parts iron filings, one part peroxide of manganese, one-half part borax, and one-half part sea salt. These ingredients are mixed together to a thick paste and used immediately after mixing. The mixture is heated gradually after having been first fired.

RELIEF OF TAPS

REVIEW OF DIFFERENT METHODS USED AND DESCRIPTION OF NEW TYPE OF TAP THREAD RELIEF

A great deal has been written upon the subject of the relief of the threads of taps, but notwithstanding this, there is no universally recognized standard as to what constitutes a properly relieved tap, and the product of the different manufacturers of taps varies in this respect. It is possible, however, by analysis and experiment, to determine fairly accurately what constitutes a properly relieved tap, and it is of interest to note that one of the leading tap manufacturers has done this, and has developed methods for producing taps relieved along lines radically different from common practice. These advanced ideas of relief will be explained in the following; but in order to cover the subject comprehensively and give as complete an idea as possible of the results likely to be obtained from taps relieved in various ways, the types that have been used in the past will be reviewed, and an analysis made of the action of taps having different forms of relief.

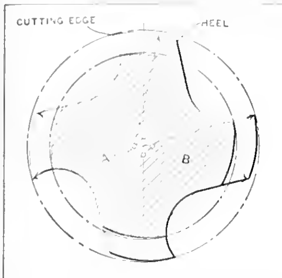


Fig. 1. Cross-section of Tap relieved both on Top and in Angle of Thread

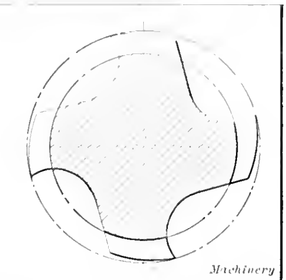


Fig. 2. Cross-section of Tap relieved on Top but not in Angle of Thread

Principles Involved in the Relief of Taps

A tap is said to be relieved when the portions of the land back of the cutting edge are so cut away that the heel of the land (see Fig. 1) is nearer to the axis of the tap than is the cutting edge. In other words, the metal of the land back of the cutting edge has been so cut away that the diameter A of the tap, as measured over two opposite cutting points, is greater than diameter B, measured over the heels of two opposite lands. The effect is simply to give to the land of the tap a relief similar to that given to milling cutters. The object of this relief is to enable the tap to cut more freely, by giving it a keener cutting edge, and by reducing to a minimum the friction between the teeth of the tap and the work being tapped.

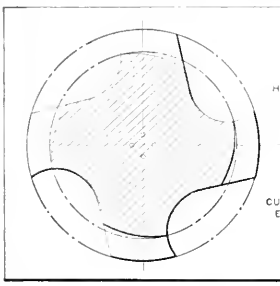


Fig. 3. Cross-section of Tap relieved in the Angle but not on the Top of Thread

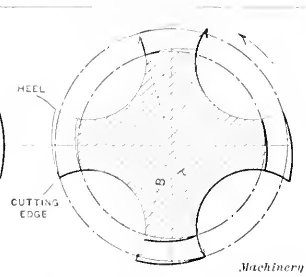


Fig. 4. Tap not relieved, warped in hardening so Diameter over Heel is Larger than over Cutting Edge

It is apparent that taps may be relieved both on the outside diameter and in the angle (and then also at the root) of the thread; as is the case in Fig. 1; or they may be relieved only on the top of the thread, but not in the angle (or at the root) of the thread, as indicated in Fig. 2. It is also possible to relieve only in the angle of the thread, leaving the outside circumference of the tap unrelieved, as shown in Fig. 3. This condition is possible, however, only when the thread is provided with a flat on the top, and permissible only where the maintaining of the width of this flat is of no importance. If the thread is perfectly sharp at the top, it is evident that any relief given to the angle of the thread will of necessity produce a relief on the top of the thread as well.

In order to intelligently analyze the subject, it is necessary to divide taps into three classes, because of the different conditions governing the type of relief required in each of the three divisions. The first class is that of straight-threaded taps; the second, taper-threaded taps; and the third, taps having one portion threaded straight and another portion threaded taper.

Straight-threaded Taps

By a straight-threaded tap, we mean a tap having the same outside, pitch and root diameter of thread at the point of the tap as at the shank end; that is, a tap having the thread parallel to the axis, as shown in Fig. 5. Of course, the extreme end of the tap may be chamfered on the top of the thread as indicated, but that does not alter the fact that the tap is straight-threaded. A number of different methods have been used for relieving taps of this class. In many instances, no relief at all has been given to the full threads, but the tops of the threads of the chamfered portion at the end of the tap have been relieved in a manner similar to that used for milling cutters. In other instances, the thread has been relieved both on the top and in the angle, clear from the cutting edge to the heel, as shown in Fig. 1. Neither of these methods, however, has proved satisfactory; the objection to the first is that the thread being full both in the angle and on the outside, causes the tap to move with excessive friction, and considerable power is required for tapping. The method of relieving the tap both on the top and in the angle of the thread clear from the cutting edge to the heel has the objection that the tap will lose its size as soon as it is ground on the face of the cutting edge,

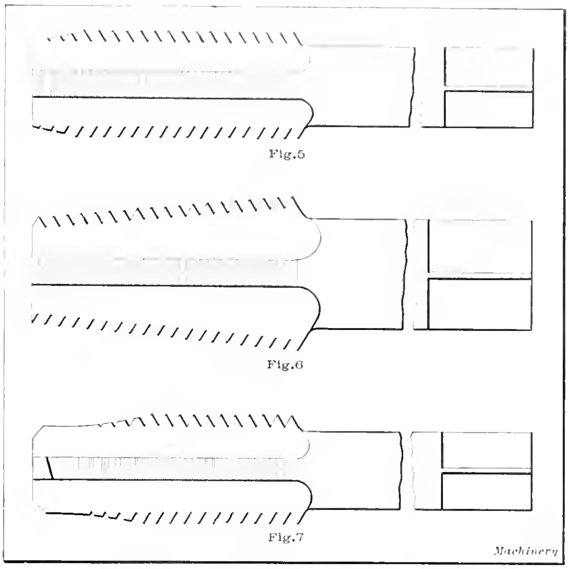
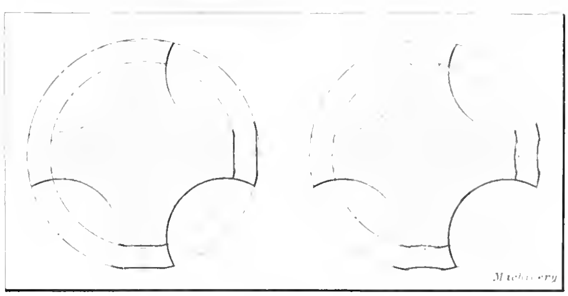


Fig. 5. Straight-threaded Tap. Fig. 6. Taper-threaded Tap. Fig. 7. First Tap in a Set of Three, commonly called "Taper Tap"



Figs. 8 and 9. Taps relieved in Center of Land both on Top and in Angle of Thread

which is the correct method of sharpening. Furthermore, it is claimed that taps thus relieved cannot cut a perfectly round and smooth hole, because they are not sufficiently supported while cutting, as the surface of contact between the tap and the work is practically limited to four points (in a four-fluted tap.)

To overcome the objection of having only point supports, taps have been manufactured with relief in the angle of the thread only, while the outside was left the full diameter of the thread from the cutting edge to the heel, as shown in Fig. 3. In this manner, the object of producing a free cutting tap has been gained, and the taps are also well supported in the hole to be threaded, but the objection remains that a tap relieved in this way loses its correct size at the pitch diameter as soon as it is ground on the face of the cutting edge. The outside diameter will remain constant, no matter how much the tap is ground on the face, but as the angle or pitch diameter is the most important dimension, it will be conceded that unless the tap is originally made considerably over size it will, after a few grindings, become appreciably smaller than standard. It is also evident that on a U. S. standard thread tap, the flat on the top of the thread becomes narrower toward the heel of the lands, if the tap is relieved in the angle of the thread only. In other words, the form of the thread will not be correct throughout the width of the land. This, however, is a matter of minor importance, as after repeated grindings it will merely provide proportionately more clearance at the top of the thread, which is often a commendable feature.

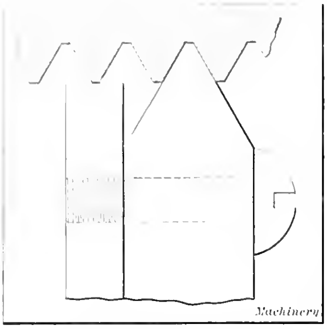


Fig. 10. Tool for relieving Taps in Angle and on Top of Thread simultaneously

A tap with a sharp V-thread, however, cannot be relieved in this manner, because as has been already pointed out, the relief in the angle will of necessity cause a relief of the sharp top of the thread as well. It is true that in practice sharp V-thread taps are provided with a very small flat on the top of the thread, but this flat is not large enough to permit of relief in the angle without relief on the outside. In the case of taps with the Whitworth form of thread, it is impossible to relieve them in the angle without also relieving the top of the thread, if the proper form is to be retained.

To overcome the objections mentioned, another method of relief has been tried, although, so far as we know, this method has not been generally employed on taps manufactured for the market. This method is shown in Figs. 8 and 9, where both the outside and the angle of the thread are relieved in the center of each land of the tap. This kind of relief can be produced in the angle of the thread by hand with a 60-degree, three-cornered file (Fig. 8) or with a regular threading tool, if done in a lathe provided with a relieving attachment (Fig. 9). The outside of the thread can be relieved by filing; but if the relieving is done in a lathe, it can be most economically accomplished with a combination tool, as shown diagrammatically in Fig. 10. In Fig. 11 this tool is shown in use on a lathe provided with a relieving attachment, where both the outside and the angle of the thread are relieved simultaneously. The object of this relief is to obtain a tap which has the same support along its periphery as one that has not been relieved; this object is secured by having a bearing both at the cutting edge and at the heel of the land. At the same time a tap is obtained producing less friction when in action, on account of the fact that the thread does not have as large a contact surface with the work as in the case of the unrelieved tap. The objection to this kind of relief is that in the case of fine pitches or taps with narrow lands, its production becomes an extremely delicate and difficult operation, and is has not proved commercially satisfactory.

Taps with Back Taper

On account of the many objections to these various kinds of relief on straight-threaded taps, some manufacturers began making the parallel portion of their taps with no relief at all, either on the top or in the angle of the thread. Instead, in order to produce a tap cutting more freely, and one that would, as has often been said, "relieve itself," most manufacturers have adopted the practice of providing their taps with "back taper;" that is, the diameter of the thread both in the angle and on the outside is made a very small amount less at the end of the thread joining the shank than at the point. (See MACHINERY, December, 1912, "Notes on the Early History of Tap Making.") This is shown in an exaggerated manner in Fig. 12, where diameter A at the point is shown larger than diameter B next to the shank. When taps are made in this way, the cutting size of the tap will be at the large end of the chamfered portion. At the shank end of the thread, the diameter will be anywhere from 0.0005 to 0.0025 inch smaller than at the point, according to the size of the tap.

This back taper has the effect of producing a tap that cuts well, and such taps are frequently referred to as "taper relieved." However, it is hardly correct to speak of this feature of the tap as a relief, and while back-tapered taps are considerably superior to those that are perfectly straight on the thread, they do not possess the desirable qualities that it is possible to impart to a tap that is properly relieved according to a method yet to be explained. If a tap that has no relief at all in the angle or on the top of the thread should happen to twist in hardening so that the cutting edge diameter A becomes less than the heel diameter B, as shown in Fig. 4, it is evident that such a tap will give trouble. Those well versed in the manufacture of taps are inclined to believe that this twisting of the lands is the cause of a great many of the complaints about improper relief and hard cutting that are received by tap makers from their customers. It is a difficulty that is practically impossible to overcome, except by adopting a method of relief that eliminates the objectionable effects of warping and at the same time overcomes the objections mentioned to the types of relief already shown. No matter how small an amount the land twists in the wrong direction in hardening, it is evident that it will cause any tap to cut hard that is not relieved in the angle of the thread.

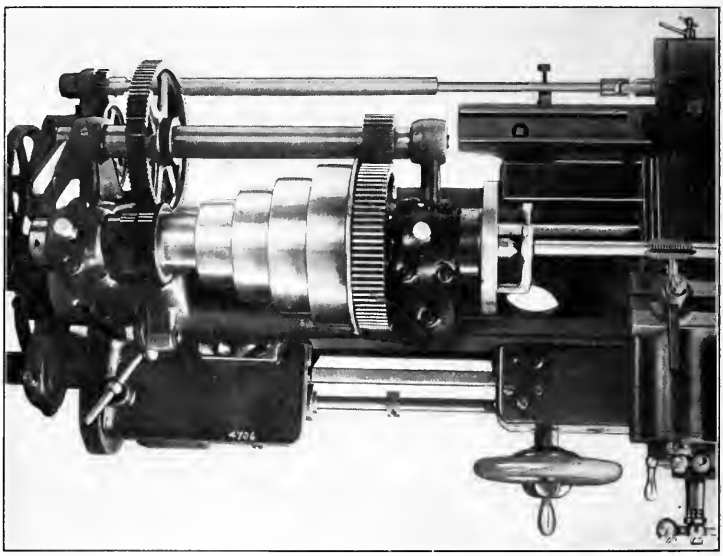


Fig. 11. Combination Tool shown diagrammatically in Fig. 10 in use for Tap relieving in a Pratt & Whitney Co. Lathe with Relieving Attachment

Of course sometimes the land may twist in what we might call the right direction. In fact, this will happen just as often as the twisting in the wrong direction, if the taps are fluted with convex cutters. In that case, the effect is that of a relieved tap. The twisting of the land in hardening can be largely overcome by fluting the tap as indicated in Figs. 1, 2 and 3. It will be clearly seen that this form of flute produces a land that is more strongly supported than is the land of a tap fluted with a convex cutter. (For information relating to tap-fluting cutters see MACHINERY, March, 1913, "Tap Fluting Cutters.")

Form of Relief as made by the Pratt & Whitney Co.

Recognizing the objections to the different types of relief so far discussed, and realizing from their long experience in the tap making business that there was an urgent demand for a tap that was relieved in such a manner that it had not only the proper support in the hole to be tapped, but also a free cutting action and a minimum of friction, the small tool department of the Pratt & Whitney Co., Hartford, Conn., some five or six years ago, originated the form of relief shown in Fig. 13 as the most desirable. As will be seen in the illustration, the top, the angle and the root are concentric for one-third the width of the land, the remaining two-thirds being eccentrically relieved. A tap made in this way can be ground for sharpening on the face of the cutting edge without interfering with the size of the tap or the form of the thread. Hence, there has been secured an eccentrically relieved tap which has enough of a concentric land to permit of sharpening without losing its size and which has more than a mere point support in the hole.

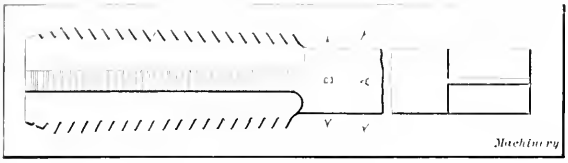


Fig. 12. Ordinary Straight-threaded Hand Tap showing Back Taper Exaggerated

Having determined upon this type of relief, the Pratt & Whitney Co. began to make taps for the market along these lines and for the last five or six years they have manufactured taps with this kind of relief; at the present time all taps suitable to be relieved in this manner are so made. The methods used by the Pratt & Whitney Co. not only secure the above described relief, but also insure the manufacture of a tap having considerably greater accuracy and refinement than it has heretofore been possible to obtain.

It will be seen that the method of relief shown in Fig. 13 is applicable to all forms of thread, the U. S., the V, and the Whitworth, and that it can be adapted with equally satisfactory results to any type of tap. On the chamfered part of the tap, the top of the thread is relieved all the way from the cutting edge, because on this portion it is important to secure a keen cutting edge, and as this part of the tap has nothing to do with the retaining of the size of the tap, there is no objection to relieving it all the way from the edge. The relief on the chamfered part of the tap is also greater than the relief in either the angle or on the top of the thread of the parallel portion, which adds to the cutting qualities of the tool. The regular relief in the angle is also maintained in the chamfered portion.

Taper-threaded Taps

In order to guard against any misunderstanding, the expression "taper taps" should be defined at the outset. While the first tap in a set of three hand taps, as shown in Fig. 7, is frequently referred to as a "taper tap," this is, properly speaking, not a correct usage of the word. A taper tap is a tap that is smaller on the top and in the angle diameter at the point than it is at the end where it joins the shank, and therefore increases gradually in both the angle and outside diameter from the point upward as shown in Fig. 6. The most common type of taper tap is the pipe tap.

It is evident that a taper tap, unless of very slight taper, would refuse to cut altogether if it were not relieved right from the cutting edge and for the whole width of the land; because, as the tap tapers and as the heel of the thread must necessarily be at a point higher up on the taper than the cutting edge (due to the spiral of the thread) the diameter over the heel is greater than the diameter over the cutting points in an unrelieved tap. While taper taps, therefore, must be relieved for the whole width of the land, both on the top and in the angle of the thread, this relief can be made of such an amount that there will be a fair bearing of the tap in the hole to be threaded and so that the tap will not bear merely on the cutting edges. It should also be remembered that when a taper hole is threaded, every tooth which is in contact presents a resting or a steadying point for the tap, while in a straight-threaded tap there are only a few teeth which are actually in the process of cutting and which present any steadying effect.

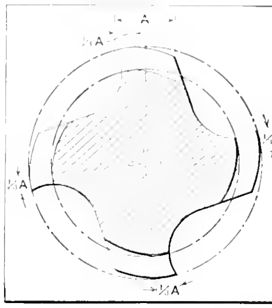


Fig. 13. Type of Relief originated by the Pratt & Whitney Co.

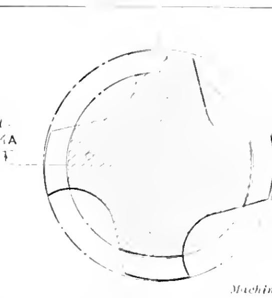


Fig. 14. Method of properly relieving Taper-threaded Taps

Most of the difficulties met with in taper-threaded taps are due to the manner in which the taps are relieved. While a tap as shown in Fig. 1 would seem to have a much greater relief than that shown in Fig. 14, a comparative test between taps relieved by various methods will show that a tap relieved as in Fig. 14 cuts far more freely than the ordinary commercial taper tap. The relief shown in Fig. 1 is, however, the most commonly used, probably because the subject has never been thoroughly investigated. An analysis of the conditions produced by relieving as shown in Figs. 1 and 14 will indicate that the tap in Fig. 14 presents a more even relief throughout, after repeated grindings.

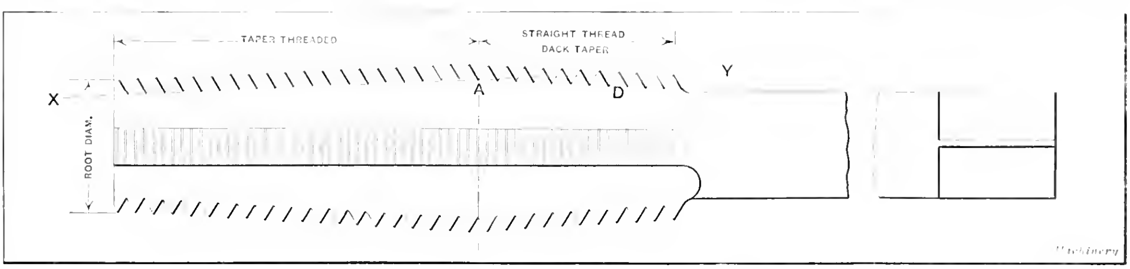


Fig. 15. Tap partly Taper-threaded and partly Straight. The Straight Portion is Back Tapered, the Back Taper being shown Exaggerated

Taps having One Portion of the Thread Tapered and Another Portion Straight

As will be seen from Fig. 15, taps of this kind (machine nut taps, some tapper taps, die taps, etc.) have one portion of the thread tapered both in the angle and on the outside of the thread and the other portion left straight, thus making a

combination of a taper and a straight tap. Taps of this style are used principally for very exacting work, such as the tapping of especially long nuts or nuts made of tough or hard material. They are also used where a nicely threaded hole is required, as each thread in the tapered portion takes what might be called a roughing cut, until the straight portion is reached and a final finishing touch is given to the thread. An ideal tap for this class of work is one in which the tapered portion is relieved right from the cutting edge, as in a taper tap, while the straight portion is relieved like a straight tap, with one third of the land concentric and two-thirds relieved, according to the practice adopted by the Pratt & Whitney Co. as already described. It is obvious that the production of such a tap by ordinary manufacturing methods would involve considerable difficulty.

Taps of this class that have been put on the market in the past are, in some cases, relieved on the tapered part, while the straight portion is not relieved. In other cases, the tapered portion is relieved both in the angle and on the outside of the thread, and the relief is then continued with the same taper into the straight part until the relieving tool runs out because it has nothing more to cut, as shown by the line XY in Fig. 15. The relief thus given to some of the threads in the straight portion is similar to that indicated in Fig. 13, although it is obvious that the proportion between the concentric and relieved parts of the land varies until the relief, which is maximum at point A, gradually decreases to no relief at all at point D. A tap relieved in this manner and threaded with a back taper on the straight portion presents a tool which, so far as relief is concerned, leaves very little to be desired. The back taper in the illustrations is exaggerated, the amount in practice being so small that it would not be visible in an illustration.

* * *

PLANING GIB-TAPERS

When planing castings for the tables of the Blanchard vertical surface grinding machines, the Blanchard Machine Co., Cambridge, Mass., employs a labor-saving kink for resetting the work for the gib-tapers. As illustrated in Fig. 1, these table castings are mounted on the planer platen in a string of five. They are set up in the usual way for the straight planing, except that beneath the right-hand projecting side of each casting is mounted a special angle block, the end of one of which may be seen outlined at the right-hand lower corner of the planer table in Fig. 1. A better

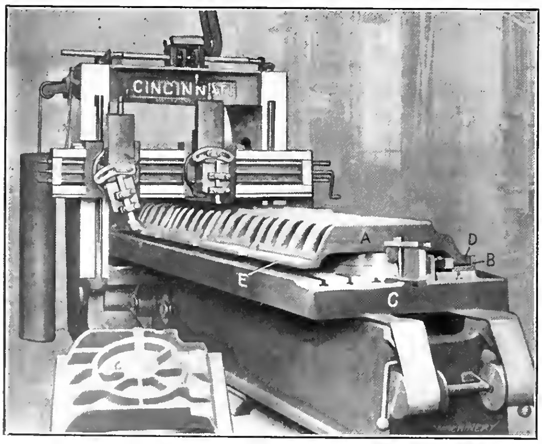


Fig. 1. Planing the Tables for Blanchard Vertical Surface Grinders

idea of this block may be obtained from the line illustration Fig. 2, where one of the castings is shown at A, with its corresponding tapered block B clamped to the planer table C. It should be especially noticed that angle block B does not in any way touch casting A while the straight planing is being done; and the tapered edge of the block is fully an inch away from the outside edge D of the work during this operation, allowing the planer tool plenty of room to work on the edge. Edges E, which are to be tapered, are not planed at this operation, but the other planing on the casting is all done at this setting.

After the straight planing has been completed, the clamping straps, one of which is shown at the end of the string of work in Fig. 1, are loosened slightly, and the castings moved to the right, over the intervening inch to bring their right-hand edges D in conjunction with the tapered sides

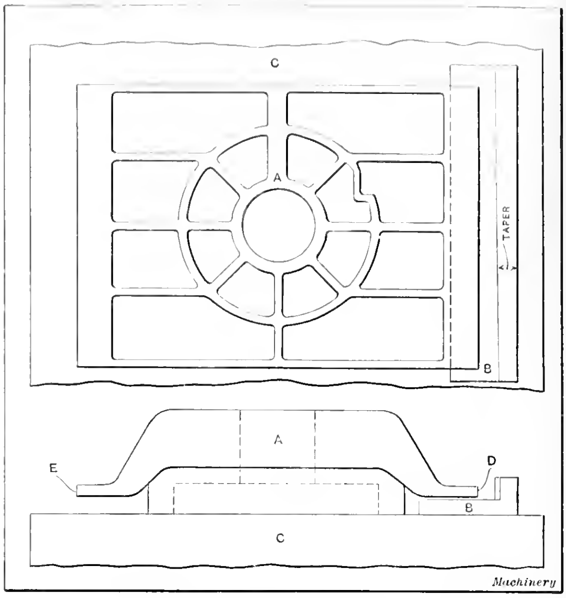


Fig. 2. One of the Grinder Tables on the Planer, showing the Blocks used for the Gib-taper Planing

of angle blocks B. Paper "feelers" are employed in locating the work against the inclined faces of the blocks, and one of these strips shows in Fig. 1. This of course throws the opposite edges of the castings out of line the exact amount of the taper in the angle block. The straps are then re-tightened and the final cut taken along the left-hand edges E of the tables, forming the necessary taper for the gibs that are to work in conjunction with these sides. C. L. L.

* * *

GERMAN MACHINE INDUSTRY

In a recent consular report some interesting statistical figures are given relating to the rapid development of the German machine industry. In 1882, the number of persons engaged in the machine and allied trades in Germany was 356,000. In 1895, it was 582,000, and in 1907, 1,120,000. Since 1907, the increase is stated to be at a still more rapid rate than during the twelve years previous. A further evidence of the importance of German machine and electrical industries is given in the fact that in 1912 the exports of all classes of machinery exceeded in value $250,000,000, as compared with $90,900,000 in 1900. German imports of machinery show a relative decrease. In 1900, they amounted to $35,200,000; in 1907, $36,700,000, and in 1912, to $30,700,000. The only classes of machinery which at the present time are imported are American machine tools, shoe machinery, harvesting machinery, computing machines, sewing machines and cash registers, and English textile machinery. A relatively small number of automobiles are imported from France.

Referring specifically to metal-working machinery, the consular report states that the imports in 1907 had a value of $2,262,000 and in 1912 of $145,000, while the exports both years exceeded $15,000,000. The exports of metal-working machinery go chiefly to Russia, Austria-Hungary, France and Italy. With relation to the world's trade in machinery and electrical apparatus, the three principal exporting countries are Germany, the United States and England, their importance, considered on the basis of the value of the exports, being in the order mentioned.

TAPER BORING AND TURNING ATTACHMENTS

DESIGN AND CONSTRUCTION OF LATHE AND BORING MILL EQUIPMENT FOR TAPER WORK

BY ALBERT A. DOWD*

The proposition of accurately machining male and female tapered surfaces is one of almost daily occurrence in every factory, while the tapers required are of every degree of inclination. The materials on which the work is to be done are also varied, both in their general form and in their composition, ranging from steel or brass bar stock of small diameter to cast iron or steel castings of great size. Conditions governing the work are widely different, as the number of pieces needed obviously makes a difference in the method of handling. When only one or two are required, and the size of the work is not prohibitive, the engine lathe is most frequently used, several well-known methods of generating the taper being possible on this machine, *viz.*, setting over the tailstock to the correct angle, when the work is of such a nature that it may be held on centers; using the compound rest with hand feed; and using the taper attachment with which nearly all modern lathes are equipped and which is too well known to need description. There are also occasional instances where the lathe may be used for manufacturing work of this kind in large quantities, by means of special attachments, although this is usually applicable to conditions requiring no other machining operations except the taper. As a general thing when the number of pieces is sufficiently large to warrant it, the work is performed on

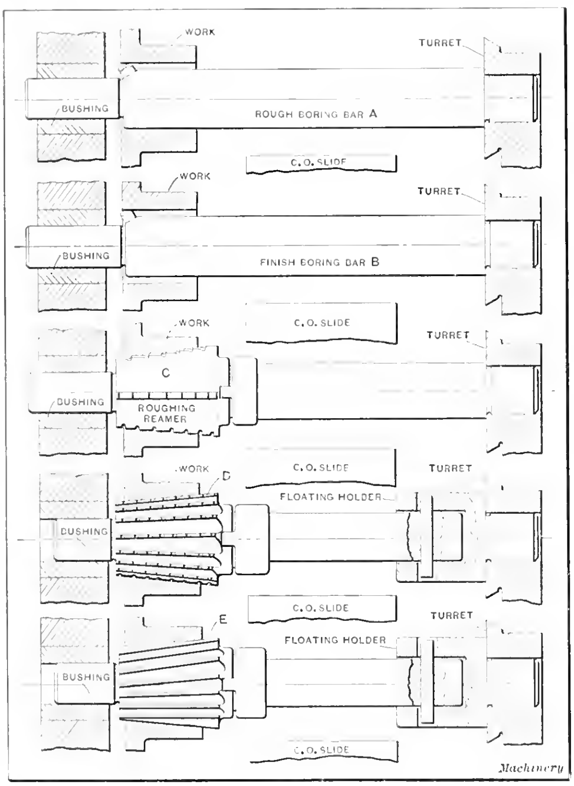


Fig. 1. Typical Boring Tools and Reamers for Taper Holes

the horizontal screw machine or turret lathe, the vertical turret lathe or the vertical boring mill. Many ingenious schemes for generating tapers on these machines have been devised, the construction of a number of which will be described and illustrated in this article.

Taper Turning Devices for Bar Stock

On turret lathes or screw machines equipped for bar work, there are various devices for turning a taper on the bar. These tools are in many instances patented, and may be purchased of the manufacturers. Obviously there are such a number of these that it is out of the question to attempt to describe each one. Detailed information may be easily obtained on request.

Method of Finishing a Taper Hole without Generating the Taper

Before taking up the subject of generating devices for taper work, let us first consider a method much used in tur-

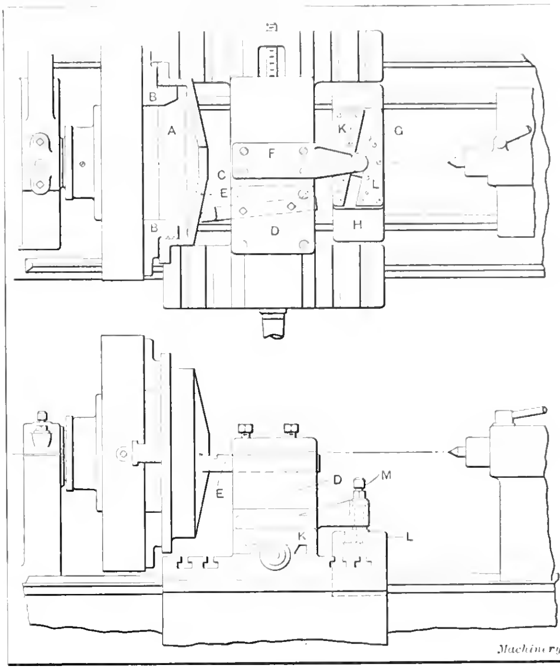


Fig. 2. Engine Lathe Attachment for turning Bevels

ret lathe practice and one which may be depended upon to give very satisfactory results, when absolute accuracy is not essential. When the tools are properly taken care of, good commercial work may be turned out by means of the tooling shown in Fig. 1. It will be noted that all the tools used, are piloted in a bushing located in the chuck. The first tool used, shown at *A*, is a plain boring bar which serves to rough-bore the hole, thereby producing an approximately true generated straight hole. The second tool *B*, is a finish-boring bar which brings the hole to about the required size for the small end of the taper. The next tool *C*, is a roughing taper step reamer which removes the larger part of the stock left in the hole, and leaves the work in the form of a series of grooves or steps with the angle of the correct inclination. A roughing taper reamer *D* is next used in a holder so made that the rear end of the reamer will float. It will be noted that this reamer is straight fluted but that a left-hand spiral groove with about 3/4 inch lead is cut the entire length of the tool. This serves to break the chip and makes for much easier cutting, also having a tendency to prevent pulling in. The hole is sized with another reamer of the floating type *E* which may be either straight-fluted or made with a left-hand spiral of five to seven degrees, depending on the angle of the taper. The method shown here will not give as accurate results as may be obtained by generating the taper, but the sizing of the hole may be kept very nearly correct with little trouble, although slight variations in concentricity are bound to occur. One of the greatest objections to this manner of handling taper work is that the operator does not keep his tools up properly, and by being careless in regard to this

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matter, he leaves the reamers to do the most of the work and the results are therefore disastrous on account of the unequal wear on the reamer.

Taper Attachment for Producing a Conical Surface on the Engine Lathe

Fig. 2 shows an attachment fitted to the engine lathe for the purpose of producing the proper angle *C* on the head

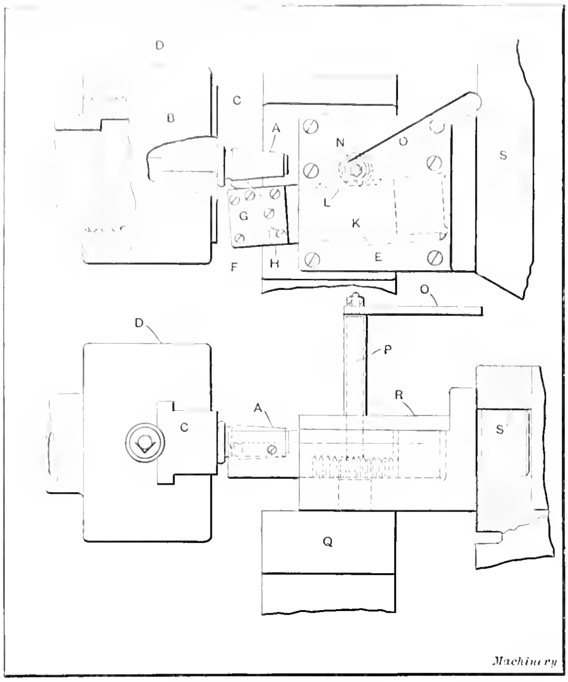

Fig. 3. Taper Attachment for Small Hand Screw Machines

casting *A*. In this case the work is held in special jaws *B* which grip the interior of the casting as shown in the upper

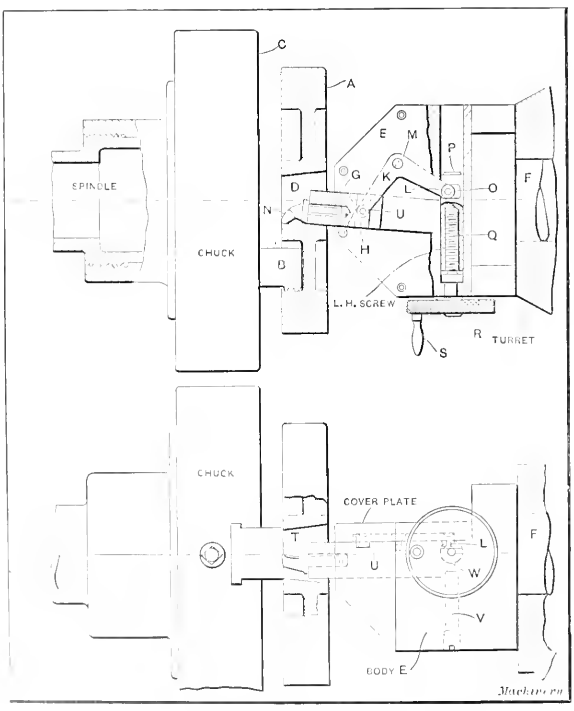

Fig. 4. Attachment for generating Small Taper Hole in a Motorcycle Flywheel

part of the illustration. The cross-slide is equipped with a special tool-block *D* in which the tool *E* is held. The casting *H* was planed on its under side to fit the inner ways of the lathe and was clamped in position by means of straps not shown. Two steel plates *K* and *L* act as guides by which the proper taper is formed. These plates are hardened and the edges of the slot were ground parallel after assembling, to insure accuracy. A bracket *F*, fastened to the cross-slide, carries a pivoted steel block *G* which travels in the slot, thereby controlling the movement of the carriage, and producing the desired taper. An oiler *M* acts as a gentle reminder that surfaces subject to friction are in occasional need of lubrication. The inner surface of casting *A* was machined on the same lathe in another setting, another set of forming plates being applied to the casting *H* to produce the required taper. This method of handling gave very satisfactory results.

Taper Attachment for a Small Hand Screw Machine

A small brass cock, shown at *A* in Fig. 3 is a good example of an outside generated taper. The stem of the cock *B* is held in the special jaws *C* of a two-jawed chuck *D*, this being obviously screwed to the spindle of a small hand screw ma-

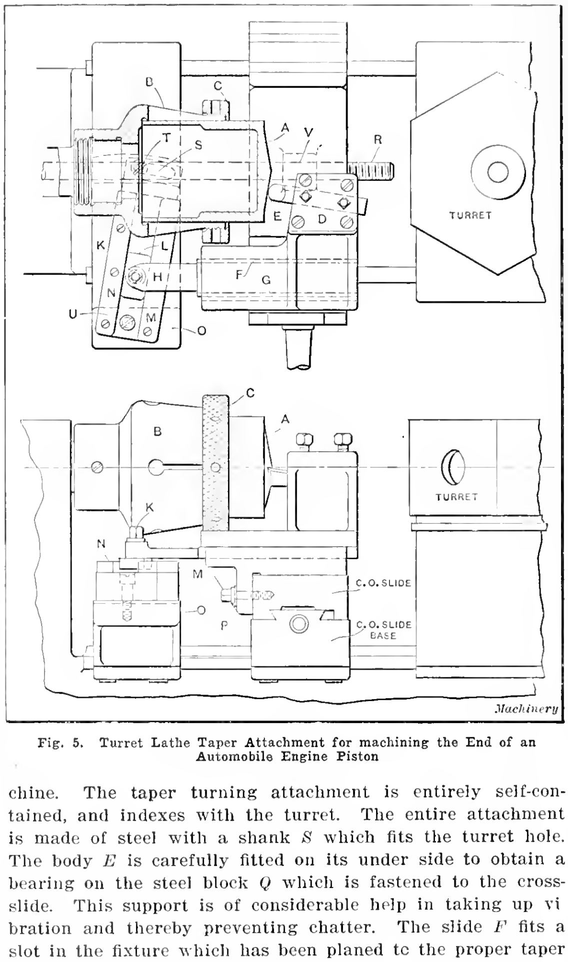

Fig. 5. Turret Lathe Taper Attachment for machining the End of an Automobile Engine Piston

chine. The taper turning attachment is entirely self-contained, and indexes with the turret. The entire attachment is made of steel with a shank *S* which fits the turret hole. The body *E* is carefully fitted on its under side to obtain a bearing on the steel block *Q* which is fastened to the cross-slide. This support is of considerable help in taking up vi bration and thereby preventing chatter. The slide *F* fits a slot in the fixture which has been planed to the proper taper and the gib *K* acts as a take-up for wear. The cutting tool *G* is of rectangular section and accurately fits a slot in the front end of the taper slide. The headless set-screw *H* assists in setting the cut to obtain the proper diameter. A rack *L* is cut along one side of the slide and meshes with the pinion *N*, the shank *P* of which runs up through the body of the fixture and is operated by the lever *O*. A cover plate *R* is carefully fitted and keeps the parts in position. Tools of this type are much used on small brass work and the work accomplished by them is excellent where very little stock is to be removed. They are built to generate a certain specified taper and can be used for no other.

Attachment for Generating Small Taper Hole in a Motorcycle Flywheel

The rather complicated little attachment shown in Fig. 4 was built for a final finishing cut in the taper hole *D* of the motorcycle flywheel *A*. In spite of the fact that the attachment itself is inclined toward multiplicity of moving parts, its action was so satisfactory that a duplicate order was received a few months after the original tool had been built. It will be noted that the jaws *B* of the three-jawed chuck *C* grip the work on the inside of the flange, and hold it far enough away from the chuck to permit back cutting on the hub and flange, thereby permitting the work to be finished in one setting. The body of the attachment *E* is made from a piece of round steel stock beveled on the front end and with the shank *F* turned at its rear end to the proper diameter to fit the turret hole. The taper slide *G* fits an angular slot cut in the body of the attachment and is reamed at its front end to receive the shank of the cutting tool *N*. This tool is forged to the shape shown and is carefully ground to gage. As the amount of metal which this tool removes is very slight, it requires regrinding only at long intervals. A headless set-screw *T* secures it in position. The bell-crank *K* is pivoted at *M* and the hardened steel rollers *L* and *U* are located at the two ends. The roller at the forward end operates the slide by its action in the slot *H*, while the roller at the other end enters another slot *O* in the operating pin *P*. A teat screw *V* enters the spline *W* cut in the under side of the operating pin, thereby preventing it from turning. The

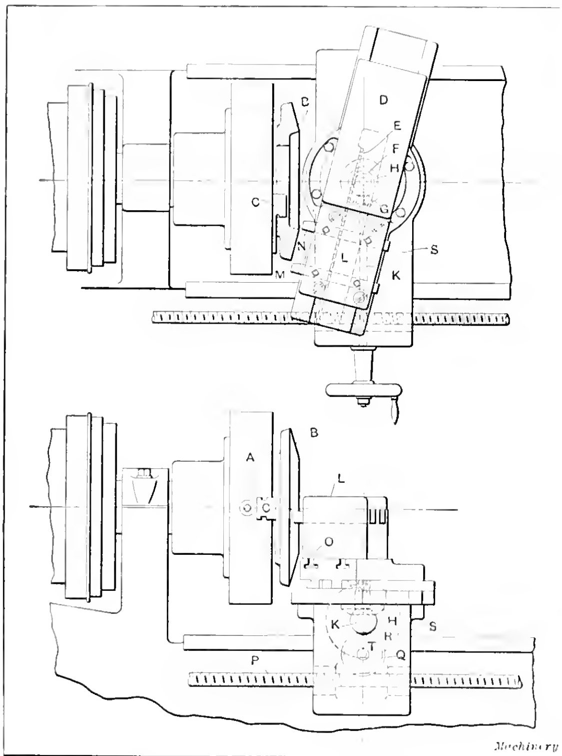

Fig. 6. Adjustable Cut-off Slide Attachment

small knurled handwheel *R* contains a little finger handle *S* which is used to revolve the screw *Q*. The rod *P* is tapped out to receive this screw, and obviously is moved forward or backward by its action, the motion being carried forward through the bell-crank to the operating slide.

Turret Lathe Taper Attachment for the End of an Auto Piston

The automobile piston shown at *A* in Fig. 5 has been finished on the outside but the end has not been formed to the required taper. It is held in a special spring chuck *B* which is closed in on the end by the tapered screw collar *C*. In this instance there were several conical headed pistons to be taken care of, the angle of the cone varying slightly in each case. The turret lathe selected for use in this operation was of a standard make, and the longitudinal movement of the cut-off slide was controlled by the screw *R* engaged with the nut *V* on the under side of the slide. This screw was operated by a handwheel and was not coupled up with the feed mechanism. It was used principally to move the slide back and forth along the ways to any desired location. It will be seen that in this instance any sort of floating action in a longitudinal direction was out of the question and it was therefore necessary to design a special tool block *D* having a dovetail slide *F* and an extension *H*, at the end of which

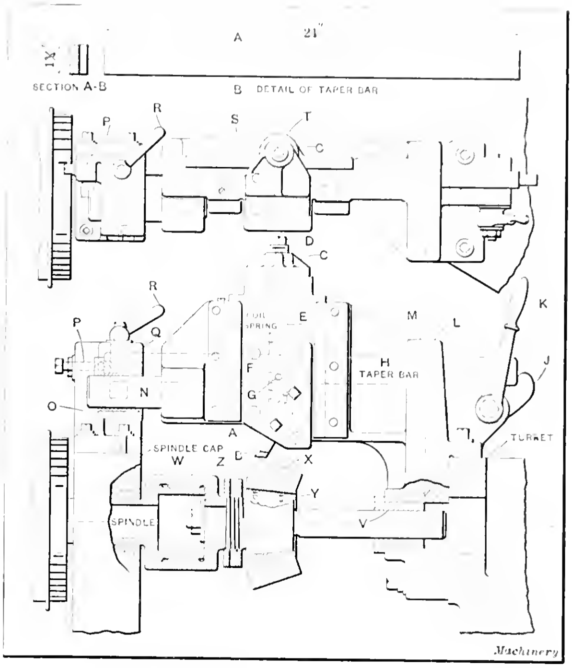

Fig. 7. Taper Attachment for machining a Bevel Pinion

the hardened and ground steel block *L* was located, pivoting on the screw pin *K*. A swivel block containing two parallel plates *N* and *M* may be swung on the shouldered screw *U*, to suit the various angles. The curved slot *S* permits the necessary movement, while the binder *T* secures it firmly. The swivel is mounted on the bracket *O*, which is gibbed to the ways in such a way that it may be moved to any desired location. When the attachment is used the cut-off slide cross feed is thrown into gear and the angularity of the swivel block determines the movement of the tool *E*. As a point in design, attention is called to the way in which the tool block is carried over the edge of the slide at *P*, for the purpose of obtaining rigidity and preventing any chance of side slip. The writer knows of a number of instances where attachments of this kind have been used with very gratifying results.

Swivel Cut-off Slide Attachment

The bevel gear shown at *B* in Fig. 6 is held in the three-jawed chuck at *C*, by means of soft jaws, and the tools *M* and *N* are used for roughing and finishing the face of the gear, the spacing of the tools being such that the finishing tool takes up the work as soon as the roughing tool has completed its cut. This entire mechanism is special.

The carriage *S* is gibbed to the ways in the usual manner and upon this carriage is mounted the swivel slide arrangement *D*. This slide may be swung to any angle within its range and securely fastened. It will be noted that the feed-screw *P* meshes with the wormwheel *Q*, and the movement is transferred through the spur gears *T* and *R* to the shaft *K*. At the inner end of this shaft the pinion *G* meshes with the bevel gear *H* on the upper end of which is the spur gear *F*. This spur gear engages the rack *E* cut along the inner side of the slide, thus giving the necessary feed movement. The

tool block L is held in place by screws which pass down through it into steel shoes in the T-slots O. The operation of this mechanism is so apparent that no comment is necessary.

Taper Attachment for a Bevel Pinion

The bevel pinion X shown in the lower portion of the illustration Fig. 7 has been bored with a taper hole and the back side faced in a previous operation. A keyway Y has also been cut for driving purposes. The equipment shown was designed for a large factory manufacturing bevel gears and pinions and the taper turning device shown is so arranged that it may be used for a variety of angles. A number of taper bars such as that shown in detail in the upper part of the illustration, were made to suit the different conditions.

The spindle nose-piece W contains a tool-steel arbor pilot supported at V in the fixture bushing. The nut Z is simply used to release the work after the machining operation has been performed. A cast-iron adapter L is screwed to the turret face, and on this is mounted the body of the fixture M. The cutting tool B is held in the sliding tool block A, which is scraped to a nice sliding fit, and has a taper gib provided for adjustment. A tool-steel block F is pivoted to the back of the slide on the pin G, allowing it to adapt itself to the angle cut on the taper bar. Referring to the upper view it may be seen that the plate S forms a cover for the open side of the fixture, and that it contains the long boss T which holds the spring E. This spring thrusts against the end of the screw D. The bracket C is fastened to the top of the slide and is tapped out to allow adjustment

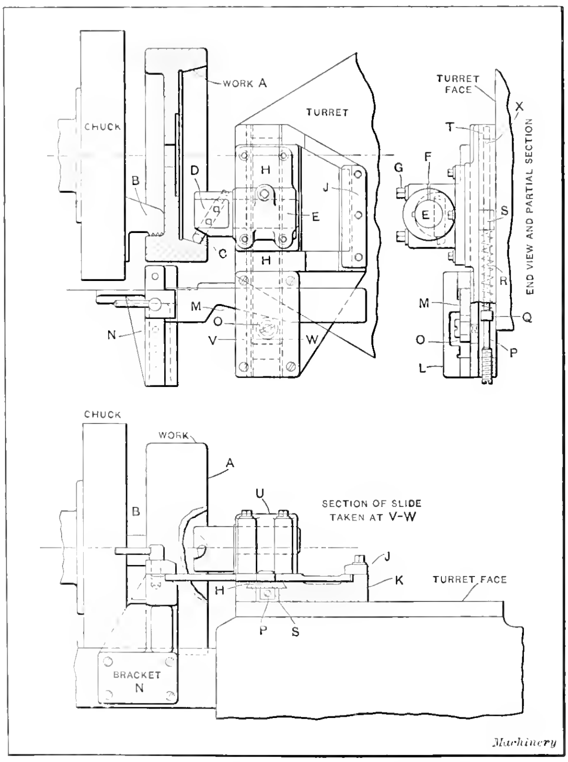

Fig. 8. Exterior and Interior Taper Turning Device

to the spring by means of the screw. A bracket O is fastened to the spindle cap and contains a bronze bushing which acts as a guide for the pilot N. The stop screw P is used for longitudinal adjustment of the taper bar H. The lever K is used to force the taper bar forward by means of the rocker J. The stud Q is slotted to receive the forward end of the taper bar, and when this has been brought forward by the lever until it strikes the end of the screw P the binder lever R prevents any backward movement of the bar. The adaptability of this attachment for various tapers is one of the good points of its design and the results obtained by its use are rapid and thoroughly satisfactory.

Exterior and Interior Taper Turning Device

The device shown in Fig. 8 is adapted for use on a turret lathe having a flat surface instead of the usual box-shaped construction. A taper bar is used in this instance also, which is cut away at M to the desired taper. The attachment may be arranged for either inside or outside tapers, but it is shown in this instance at work on the clutch taper of the

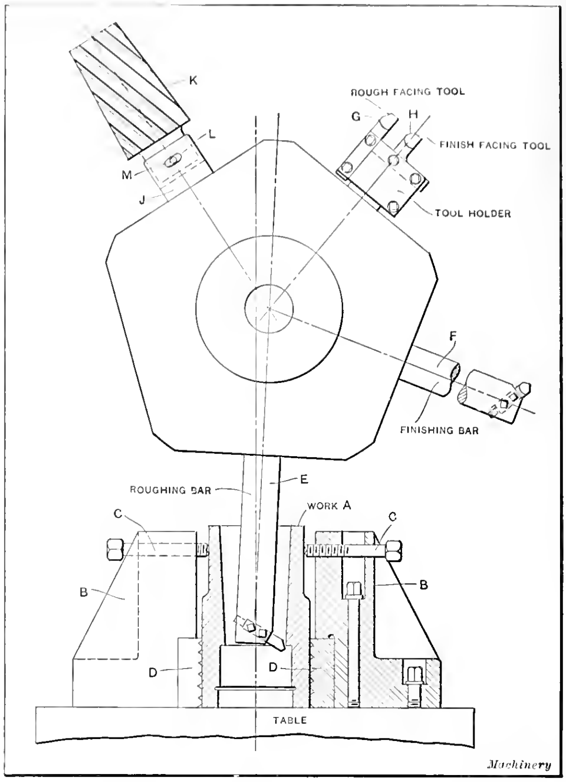

Fig. 9. Attachments for Vertical Turret Lathe and Vertical Boring Mill

piece A, this being held by the inside in the chuck jaws B. The bed or body of the fixture K is fastened to the face of the turret and is dovetailed to receive the slide H. A lug S on the under side of this slide receives the thrust of the spring R (shown in the end view section). A screw P forms an adjustment for the compression of this spring through the collar Q which is made removable and can be transferred to the other end of the rod at X, when it is desired to use the attachment for outside tapers. The roll O is fastened to the slide and in its contact with the taper bar produces the required taper. The tool-holder U is split along the side at F and is bored at E to receive the shank of the tool bar D. The binder screw G is used for clamping. A cast-iron cover plate L is fitted so that the pads shown on its under side allow free movement to the passage of the bar. The bracket N is fastened to a pad on the side of the bed and is cut away at the top to the proper height so that the taper bar M will rest upon it. It is clamped in position by the binder shown, in order to prevent any chance for retrograde action. This attachment has been very successful and is adapted to a wide range of casting work.

Attachments for Vertical Turret Lathe and Vertical Boring Mill

Fig. 9 shows the simplest of conditions which are met with in vertical turret lathe practice, and the method of handling requires no special attachments, the swivel slide of the main head being sufficient to take care of the taper boring, the hole being finally reamed to size by a floating taper reamer.

The work A is a cast-iron hub and it is held in the special jaws B. The work is centered by the steel inserted jaws D and the set-screws C are simply used to prevent vibration. The roughing bar E is first used to generate the taper and it is followed by the finishing bar F. Then the rough- and finish-facing tools G and H face the work, after which the floating taper reamer K is used to size the hole. It will be noted that the upper end of the reamer is flatted and enters a slot in the holder J, the pin M acting as a driver and the slot L allowing lateral movement.

Special Gearing used to produce Tapers

The arrangement shown in Fig. 10 is not adapted to all conditions but may be used when the required angle is not too acute to permit the use of the proper gear ratio. A piece of work such as that shown at A may be handled to advantage by this method.

The strap L is slotted at M to receive the stud S, which acts as a support for the idle spur gear N. The lower spur gear O is keyed to the shaft, while the upper gear P is thrown into use by the clutch mechanism Q, by the action of the knurled screw R. Obviously the gear ratios between P and

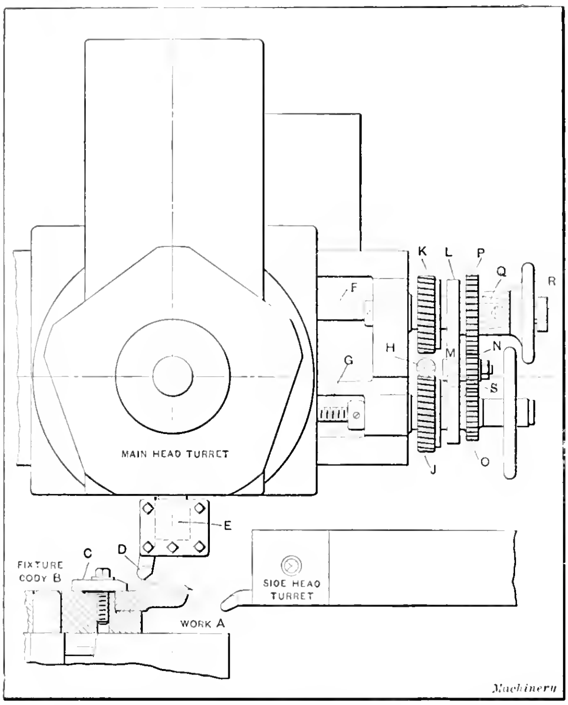

Fig. 10. Illustrating Use of Vertical and Horizontal Feed Combination to produce Tapers

O must be so proportioned that the combination of the horizontal and vertical feed movements will produce the required angle. Attention is called to the fact that the power feed worm H is thrown into mesh with the gear J on the horizontal feed-screw G when the attachment is to be used, but it will be seen that the operation of the feed works is not disturbed by the arrangement shown, the gear P running idle unless the clutch is thrown in.

The work A in the instance shown is held by straps C on the special fixture body B. The tool D is held in the toolholder E and follows the angle generated by the gearing. When it is required to produce an angle such that spur gearing cannot be obtained to give the exact taper, the nearest gears obtainable may be used, and the swivel slide of the main head can be set over to compensate for the variation in the gearing.

Makeshift Taper Arrangement for a Rush Job on the Vertical Turret Lathe

Fig. 11 shows a method of setting up a vertical turret lathe for a rush job, consisting of a few cast-iron male clutch members shown at A. The work is held by the jaws B on the inside of the rim and the tool C is held in the side head turret. A steel plate F cut to the required taper is held in the toolpost G in the main head turret. A roll holder D is fastened in the upper side of the side head turret and the roller E comes in contact with the tapered plate and thereby

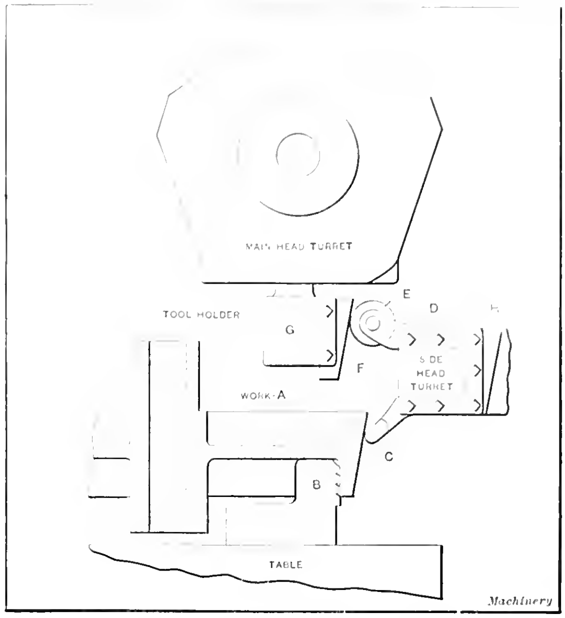

Fig. 11. Makeshift Taper Arrangement for Emergency Vertical Turret Lathe Work

controls the movement of the tool. A flat angular sweep tool H is used for finishing the work. In using this arrangement it is only necessary to lock the main head turret in the proper position and bring the roll E against the forming plate. After this the down feed of the side head is thrown

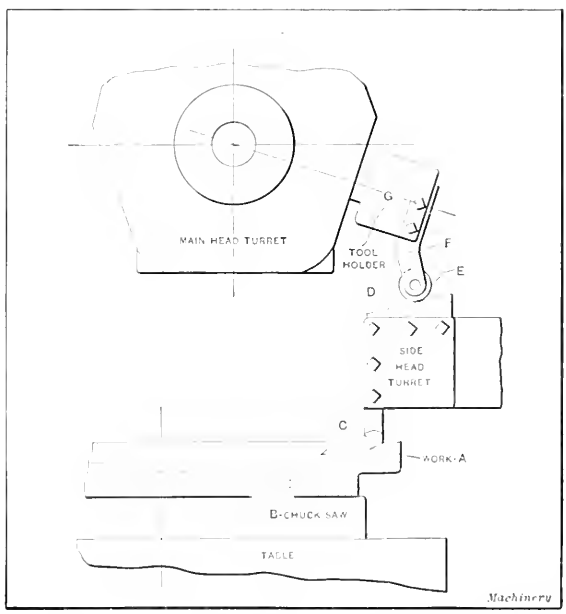

Fig. 12. Emergency Taper Attachment for Vertical Turret Lathe Work

in and the roll crowded against the plate by the transverse feed crank on the apron. This method is very good for a short job and the machine may be quickly set up. Several roll holders of this kind will be found useful adjuncts to the tool equipment of the vertical turret lathe.

Another Makeshift Taper Arrangement

Another instance of a short rush job is shown in Fig. 12, the work A in this instance being held by the inside in the

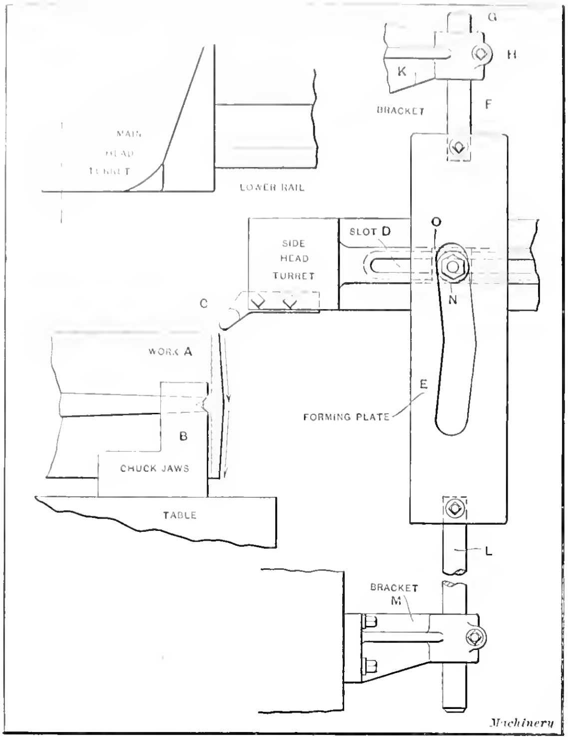

Fig. 13. Taper Attachment for crowning Tools

chuck jaws *B*. The tool *C* is held in the side head turret and is forced down the angle by the contact of the angular plate

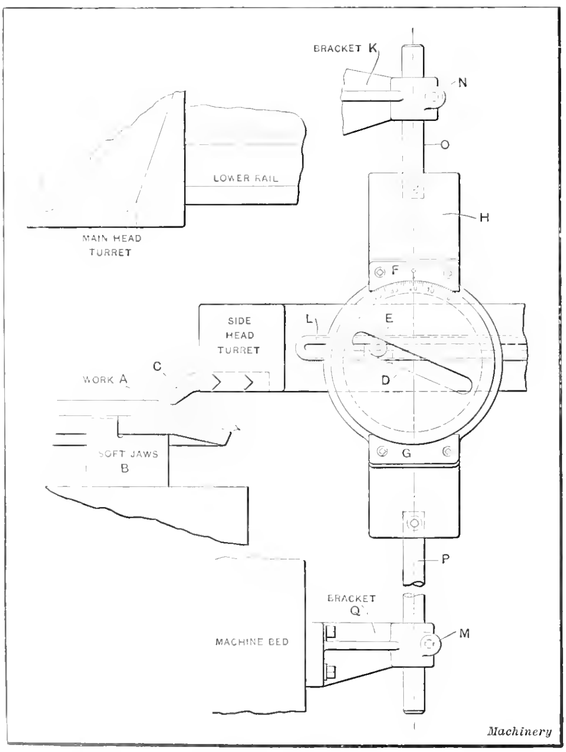

Fig. 14. Vertical Side Head Forming Attachment for the Bullard Vertical Turret Lathe

D with the roll *E*. The shank *F* which holds this roll is secured in the tool-holder *G*, in one of the side holes in the main head turret. When this arrangement is used the transverse feed of the side head is thrown in and the plate *D* crowded against the roll by means of the vertical feed crank on the side head apron. It will be readily understood that this arrangement and that shown in Fig. 11 are not to be considered in the light of attachments for taper turning, but they are given as instances of methods which may be used for short jobs, where no taper attachment is available. It is evident that these methods tie up the main head and prevent its use for cutting purposes while the taper is being formed. As this naturally increases the cutting time necessary to produce the work, the use of such an arrangement is advised only in cases where a few pieces are to be machined.

Angular Taper Attachment for Crowning Pulleys

Fig. 13 is an arrangement which is used where a double angle is required, such as the crowned portion of the pulley *A*. In this case a set of special jaws *B* grip the work on the inside bead in the V-shape part of the jaw. The movement of the tool *C* is controlled by the forming plate *E*, which is cut to produce the angular movement required. This plate is

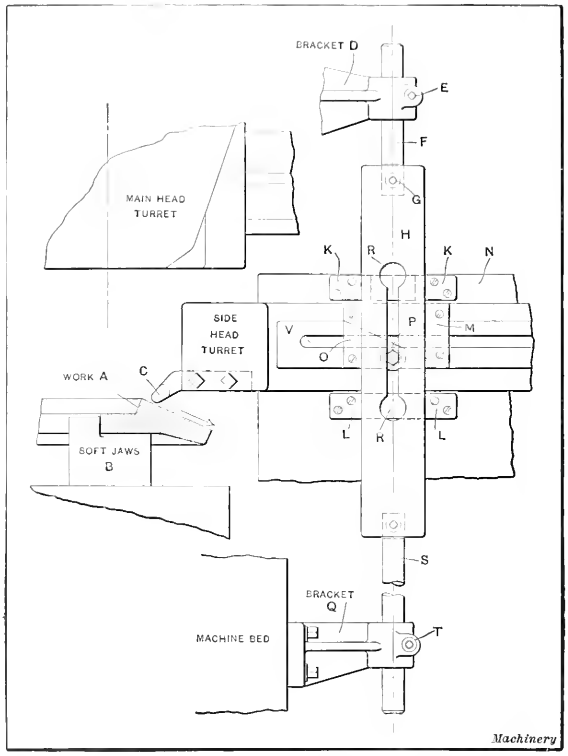

Fig. 15. Taper Turning Attachment for the Bullard Vertical Turret Lathe

fastened at each end to the bars *F* and *L*, and these bars are, in turn, secured in the upper and lower brackets *K* and *M*. The upper boss *G* is split and the binding screw *H* pinches the bar and holds it in the desired position vertically. The arrangement of the lower bracket is on the same principle. Both the upper and lower brackets are fastened to pads on the bed of the machine. When this attachment is used the T-slot *D* is cut along the entire length of the side head slide so that the T-stud *O* which carries the roller *N*, may be adjusted so that various diameters can be machined. This attachment is very satisfactory for work of this nature.

Swivel Side Head Forming Attachment for the Vertical Turret Lathe

Fig. 14 represents an attachment made by the Bullard Machine Tool Co., Bridgeport, Conn., for the Bullard turret lathe. The work shown in this instance at *A* is a large bevel gear which is held by the previously bored interior surface in the soft jaws *B*. The tool *C*, in its angular movement is controlled by the inclination of the slot *D* in the circular swivel plate. This plate is graduated in degrees around its

upper edge so that any angle may be easily obtained. The clamps F and G secure it in position after the setting has been made. The disk containing the slot is mounted on the plate H which is of circular section at the center to allow free access to the roll and block E. As in the previous instance a T-slot L is cut along the entire length of the side head slide, thereby permitting various diameters to be machined. The bars O and P are secured in the brackets K and Q by the binders N and M, these brackets being secured to the bed of the machine. This attachment is adapted and may be used for many varieties of work and the results obtained are uniformly satisfactory.

Another Taper Turning Device for the Vertical Turret Lathe

The device shown in Fig. 15 is also made by the Bullard Machine Tool Co., and is adapted to both angular and formed work, and therefore is more comprehensive in its uses than that shown in Fig. 14. The piece A, held in the soft jaws B, is the same as that previously shown. The principles in the design of this attachment are just opposite to those of the other, for in this case the roller P is located in the slotted plate and may be quickly removed through either of the end holes R, so that the side head may be used for straight work during the same setting of the piece, without much trouble in preparation. The plate H is fastened to the rods F and S and vertical adjustment is obtained by sliding up or down. The binding screws E and T secure it in the desired vertical position. A T-slot V is cut along the entire length of the side head slide and a cast adapting plate O is secured in it by means of T-bolts. The angular plate M is screwed and doweled to the adapter. The brackets K and L are fastened to the side head down slide and are fitted to the edges of the

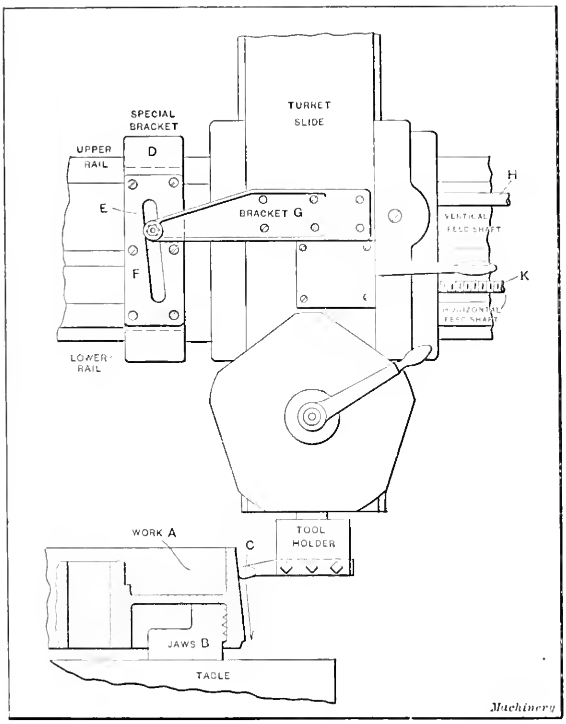

Fig. 16. Taper Attachment for a Vertical Boring Mill

plate H, in order to avoid any bending action which might be produced by the pressure against the roller P. The brackets D and Q are similar to those used in the former case.

Taper Attachment for Vertical Boring Mill

The work A shown in Fig. 16 is a male taper clutch member, and the machine upon which the work is to be done is a vertical boring mill with a turret head. The piece is held by the inside in the jaws B and the tool C forms the taper. In order to permit lateral motion a special nut was required for the horizontal feed shaft K. This nut is not shown in the illustration but was made somewhat on the principle of a lathe feed shaft nut so that it could be coupled and uncoupled rapidly. A special bracket D was fastened to the rail to the left of the turret slide and the forming plate E was fastened to it. A special bracket G was fastened to the turret slide and served as a support for the roller F. In use the vertical feed shaft H is thrown into gear and the turret allowed to float laterally as controlled by the forming plate E. When the other turret tools were to be used, the

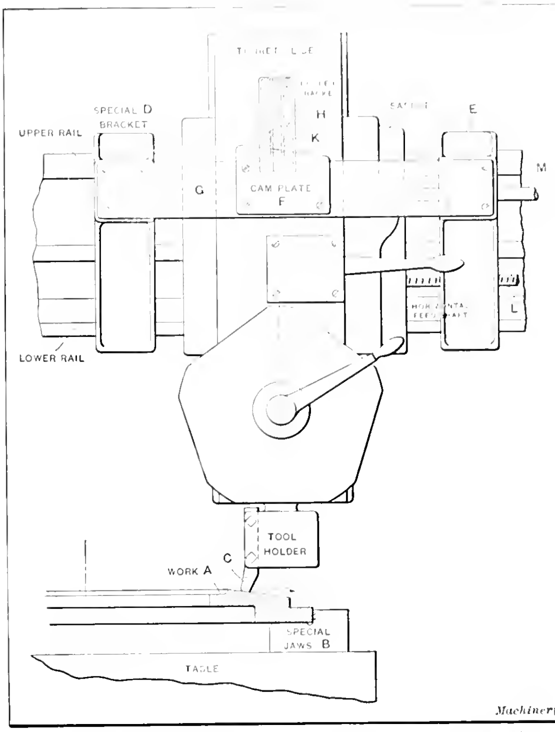

Fig. 17. Angular Forming Attachment for a Vertical Boring Mill

roller F was removed and the horizontal feed shaft nut recoupled. The action of this device was very satisfactory.

Angular Forming Attachment for a Vertical Boring Mill

A very acute angle was to be produced on the work shown at A in Fig. 17 and a vertical boring mill was used to perform the operation shown. The work is held by the outside by the special jaws B; the tool C is used to perform the work. Two brackets D and E are bolted to the rails, one on each side of the turret slide and the cast-iron plate G is used to connect them and form a support for the cam plate F. A portion of the turret slide is machined off to permit the attachment of the roller bracket H. This bracket is slotted with a T-slot and the roller K mounted on a T-stud may be readily adjusted in it. In using this attachment it is only necessary to throw in the horizontal feed shaft gears and keep a downward pressure by hand on the cam plate F, by means of the handwheel on the end of the shaft M.

The various forms of taper attachments and devices which have been mentioned in this article cover nearly every variety of work and may be adapted to nearly any form of taper requirements that may be met with in the course of general manufacturing.

* * *

A "big voice" telephone system is being introduced in factories and warehouses for locating employes and transmitting orders. The system is also being used for the novel purpose of distributing music during working hours or at the noonings. The effect of music in some trades is very beneficial; if the work is of a monotonous repetitive nature it relieves the tedium, makes the workers cheerful and accelerates their movements, thus increasing production.

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THE HEAT-TREATMENT OF STEEL

The growth in common knowledge of improved scientific methods of heat-treating steel during the past ten years has been rapid and wide-spread. The development of the automobile, which requires superior materials for durability, has been the prime moving force in the spread of better methods, and the effect on all branches of industry must be beneficial.

The papers on heat-treating methods and appliances read before the October meeting of the National Machine Tool Builders' Association constitute a valuable symposium, notwithstanding some differences of opinion expressed. Ten years ago a large part of the knowledge now freely disseminated was unknown, and that which was known was carefully guarded in a few of the leading plants of the world.

Perhaps one of the greatest benefits to be derived from exact knowledge of steel treatment is the banishing of superstition. When men work in the dark, doing things they don't understand, to bring about results that may or may not be satisfactory, they cannot reason logically on their business in general. In order to progress, a clear understanding of principles must be had, and when that has been acquired, the effect will be noticeable in all branches of the business.

* * *

MECHANICAL SECTION OF THE N. M. T. B. ASSOCIATION

When a mechanical section was proposed for the National Machine Tool Builders' Association, some doubt was expressed as to the expediency of devoting the time of the convention to the reading and discussion of technical papers. It was thought by some prominent members that the profitable work of the association in convention lay rather in the direction of harmonizing differences and bringing about understandings that would result in the betterment of the industry.

The last annual meeting, which was notable because of the presentation of six excellent papers on the selling, accounting and metallurgical sides of the machine tool business, was undoubtedly made more interesting and profitable to those members in attendance by the reading of the papers than if the same time had been devoted to strictly commercial subjects. The keen interest displayed showed that the members were eager to get the benefit of the experience and opinions of those who had specialized in the lines which they represented.

It has been contended that such papers should properly be presented before the meetings of the American Society of Mechanical Engineers, and while this may be theoretically true, practically the machine tool builders would not receive as much benefit. The large and varied membership of the A. S. M. E., the crowded programs and the different atmosphere, would not be conducive to the free discussion of papers peculiarly of interest to machine tool builders.

We believe that the National Machine Tool Builders' Association can profitably develop a mechanical section, and that it should do so with the primary object of discussing principles of design, details of construction on which there can be common agreement, shop construction, metallurgical and foundry practice, and similar subjects. The strengthening of the technical programs will give greater interest to the proceedings, and the publication of the papers in the mechanical journals will advertise the existence of the association to the manufacturing world. The value of the association to its members in some emergencies is its power wielded as a unit; but to have power it must have the prestige and influence that come only from work unselfishly done.

* * *

THE APPRAISAL OF MANUFACTURING EQUIPMENT

To estimate the value of a going manufacturing concern is a problem of no little difficulty. Hardly any two experts will agree in their valuations. The market price of the standard machines and tools, that is, those machines and accessories which can be used without change for other lines of manufacture or for repair work, can be estimated closely by those in touch with the demand for second-hand equipment. But to appraise the property of a going concern on the basis of disintegration and sale to the highest bidders is manifestly to grossly underrate its actual value.

Tool equipment that has cost thousands of dollars might be rated at its scrap value only, whereas its actual value to the concern might be eighty or ninety per cent of the cost. But all machines and equipment wear out or become obsolete in time, and a certain charge should be made each year to provide for the overhead cost of manufacture. What these charges shall be depends very much on the nature of the business.

Take, for example, chucks, jigs and fixtures. Chucks for lathes and planers are standard equipment, useful in every machine shop. To estimate their life at twelve to fifteen years under average conditions of use seems conservative, but to extend the same lease of life to jigs and fixtures is not. The conditions existing in the shops inspected by Mr. McKay whose article on appraisal of manufacturing plants appeared in the May number may have given warrant for that assumption; but plants devoted to other important industries surely would not. An expert who devotes his time largely to the appraisal of automobile plants follows the practice of discounting one-third yearly on all tools, jigs, fixtures and similar equipment.

The automobile plant, of course, presents an extreme of rapidly changing conditions. But somewhere between it and the conditions surrounding the manufacturer of standardized machines lies a mean of average life to be reckoned with in making appraisals in general.

* * *

KEEPING MACHINERY IN GOOD REPAIR

One of the dangers of punch press operation is "kicking back." If the clutch pin slips or breaks at the moment of greatest pressure, the ram may fly upward, reversing the crankshaft, and drop down again with disastrous effect. Some of the safety devices provided for guarding the hands of operators fail in this emergency, and serious accidents have occurred with presses that were supposed to be fully protected.

Machinery in general, and presses in particular, must be kept in first-class condition in order to prevent accidents. Safety devices have their place, but human ingenuity can hardly provide against the accidents that may happen when the cycle of mechanical movements is interrupted by the failure of an important part. The repair man of a modern factory may be likened to the outpost of an army. He must be constantly on guard to prevent disaster.

DANGEROUS CHISEL HEADS

The heads of cold chisels, sets, punches and other percussive tools of the class driven by hammers and sledges soon batter and break away under repeated blows. The bits of steel displaced and sent flying by the hammer blows are often causes of painful accidents. The eyes are especially vulnerable, and in foundries, steel works and machine shops especially, many workmen have lost the sight of an eye by being struck with a bit of steel broken from a chisel head.

If goggles with safety glasses were always worn, the danger to the workmen actually engaged in chisel work would be reduced to a minimum, but they are in no greater danger oftentimes than are others near by. If the battered ragged heads were ground off regularly, the danger of steel flying off and causing accidents would be small, but precautions like this are difficult to enforce; there is no one in the imperfect organizations of most plants to keep close watch of such apparently trivial details. The expense of keeping the heads ground off is, too, an item of some importance.

The unsightly appearance and danger of ragged heads can be eliminated by proper heat-treatment of all percussive tools. Tool-dressers should be impressed with the importance of hardening and tempering the heads of chisels, sets and flatters as carefully as the cutting parts. The article by Mr. Cran in this number gives specific directions for treating tool-heads, with illustrations of tools treated and in use.

* * *

A QUESTION FOR THE GRINDING EXPERT

As is well known by those who have had experience in cylindrical grinding, it is difficult to lay down rules for determining the proper grade and grain of wheel, work speeds and wheel speeds, because so many variables must be considered. Certain fundamental principles are recognized by all grinding authorities, but at least one important point has not been definitely settled; in fact, the makers of grinding machines hold opposite views regarding it. We refer to the question of work speeds, and more particularly to the changes of speed made for the roughing and finishing cuts. Some advise a reduction of speed for finishing and others an increase in speed. This appears to be a fundamental question and one about which there should be no disagreement at all.

We realize that both sides may be right for the particular conditions under which the grinding is done, but are the conditions right in each case? If one method is more efficient than another, both the grinding machine manufacturer and the grinding machine user would benefit by having the best practice generally adopted. This difference in practice can be accounted for by the fact that wheels of different grades are used for grinding the same kind of material. In some shops soft free-cutting wheels are employed, while in others the wheels are harder and more compact. In the case of soft wheels, the speed for roughing should keep the wheel face sharp, and as a result it leaves a rather rough surface on the work. Hence the work speed is reduced for finishing with the same wheel in order to obtain a finish that cannot be obtained with a higher speed. On the other hand, with a wheel of harder bond, the speed is increased considerably for the light finishing cut. A comparatively soft wheel is generally conceded to be the most efficient grade for roughing, but is it economical to use a wheel that is hard enough to permit increasing the work speed for finishing, and does this increase of finishing speed compensate for the loss of efficiency in roughing? What is the reader's opinion?

* * *

A curiosity in arithmetic has recently been worked out by a British astronomer in answer to the question: What is the largest number that can be expressed with three digits? The answer is 9^{9^9} (nine raised to the ninth power of nine, or $9^{387\,420\,489}$). The number which this represents is so big that it is awesome. If it were printed in full it would fill thirty-three volumes of eight hundred pages each of fine type. The first twenty-eight figures are 428,124,773,175,747,048,036,987,115,9 and the last two are 89. In between these are 369,693,070 figures! —*Saturday Evening Post.*

MEN WHO HAVE WORKED FOR ME

BY A. F. ORMAN

I remember reading an interesting article entitled "Foremen For Whom I Have Worked," and it suggested an article on the converse subject. One man I remember particularly who was a genius in working out methods of overcoming difficulties which befall us in our line. A few instances will suffice to show what I mean. Once when he had a steam hammer cylinder on the planer for the purpose of planing grooves down each side and across each end of the face which is bolted onto the guides, to receive a 3/8-inch copper wire gasket, he set the work up for the endwise grooves and planed them; and then instead of tearing the job down and turning it at right angles, as many others would have done, he turned the tool at right angles and had the helper run the head across on the rail with a long crank which he had on hand. You can imagine how much quicker and easier this operation was when done in this way.

In fitting main-rod brasses he would put them on the pin, pull them together with bolts and clamps, and then insert the "feelers" to ascertain the play. By using the graduations on the shaper head, one-half of this amount was planed off each brass, of course allowing something for fitting. I noticed his method of making some buttons, of which there were about a dozen. He secured six pieces of cold-rolled stock, each long enough for two pieces after allowing for the width of the parting tool. He gripped them in the three-jawed universal chuck and turned the ends to 3/4 inch in diameter, making use of the graduations on the screw; and then inserted the parting tool and cut them all into two pieces. He next gripped them across the 3/4-inch diameter, being sure the shoulder was against the jaws of the chuck, set the facing tool at the proper distance from the shoulder, locked the carriage, and proceeded to face them all off to the same length without moving the carriage longitudinally during the process. These things in themselves may not seem remarkable, but when you have an opportunity to observe the different methods of different men, you will see that the time saved by these simple rules amounts to something in a very short time.

Another man who worked for me for one week was a "home guard." He had worked in all the local shops and started a repair shop of his own soon after I "let him go." I asked one of the apprentice boys—who happened to be a neighbor of his—how he was getting along. He replied: "I stopped in his shop one day. He was drilling a 7/8-inch hole in a piece of brass, had the press running on the slowest speed, and was squirting lard oil on the drill." The superintendent had intimated that I must be mistaken when I said that this fellow was not a good mechanic.

At another time I had two apprentices in the shop. One of these boys could do a splendid job if it happened to be something that he had done before, but if some one else had done the job the last time he did not take sufficient notice of the work to be able to repeat it without being coached. The other boy, though he never neglected his work in so doing, kept his eyes open for ways and means of doing other work than that which he was engaged upon. It is unnecessary for me to say that when I was ready to promote him to the next machine he had, by observation, mastered the principle of its operation and was ready for the promotion. Though he had never performed an operation on the planer, when I gave him a somewhat complicated job to do on this machine I was pleased to see that he was familiar with the principles of clamping the work and the use of the stops, clapper box adjustment, etc., though he was a little awkward with the shifter, which was to be expected.

The next fellow who comes to mind should have had a gold medal for "gall." He had recommended himself very highly as coming from a large locomotive shop and said he could run any kind of a machine. The first job I gave him was a planer job—an oil cellar for a driving box. He put it on the platen, put two clamps on it, and evidently thought it unnecessary to use any stops. He then started the machine. The dogs didn't happen to be in the right places

so that the platen reversed before the job reached the tool. He stopped the machine by putting the belt on the loose pulley, took the clamps off the job, and shifted it further up on the platen so that it would reach the tool before it reversed. He didn't even know what the dogs were there for. I let him go, as I was afraid he might get hurt.

Another man was given a lathe job on a machine which had a back up belt for thread cutting. He happened to pull the shifter the wrong way and started the lathe backward. He looked at the machine as if he thought there was something wrong, but instead of trying to right it he put the tool against the work. Finding that this would not do, he turned the tool upside down and was endeavoring to adjust it this way when my attention was attracted to him. I told him that he was discharged and he got mad and quit. Then there is the fellow who, when given any kind of a job on any kind of a machine, thinks that the first thing to do is to get it in the machine and start a cut before figuring out the best way to proceed. He is not to be compared with the man who figures out the method of procedure first and then puts the piece in the machine.

I have noticed that a considerable number of mechanics who had the reputation of being above the average failed to appreciate the fact that in doing duplicate work it is often quicker and easier to change the piece than to change the tool for the different operations. For instance, consider the case of turning studs on centers when one end is 3/4 inch and the other is 7/8 inch. In turning the end to 3/4 inch, set the tool on the first stud and run the cut up as far as it is to go, run the carriage back for the next cut, and then take the stud out of the lathe and put in the next. Duplicate this operation until all are turned. Then to chase the threads, set the tool for the first one, marking the graduation for each cut and particularly for the last one. You can take a little time to insure a good fit on the first stud; then chase the rest of them without changing the tool and see how much easier it is than to change the tool for each one, not to say anything about trying the gage three or four times on each stud. To those who have mastered these principles the suggestions herein contained may seem superfluous, but I can only say that I have had an opportunity to observe the methods of a number of mechanics, and the ones who make use of all or most of the "kinks" here enumerated are the exception to the rule.

Once in a while you will find an attachment for some machine which does not seem to be of any use, but as a rule they are of benefit if you will only take the trouble to use them. I noticed one of the boys trying to figure out some way to put a piece in the lathe, one end in the chuck and the other in the steadyrest. It was a long piece and there did not happen to be any center in the ends. The piece was a standard size of 1 3/4 inch. I suggested that he put an arbor of this size on the centers, adjust the jaws of the rest, and then put the piece in it. He had no further trouble, but had spent considerable time trying to do it some other way before the suggestion was made. The foreman have their little peculiarities and so have the men.

* * *

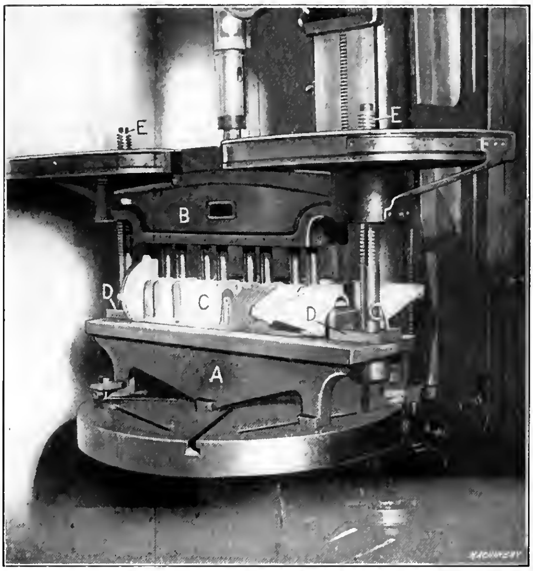
HOT BLAST METAL TREATMENT

A peculiar action has been noted in the operation of the Tolhurst centrifugal dryer for cleaning, drying and brightening small metal articles. This apparatus consists of a centrifugal machine, similar to an oil extractor or clothes dryer, and a fan supplying a blast of hot air. The articles are placed in a basket and whirled at a peripheral speed of 6000 to 8000 feet per minute, depending upon the diameter. The blast of hot air is delivered to the machine in the center of the basket; the impelling force of the fan and the centrifugal force of the whirling mass causes the hot air to pass quickly through the articles. The result is rapid drying and brightening. The temperature of the hot blast when used in government mints varies from 95 to 160 degrees, depending upon the metal, the lower temperature being used for copper and the higher temperature for silver and gold. The peculiarity alluded to is the rise in temperature of the articles in the basket. Frequently the temperature will rise to 212 degrees F. and sometimes higher. The cause is supposed to be the friction of the air passing over the work. A curious feature, however, is that the temperature of the delivered air is cooler than that of the hot blast.

* * *

DRILLING MACHINE FIXTURE FOR BROACHING PUSH-ROD GUIDE HOLES

The accompanying illustration shows a broaching fixture made by the Willys-Overland Co., Toledo, Ohio, for broaching the keyways in the push-rod guide holes of four-cylinder engine aluminum crank-cases. The fixture, which comprises a bed *A* and head *B*, is held on the table of a Cincinnati-Bickford upright drilling machine. The base *A*, on which the crank-case *C* rests, is finished on its top surface, and on it are fixed two locating L-pieces *D*, for aligning the crank-case lengthwise. The eight spindles which carry the broaches are held in the head *B* which is carried on two screws *E* fastened in the base. These screws are provided with square threads and fit in threaded nuts that form bushings inserted



Broaching Eight Push-rod Guide Holes in a Special Fixture attached to a Cincinnati Vertical Drilling Machine

in two large gears, not shown. These two gears are rotated by means of a central gear fastened to a driver held in the spindle of the drilling machine.

In operation, the back-gears of the drilling machine are thrown in and as the spindle descends it rotates the two large gears through the medium of the intermediate gear, thus drawing down the head of the casting and forcing the broaches through the crank-case. When the eight keyways, which are 3/16 inch wide by 3/16 inch deep, have been cut, the rotation of the spindle of the drilling machine is reversed, thus carrying the head of the fixture up again and removing the broaches from the crank-case. The push-rod guide holes are 1 3/16 inch in diameter, and the total broached length is approximately 3 1/2 inches. The eight holes are broached in exactly one minute, not including putting the work on and removing it from the fixture. D. T. H.

* * *

A steel girder, 139 feet long and weighing 180 tons, which is said to be the largest ever built in America, was recently put in place over one of the principal streets in Lynn, Mass. The girder is one of four carrying the B. & M. R. R. tracks but the other three are supported by pillars in the center and are not, therefore, so long or heavy. A pillar could not be placed to support the middle of the girder in question, however, because of the position of the street railway tracks. Hence it had to be built to cover the entire span without support in the center.

CARBONIZATION OF SHAFTING*

MATERIALS FOR CARBONIZING—STEEL TO USE—FURNACE TEMPERATURES—QUENCHING MEDIUMS

The increasing use of anti-friction bearings in various forms, as well as other developments in the construction of machinery, has made necessary the use of harder and better surfaces for shafts than has heretofore been considered good practice. Before entering into any detailed discussion of this subject, we should first have some understanding of what the problem really is, expressed, if possible, in concrete figures. Let use take a piece of soft steel which has been turned and ground to a definite size. We find its hardness, as measured by the Shore scleroscope, to be somewhere between 15 and 25, whereas with a piece of cold-rolled shafting, we obtain 30. Alloy steel of suitable analysis and properly treated will give 60, and if we take still another piece of material, carbonize it and follow this by suitable heat-treatment, we can obtain 80, as shown by the scale of the instrument. Therefore, we can see from these approximate figures, that the method and material to be used is largely a matter of the specific result desired and, obviously, it is impossible to utilize any one method or material for all requirements.

Aside from the condition of the surface, there are other important considerations. Taking the elastic limit of the material as a measure of its load-carrying capacity, we find 40,000 pounds per square inch an average result for soft steel, and 170,000 pounds not excessive for properly heat-treated alloy steels. In the case of carbonized shafts, there is no material increase in the elastic limit, the improvement being entirely a matter of surface condition. Hence, we see the possibility of not only obtaining the required surface, but, at the same time, materially increasing the factor of safety of the shaft, or using a smaller shaft with the same factor, as may be preferable. If the surface requirements are represented by a scleroscope reading greater than approximately 60 to 65, the problem must be approached from the standpoint of carbonization, unless we are willing to use expensive alloy steels which, in this discussion, are considered neither possible from the standpoint of first cost nor a necessity. Carbonization gives ideal results as to surface conditions but no increase in the elastic limit. On the other hand, if a scleroscope reading of 60 to 65, or less, is considered to be a satisfactory standard, it is feasible to use many alloy steels at low cost which, when of the proper analysis and suitably heat-treated, will not only give equally good results as to surface conditions, but a material increase in strength as well. The problem then is naturally divided into two general divisions each requiring a different discussion. First, carbonized shafts having a surface hardness greater than 60 to 65; second, heat treated shafts having less hardness than the figures stated.

Carbonized Shafts

Perhaps no branch of the thermal treatment of steel has been more thoroughly investigated than that of carbonization, but the results show conclusively that there is no standard American practice, either in regard to methods or material. This is doubtless due to variation in local conditions. For instance, one who carbonizes arbors or shafting is not so much concerned about the toughness of the core as one who treats pieces of thin cross-section. Again, one so-called authority will insist that the transition from case to core should be gradual with no sharp line of demarkation, whereas one who is carbonizing very thin sections or shells knows from experience that the case must, necessarily, be distinctly defined and concentrated in order to use to the best advantage the small space allowable to obtain such conflicting properties as toughness and hardness. Where the number of parts requiring carbonization is comparatively small, a high-speed carbonizer whose strength is spent on the first run may prove satisfactory, but if the number of parts runs up into the thousands daily, a more economical material would be adopted. If our problem is that of a few pieces a week, the irritating effect of prussiate of potash is not particularly objectionable, while with a condition involving many thousand pieces daily, in all extremes of weather, its effects are more in evidence. Thus, the authority who endeavors to lay down a hard and fast rule is treading on dangerous ground. Bearing in mind, therefore, the wide divergence of conditions, even when limiting ourselves to shafts, let us first consider the best material for our specific purposes.

Steel for Carbonizing

In considering the steel to be used naturally the carbon content is the point at issue. My experience has indicated that a material varying from 0.15 to 0.20 per cent carbon is the most satisfactory from every viewpoint. Many authorities recommend a carbon content as high as 0.27 per cent, but the writer has not found it possible to obtain uniform and satisfactory results, in a large way, with such material. Irrespective of the particular analysis that may be decided upon, the matter of uniformity is of even greater importance. No matter what the source of supply may be, it is advisable to analyze ten per cent of the material received, in order to avoid irregularities which sooner or later develop.

Carbonizing Mixtures

Most of the carbonizing compounds upon the market contain simple ingredients which can be mixed readily upon the premises, although some are almost beyond the realm of chemical analysis. In fairness it may be stated that a few of them give very good results, but the price is generally set in proportion. For all-around purposes, those which can be mixed easily upon the premises are best. If this method be adopted, the metallurgist in charge can superintend the entire grinding and mixing process and keep the quality of each ingredient up to a standard. The two following mixtures, which for convenience are designated "A" and "B," are easily prepared, reasonable in cost and have given satisfaction in the treatment of several million pieces of the most exacting requirements.

MIXTURE A

	Per Cent
Raw bone	35
Bone black	27
Charred leather	11
Wood charcoal	27
	100

MIXTURE B

	Per Cent
Potassium ferro cyanide	5
Sal soda	14
Coarse salt	9
Powdered wood charcoal	72
	100

The characteristics to be considered in a carbonizing mixture are: Hardness imparted to the work; rate of penetration; cost per pound and renewal cost; ease of manipulation in grinding, mixing, packing, etc. The following table shows mixtures "A" and "B" compared in the first three respects, with one of the best carbonizers on the market, which for convenience is designated as mixture "C."

Material	Scleroscope Reading	Time to Penetrate 5/64 inch	Cost Per Pound, Cents	Per Cent of New Material Required for Renewal
"A"	70	13 hours	2.6	55
"B"	75	12 hours	1.3	30
"C"	75	14 hours	2.5	80

The hardness was determined by using properly carbonized heat-treated and polished specimens and naturally varied somewhat, the values given in the table being averages of several readings. The time to penetrate to a given depth was obtained on specimens of shafting one inch in diameter. The carbonizing process was similar to that recommended later in this article. By referring to the preceding table, it will be seen that mixture "B" shows a gain of about 14 per cent over mixture "C" and about 8 per cent over "A," in respect to speed of penetration. In initial cost, material "B" is the cheapest, while "A" and "C" are about the same. The quantity of fresh material which must be added to that which has already been in the furnace, to restore it to the desired strength, shows a marked advantage in favor of "B." Moreover, material "C" was practically useless after one heat. While cost is an item of minor importance, and quality is cheap at any

* Abstract of a paper by Jay G. Weiss, works manager Hyatt Roller Bearing Co., read before the National Machine Tool Builders' Association, New York City, October 23, 1913.

price, if the other properties are balanced, cost might judiciously be considered in selecting carbonizing mixtures; hence, this data was added for the sake of completeness.

Packing Parts to be Casehardened

If the shafts are not too long, they should preferably be packed in pots standing on their ends, but if the length does not permit of this arrangement, they may be packed in rectangular pots in horizontal layers. Irrespective of the method of packing, each piece should be kept $1\frac{1}{2}$ inch from adjacent pieces and 2 inches from the pot walls. This clearance, which may seem excessive, allows for any settling of the mixture while in the furnace, for if the pieces should come in contact with each other, the penetration would be retarded and the surface would be defective at that point. A layer of mixture 2 inches deep should be placed in the bottom of the pot and be thoroughly tamped down; every successive layer should also be tamped. The pot cover should be thoroughly sealed or luted with fireclay. Large pieces which are too long for pots may be packed in pipe, the latter having a cap on each end, the threads of which have been coated with graphite to facilitate removal. With this arrangement, all moisture must be excluded from the mixture to prevent the formation of steam which might result in an explosion. The pots should be spaced in the furnace so that 2 inches of space is available for the circulation of heat around every part of the pot surface. Even with this precaution, the pot nearest the furnace door will not be heated exactly the same as those farther back, and this should be allowed for. My experience has demonstrated that the best material for the pots is either cast steel or white iron.

The Carbonizing Heat

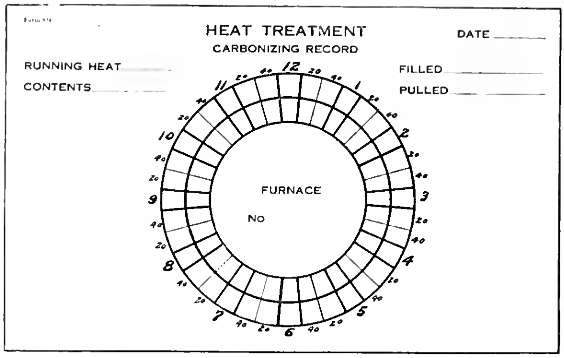
There is a difference of opinion as to the proper temperature for carbonizing. Temperatures ranging from about 1600 degrees F. to 1800 degrees F. are used quite generally. The writer has found that 1725 degrees F. is a safe heat, which does not endanger a good steel. Higher temperatures may be used, but while the duration of the "run" is shortened, the quality of the work is likely to be impaired. For the accurate measurement of this temperature, only the very best make of pyrometer should be employed, those of the high-resistance type being preferable. They have the great advantage of simplicity, as the wiring does not need to be especially calibrated for each location, within reasonable limits, and it is possible to attach recorders to the same circuit without affecting the indicator reading. The pyrometer should penetrate the furnace wall and be placed as near to the work as possible, without liability of actual contact. When located vertically, the life of the porcelain jackets is increased, but the temperature of the cold junction is kept higher owing to the direct radiation from the top of the furnace. By inserting a pyrometer of sufficient length horizontally into the furnace wall, the cold junction may be kept at a lower and more uniform temperature.

At the beginning of the heat the temperature may be kept, say, 50 degrees F. higher than normal, until the heat begins to penetrate the work, when it should be reduced to normal. No fixed rule can be given for the time of complete saturation, as the size, shape and thickness of the pot wall, as well as the size of the work and kind of mixture, are determining factors. The duration of the run can be determined only by actual trial, depending upon such factors as the nature of the steel being treated, the carbonizing material, the degree of temperature and depth of case required. The best practice is to put a trial piece of the material into one of the pots in each furnace and remove this piece about an hour before what experience has shown to be ample time. This trial piece is then heat-treated, as described later, and the depth of the hardened case of a cross fracture is observed. A very accurate estimate can then be made as to the time to remove the rest of the work.

With mixture "B" (see foregoing table) twelve hours will produce a case about 5/64 inch deep on a 1-inch shaft of 0.15 per cent carbon content, with a temperature of 1775 degrees F. for the first two hours and 1725 degrees F. for the remainder of the run. A complete temperature record of each run in each furnace should be kept, the temperature being tabulated at least every twenty minutes. A convenient blank for this tabulation is shown in the accompanying illustration. The temperatures are first recorded in the outer radial spaces, and if the run exceeds twelve hours duration the inner spaces can then be used. Uniformity of temperature is, of course, a very important factor and no matter what type of furnace or fuel is used, more or less regulation is necessary. Perhaps a brief description of the method employed at the Hyatt Roller Bearing Co.'s plant to effect this control would be of interest.

Colored Light System of Controlling Furnace Temperatures

In the Hyatt plant, there are approximately twenty-five large carbonizing furnaces fired with fuel oil and over one hundred semi-automatic gas furnaces for heating alloy steels. The gas furnaces are supplied by a battery of gas producers having a total capacity of 2500 horsepower. The physical laboratory is located on one of the floors of the heat-treating building, and the temperature control room is a part of this laboratory. The furnaces are distributed on the four floors all over the building. Each furnace has a pyrometer which is connected by wires in an iron conduit, with the temperature



Blank for recording Furnace Temperatures

control office. Over each furnace there is a small signal board with three lights; one white, one red, and one green. These lights are also connected with the temperature control office. All these circuits lead to a marble switchboard which has three signal lamps for each furnace, these being in series with corresponding lamps over that particular furnace. There are two operators at the switchboard, each one having control of the furnaces of two floors. By touching a key, the operator can set the pyrometer of any furnace. If the temperature indicated by the pyrometer is normal, or within the allowable tolerance, an observation of the next one is taken, and so on. If the temperature is found to be too high, by touching another key the light over the furnace is changed to red, and if it should be found to be too low, the light is changed to green. At the same time, the corresponding light on the furnace signal board changes. Each attendant has under control six furnaces, and by simply looking at the signal boards he can determine readily whether the temperatures are high, low, or normal, and make the necessary regulations. After signalling a red or green light, the switchboard operator soon returns and takes another reading of the furnace to ascertain if the proper regulation has been made.

Heat-treating after Carbonizing

When the steel emerges from the carbonizing furnace, it is of a dual nature, the case containing say, 0.80 to 1.25 per cent carbon and the core 0.10 to 0.20 per cent carbon. Consequently, the carbonizing temperature is considerably above the critical range of both the case and the core, especially the latter, and as the duration of the run is several hours large crystals form readily in both case and core under these conditions. To restore the steel to the best grain size, two heats are required; a high one for refining the core, and a lower one for refining the case. Of course, it is possible, as well as quite common, to quench the work directly from the pot, using this heat as the first or "core heat" and then following with a second or "case heat," or the second may be omitted

entirety. In the latter instance, the temperature is too high to produce the best refinement of the case, although the core structure may be satisfactory. Again, if the work is allowed to cool so that the temperature is about right for the case, the core will not be perfect. Another disadvantage is due to delays in getting the work from the pot to the quenching medium, the pieces cooling more or less, and thus giving results that are far from uniform. In view of these facts, the writer is a strong advocate of applying two heats after the work has cooled from the carbonizing temperature.

We now come to the important question as to what are the correct heats. There is apparently a great difference of opinion on this subject, owing to such varying factors as the rate of penetration of different quenching mediums, the effect of the mass of the article quenched, and the temperature of the quenching medium. As previously mentioned, the first heat is usually between 1600 and 1800 degrees F. The second heat varies between 1375 and 1475 degrees F. If a single heat is used, the range will vary still more, running high or low, according to whether the quality of the case or core is to be sacrificed.

Quenching

Perhaps nothing connected with the heat-treatment of steel is of more importance than quenching. Slight variations in the angle of immersion often result in distortion of the work, apparently out of all proportion to what might be expected. Shafts should be immersed vertically and moved in the same position up and down until the quenching is complete. No matter how large the work, the results obtained will pay for any special apparatus necessary to carry out this method.

Where the maximum hardness is desired and only one heat is to be taken, water will give the best results, but the danger of distortion is greater than when oil is used; this applies even more to brine and cold water. When two heats are employed, it is advisable to quench first in oil, for as the first temperature is higher, distortion is more likely to occur. After the second heat, the work may be quenched in water. Good results may be obtained by using water in both instances, as far as the structure of the steel is concerned, but there would be greater danger of distortion. When oil is used, care should be taken to maintain its temperature fairly constant.

The advantage of drawing after carbonizing is much disputed. Opponents of this method claim that the core should have the requisite toughness and that any temperature which would toughen the case would soften the core. While this may be true to a certain extent, the writer has found that in some instances good results can be obtained by drawing at about 400 to 450 degrees F., as this temperature relieves the strain in the case somewhat, without materially sacrificing its hardness.

Heat-treating Shafts

The difference between the two methods being discussed is that in one case a material is used to which carbon must be added to obtain the required hardness, whereas with the other method, a material is used in which the carbon forms a constituent part. The amount of carbon depends upon the particular result that is required in each instance. Shafts to meet the general needs in machine tool construction should have a carbon content of 0.40 to 0.50 per cent and, combined with this, the writer suggests alloys of $1\frac{1}{4}$ per cent nickel and $\frac{1}{2}$ to 1 per cent chrome. Steel of this particular analysis has been used very extensively during the past few years and can be readily obtained at a moderate cost. This steel requires only a simple heat-treatment at about 1500 degrees F., the exact temperature depending upon the carbon content. It should preferably be quenched in oil having a temperature not exceeding 80 degrees F. It should also be drawn at 800 degrees F. for approximately an hour, the exact time depending upon the size of the shaft.

With this material, heat-treated as described, a hardness of from 60 to 65 (scleroscope reading) and an elastic limit of at least 150,000 pounds per square inch, can be obtained readily even if the sections are fairly large in diameter. Such a method of solving the problem has the advantage of far greater simplicity, as to apparatus, and is less expensive than the carbonizing process. In fact, it is the opinion of the writer that a simple heat-treatment for an alloy steel of the general analysis suggested is so far superior to the hazard and expense, both direct and indirect, of carbonizing, that there is in reality no comparison between the two methods. This is entirely independent of the fact that in the heat-treatment method, we have a material combining strength, toughness and more lasting quality.

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INTERNATIONAL ENGINEERING CONGRESS

An International Engineering Congress in connection with the Panama-Pacific Exposition in San Francisco will be held September 20-25, 1915. The congress will be conducted under the auspices of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers. The purpose and scope of the congress will be, first, the gathering together of a large and representative body of engineers from all civilized countries for the purpose of forming or renewing personal acquaintances and interchanging views on various phases of professional work; and second, the reading and discussion of papers before the various sections and their publication later in such form as will constitute a valuable addition to engineering libraries. The scope of the congress is to be truly international; it will embrace the various branches of the engineering profession. Eminent engineers throughout the world will be invited to contribute papers on assigned topics, and in the selection and distribution of these topics endeavors will be made to secure papers representative of the world's best engineering practice in the various branches of the profession.

All papers will be presented in English. If papers are written in other languages, they will be translated into English free of cost to the author. The general field of engineering to be covered has been divided into ten groups or branches, which, together with a special field, the Panama Canal, will constitute eleven sections, each of which will be presided over by a chairman. The sections are as follows: (1) The Panama Canal; (2) Waterways and Irrigation; (3) Railways; (4) Municipal Engineering; (5) Materials of Engineering Construction; (6) Mechanical Engineering; (7) Electrical Engineering; (8) Mining Engineering; (9) Naval Architecture and Marine Engineering; (10) Military Engineering; (11) Miscellaneous. The fee for membership in the congress is $5. The fee will entitle the member to receive the index volume and any single volume of the transactions which he may select, and the right of full participation in all the general activities and privileges of the congress.

The officers of the committee are: W. F. Durand, chairman; W. A. Cattell, secretary and treasurer; E. J. Dupuy, executive secretary. The offices are in the Foxcroft Bldg., San Francisco, Cal.

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CENSUS OF WORLD'S AUTOMOBILES

A complete census of the number of motor vehicles in the world was compiled for the first time for the International Road Congress recently held in London. According to the data compiled, the United States possesses more than one-half of all motor vehicles, including motorcycles, in the world, the total number for the United States being 628,185. England comes next with 125,728, France with 89,185, and Germany with 70,006. The total number of motor trucks in the world is stated to be 69,556. The automobiles exceed greatly the number of trucks in all countries except in Germany, where it is stated that there are 49,126 trucks and only 15,618 pleasure cars. It is very likely, however, that this statement is due to a misunderstanding of the German expression for commercial car, which is probably meant to include all cars used for commercial purposes and hence the very large number of taxicabs in use in German cities. It is estimated that there are 300,000 motor vehicles manufactured yearly.

METHODS OF HEAT-TREATING STEEL WITH ELECTRICITY*

A DISCUSSION OF THE FEATURES OF THE DIFFERENT TYPES OF FURNACES IN GENERAL USE

BY E. F. LAKE†

The growing demand for a higher quality in heat-treated steels and for a constant improvement of the physical properties of the metal is making the electric furnace a commercial necessity, both in the manufacture of the metal and in its hardening and tempering. Efforts are also being made to use electric furnaces in the fabrication of steels, and such furnaces are now in use for heating steel before it is drop-forged and bent to shape for leaf springs. This is due to the fact that when so heated impurities which are injurious to steel are either removed from or not allowed to penetrate the metal, and thus are present in lower percentages than when the steel is heated in furnaces that use a flame to generate the heat. Another reason is the ease with which the temperature can be controlled and, consequently, the greater accuracy that can be obtained in securing the correct degree of temperature that is required for heat-treating or refining the steel. This has caused many different types of electric furnaces to be developed for heat-treating steels and several different principles are utilized in their design and construction. Of these, the Hoskins types were described in a former article and consequently will not be considered here. Most of the remaining types use either the arc or resistance principle for supplying the necessary heat to the oven or liquid bath furnace. Some, however, heat the steel on an open plate, and others after it has been submerged in the quenching bath.

A recently developed type of electric furnace is shown in Fig. 1. This is the Baily furnace, built by the Electric Furnace Co. of America, Alliance, Ohio. It is shown in use in the manufacture of leaf springs. In this instance the operation consists of inserting leaf No. 1 in the furnace and bringing it up to the fabricating heat, which must be 1800 degrees F. to make it bend properly to shape. The leaf is then removed and throughout its whole length made to fit tight against the bottom plate *A*, by two men who use tongs for this purpose. The bottom plate is held to the proper curve by pins through the eyes and holes in uprights *B* and the central supporter *C*. Leaf No. 1 is then replaced in the furnace, brought up to the hardening temperature and then taken out to be quenched in oil contained in a tank. After that, it is again placed in the furnace where the oil is burned off to get the drawing temperature. The next operation is to fit leaf No. 2 to leaf No. 1 which is held in the frame, and to harden and temper it. Then leaf No. 3 is fitted to leaf No. 2 and so on until the whole spring is built up. Owing to the inequalities in the curves, each spring must be kept separated and each leaf has its individual stamp, as none of the leaves will fit into any other spring. This accounts for the precision with which the spring plates are laid out on the rack at *E*.

Fig. 1. The Baily Furnace in use in the Manufacture of Leaf Springs

It can be seen at a glance that this is a misuse, or abuse, of the electric furnace and destroys its greatest point of excellence, namely the accuracy with which the temperature can be controlled. The correct hardening temperature of carbon spring steels is about 1500 degrees F. To reinsert the leaves in a furnace whose temperature is maintained at 1800 degrees, or more, and get them all within 150 degrees of the correct hardening temperature, during a day's run, is an impossibility. Occasionally one leaf may be taken out at the right temperature, but no means have been devised for telling when the whole length of a leaf has reached a temperature of 1500 degrees F., when it is in a furnace heated to 1800 degrees. Man's eyesight is not sufficiently delicate or accurate. Burning the oil off to obtain the drawing temperature is not to be spoken of seriously. If a separate furnace were used for the hardening operation, the heat in the oven could be maintained at the correct temperature, which would be 1500 degrees in this case. Thus steel could be allowed to remain in the oven of the furnace until it had reached a uniform temperature and then be taken out for quenching. Pyrometers could be used to measure the temperature of

* For further information on the electric heat-treatment of steel see "Electric Furnace Heat Treatment of Steel" in the October, 1913, number of MACHINERY, and other articles there referred to.

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the furnace oven, which would also be the temperature of the steel, and a more uniform product would be obtained. Another furnace operated at the correct drawing temperature would insure uniformity for that operation. The springs would then be much stronger and more resilient. The work could be turned out much faster in this way and with cheaper labor, which would lessen the cost of production.

The furnace is supplied with all the accessories that are necessary for obtaining accurate temperatures and maintaining them during any period of operation. The transformer is located at *F*, the oil switch at *G* and above it at *H*, the regulating controller. With these accessories the voltage can be varied to control the number of kilowatts of power supplied to the furnace, thus regulating its temperature. The switchboard *I* holds an ammeter, or current indicator, to show the amount of current that is flowing at any given time; a wattmeter to show the amount of power that is consumed per hour, day or month; a voltmeter to show the voltage of the current; and a recording pyrometer that shows on the chart the temperature the furnace has attained at any time during the day. These charts can be filed away to keep a permanent record of the temperature of the furnace on any work that is turned out.

A closer view of the furnace is shown in Fig. 2. In this illustration, the cold spring plate *A*, to which the hot leaves are bent, can be more plainly seen and also the rack in which it is held. The rack on which the spring leaves *J* are placed to drain off the oil can be seen in the tank *D*. The front of the oil switch is shown at *G* and the switchboard at *I*. At *K* are shown frames that cover the outer ends of the electrodes and their copper connections, to protect the workmen from the current. No flames, smoke, gases, fumes, or roar comes from this furnace; therefore, no chimneys, piping or blast are needed and an air blast or steam is not required, as in the case of furnaces that use a flame. The temperature of the room is also lowered, as most of the heat is confined inside the furnace. Thus the working conditions are made so much more pleasant that the operators are able to produce more springs for a day's work.

This furnace is called the 100-kilowatt size which means that its maximum consumption of power is 100 kilowatts per hour. The heating chamber is 5 feet wide by 7 feet deep by $1\frac{1}{2}$ foot high and 600 pounds of steel plates can be heated to 1650 degrees F. in one hour. With all openings closed, the furnace can be maintained at this temperature with about 20 kilowatts of power, which replaces the heat lost through the walls, this result being obtained by adjusting the switch so that 200 amperes at 100 volts will be flowing into the furnace. It is based on the theory that each kilowatt liberates 3412 B. T. U.'s in the furnace. If the doors of the furnace are left open, it will require another 8 kilowatts to replace the heat lost through them, and if there are any holes in the sides or roof of the heating chamber for the heat to leak out, it would require considerably more power to keep the furnace up to the desired temperature. Therefore, it is important that no openings should be allowed to remain in the walls, and as the furnace can be completely relined with silicon-carbide, at a cost of some \$2 or \$3, there is no excuse for leakages to occur.

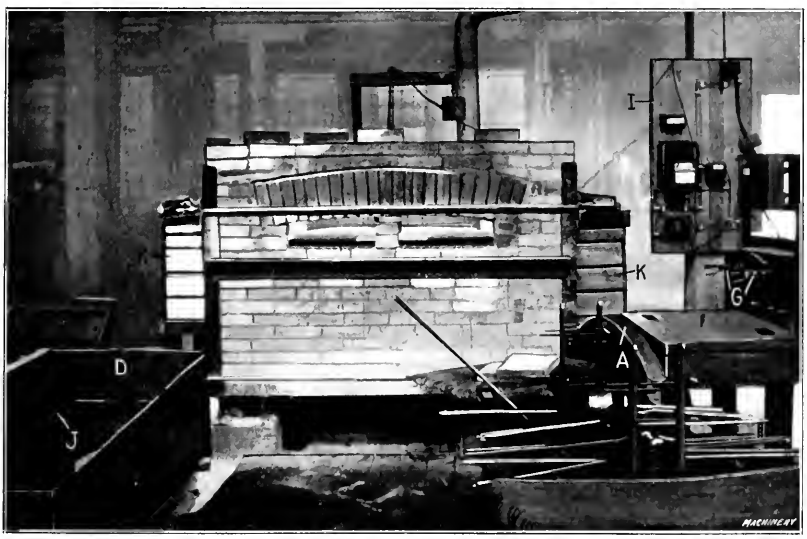

Fig. 2. Closer View of the Furnace illustrated in Fig. 1

With the preceding data, it is a simple matter to calculate the amount of current required to heat a given amount of steel. To heat one pound of steel to 1650 degrees F. requires 300 B. T. U.'s; therefore to heat 600 pounds every hour would require 180,000 B. T. U.'s per hour. This result divided by 3412 gives 53 as the number of kilowatts per hour that the furnace requires to generate this amount of heat. If we add 20 kilowatts for the wall loss and 8 kilowatts for the loss through the door, we have a total of 81 kilowatts per hour as the amount of power that is needed to heat 600 pounds of steel per hour. This can be obtained by adjusting the regulating switch to give 500 amperes at 160 volts. To leave the switch at this adjustment when the furnace was empty would run its temperature up too high, so that if it was required to maintain a temperature of 1650 degrees F while the furnace was standing idle for a short time, a readjustment of the switch would be made to give 200 amperes at 100 volts to make up the wall loss of 20 kilowatts when the doors are closed. If the doors are left open, enough more power would be required to make up the 8 kilowatts loss through that opening.

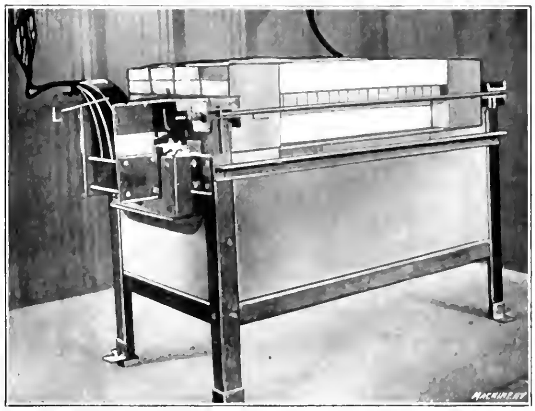

Fig. 3. A 60-kilowatt Baily Furnace for use in a Forge Shop

A 60-kilowatt furnace that was built for a forge shop in Alliance, Ohio, is shown in Fig. 3. This furnace is operated every day to heat chrome-vanadium steel to a forging temperature of over 2000 degrees, and allowed to get cold at night. It has a capacity of 300 pounds of steel per hour and is of the same type as the heat-treating furnaces. In fact, it could be operated just as efficiently at the hardening temperatures of the carbon or alloy steels. At *L* are shown the coppers that carry the current to the electrodes, two copper plates being attached to opposite sides of each of the two electrodes.

The principle on which these furnaces operate is shown by the diagram Fig. 1. Here *T* represents the heating chamber and *S* the opening or door leading into it, while *P* is the floor of the heating chamber on which the work is placed that is to be heat-treated. The leads which conduct the current to and from the furnace are shown at *L* and the copper plates that conduct it to the electrodes *X* are shown at *K*.

A channel O running underneath the floor of the heating chamber is filled with a resistance material, which in this case is coke ground to about the size of peas. The electrodes N extend several inches into the ground coke, and as the electricity passes through the resistance material, from one electrode to the other, the required heat is generated. As many channels may be used as the size of the heating chamber makes necessary.

The salt bath furnace illustrated in Fig. 5 is one in which the steel is immersed in molten salt to bring it up to the proper hardening or drawing temperature. The noteworthy feature of this furnace is that it is electrically heated, and such a furnace can be made to last indefinitely. It is best to construct a sheet-steel shell A that is held together with angle irons, lined with one inch of asbestos and then built up with about 12 inches of common brick B on the bottom and four sides. This brickwork should again be lined with one inch of asbestos C, inside of which about 8 inches of fire-brick D is laid on the bottom and four sides. When completed, the pot so formed should be of the right size for ordinary classes of work. It ought to be enough larger than the steel to be heated to allow space for two electrodes E of boiler plate on opposite sides of the pot, as these are placed inside of the salt bath, and also to allow for keeping the steel at least one inch away from the bottom, sides and electrodes, and immersed two inches below the top of the bath. When such a furnace has cooled down, the hard salt is not a good conductor of electricity. Therefore in starting up, it is necessary to chip a channel across the top of the salt, lay a ½-inch round carbon F in the channel, cover it with the salt chips and start them melting with a hand electrode, as shown in the illustration. When the channel is filled with molten salt, from one boiler plate electrode to the other, it will start the electric current flowing and the balance of the salt in the bath will soon become molten. The temperature is raised and controlled in practically the same manner as with the oven furnace previously described. The electrodes will last something like 3000 hours at temperatures that are high enough for hardening carbon steels.

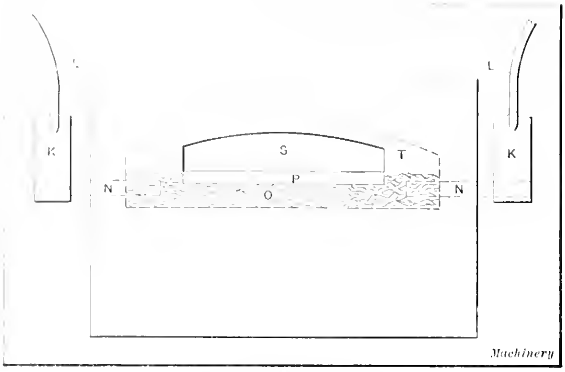

Fig. 4. Diagram showing the Principle on which the Baily Furnace operates

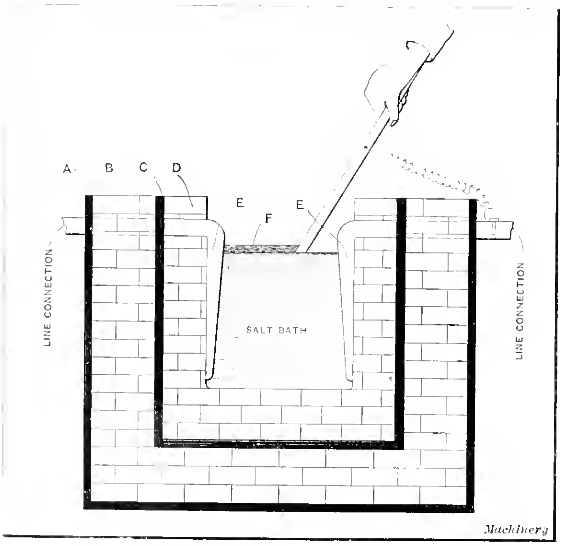

Fig. 5. Electrically Heated Salt-bath Furnace showing Method of starting with a Hand Electrode

When steel is heated to the hardening temperatures in a salt bath and then removed to be quenched, a thin coating of the salt adheres to the steel and prevents oxygen from attacking it and forming an oxide on its surface or raising a scale, while it is passing through the air to the quenching bath. This adhering salt cracks off when it is suddenly chilled in the quenching bath and leaves the steel with a natural color instead of with the black appearance that is produced when hardening it in other ways. At the higher hardening temperatures of high-speed steels, the salt bath furnaces that use graphite crucibles cause the tools heated in them to become pitted. In this electric furnace, however, the pot that holds the salt bath can be built up of other refractory materials, such as silicon-carbide and electrically calcined magnesia, and then no pitting occurs at any of the temperatures used for hardening.

Many different kinds of salts have been experimented with and the best kind to use for the bath depends on the temperature that is required. The melting points of the various salts that have been used are as follows:

MELTING POINTS OF DIFFERENT SALTS USED FOR HEAT-TREATING STEEL

Name of Salt	Melting Temp., Deg. F.	Name of Salt	Melting Temp., Deg. F.
Barium Chloride....	1580	Potassium Carbonate	1526
Sodium Chloride....	1418	Sodium Carbonate...	1317
Potassium Chloride..	1346	Lithium Carbonate..	1283
Calcium Chloride....	1328	Potassium Nitrate...	644
Magnesium Chloride.	1306	Sodium Nitrate.....	572
Lithium Chloride....	1112	Sodium Silicate.....	113
Lead Chloride.......	932	Barium Fluoride....	1832
Cupric Chloride.....	928	Calcium Fluoride....	1832
Silver Chloride......	844	Magnesium Fluoride.	1664
Cuprous Chloride....	813	Sodium Fluoride....	1656
Ferric Chloride.....	572	Lithium Fluoride....	1474
Zinc Chloride.......	504	Potassium Fluoride..	1454
Aluminum Chloride.	356	Strontium Fluoride..	1350

Of these some are too expensive for commercial work, others volatilize too easily and still others cannot be used for various reasons. Several combinations can be made that are better than when one salt is used alone, and some of these combinations have a lower melting point than either of the salts forming the mixture. For temperatures between 1800 and 2400 degrees F., chemically pure barium chloride is without doubt the best salt to use, as it volatilizes less than any of the others and is low in price. For temperatures between 1400 and 1650 degrees F. three parts of barium chloride to two parts of potassium chloride give excellent results. For any of the drawing temperatures below 1075 and above 480 degrees F. equal parts of potassium nitrate and sodium nitrate make a salt bath that is satisfactory in every way. This can be kept molten at 400 degrees F. if it is continually stirred, but if left standing it will solidify at about 475 degrees F.

When the proper salts are used there is very little loss from volatilization and aside from the cost of current, the expense of operating this furnace is very slight. It is particularly adapted for treating small work that can be loaded into metal baskets or racks and then immersed in the molten salt, as large quantities can be handled in this way and the work is clean when finished. In one case, 70 pounds of safety razor blades are heated to the hardening temperature in this way. They are next quenched and then reheated to the drawing temperature in another electrically heated salt bath furnace. Both furnaces are maintained at the correct temperatures for the hardening and tempering operations by a switch with eleven points that correspond to ten steps either

way and thus gives twenty-one adjustments. A pyrometer tells when the bath is at the correct temperature, and then it is only a question of leaving the work in the bath long enough to reach a uniform temperature. The thickness of the work determines the length of time it should be kept immersed, and with a little experience this can be definitely determined.

The electric arc has been successfully used for heating steel to hardening temperatures, and it is especially applicable for localizing the hardening in a certain part of the piece, the point of a cutting tool being a notable example. In Fig. 6 is shown a homemade apparatus that was rigged up for this purpose. The barrels filled with salt water take the place of a more expensive transformer and rheostat. By raising and lowering the steel terminal plates *A* in the barrels, the electric current can be controlled so that the tool is heated to the desired temperature. The carbon holder *B* is a very simple thing to make and any cast-iron plate *C* can be set on a rubber mat *D* to hold the tool *E* to be heated. A welding heat can also be obtained with this apparatus. It is essential that all parts of the body be protected from burns, as the heat from the arc will burn any exposed part in the same way that a sun glass burns on a hot day. Therefore it is necessary to wear gauntlets and a face shield with colored eye-glasses.

The steel is only heated in a spot directly under the carbon, and to heat the desired surface it is necessary to keep the carbon moving in a circle. It should not be brought too near the cutting edge of the tool and the arc should be started at a very low voltage, which is steadily increased to the desired point by adjusting the shunt rheostat. The carbon must also be kept a short distance away from the steel, for if it touches it is very likely to melt the metal at that point. The correct hardening temperature must be judged with the eye, as it would be very difficult to measure it with any kind of an instrument.

As steel becomes non-magnetic when it reaches the correct hardening temperature, or the transformation point, a magnet similar to that shown in Fig. 7 might be used to ascer-

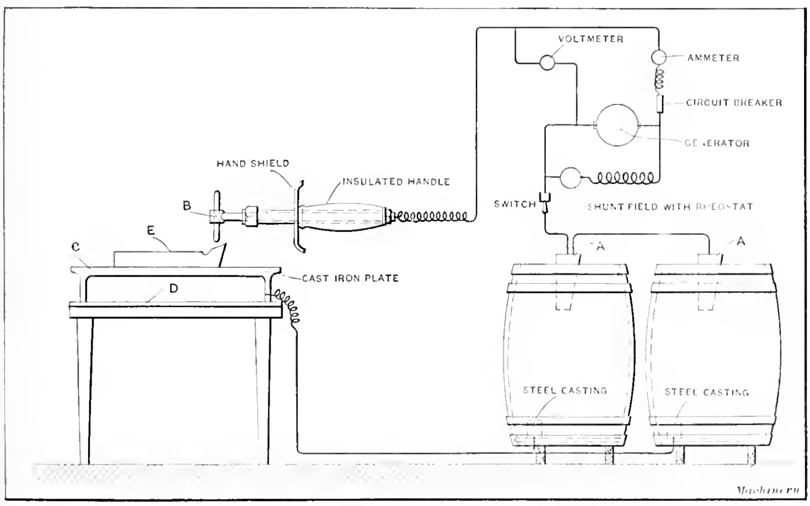

Fig. 6. Electric Arc Arrangement used for Local Hardening

tain when it had reached the non-magnetic stage. This magnet was made especially for use in hardening steel. As steel cannot be instantly cooled from the hardening to atmospheric temperature, it must be heated to from 25 to 40 degrees above the non-magnetic point to allow for the lag when quenching. It is very difficult to judge these 25 to 40 degrees and hence the magnet cannot be used for accurate work in hardening. The rapidity with which a piece of steel can be heated to the hardening temperature is the greatest recommendation of this apparatus, as it takes only two or three minutes to heat quite a large surface on a fairly thick piece. If it were not heated and quenched quickly, the oxygen in the air would have time to raise quite an oxide or scale on the heated steel.

If this principle were used regularly it would be much better to fit it up with a transformer and switchboard control in place of the water barrels, as these require constant attention to keep the water from boiling over, and to raise and lower the terminal plates.

The most rapid method of hardening steel is doubtless that in which the furnace shown in Fig. 8 is used. This consists of a cast-iron tank containing a potassium carbonate solution, a clamp in which to hold the piece to be hardened, and a rheostat, switches, fuses and wiring. After clamping the tool, it is only necessary to turn on the current, lower the tool into the solution and, when it has attained the proper temperature, turn off the current and allow the steel piece

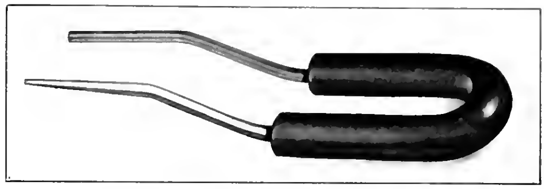

Fig. 7. Magnet used for determining the Critical Temperature of Steel

to be quenched by the solution. When the steel enters the potassium carbonate solution, it completes the circuit and immediately begins to heat up. The correct temperature is reached on a good-sized piece in about a minute and, being quenched before it is removed from the bath, nothing can attack the steel to discolor it. Consequently, when taken from the bath it has a clean steel-colored appearance. Being heated uniformly on all sides, there is no tendency for the work to warp or become distorted, and it can be lowered into the bath only as far as it is desired to have it hardened. With a little experience, the rheostat can be set at the point that will heat the steel to just the required temperature, and then it is only a question of leaving the steel in the bath long enough to attain this temperature before turning off the current. For permanent use, this apparatus can be fitted up to enable the current to be quickly regulated for obtaining any desired temperature in the steel, so that accurate results can be obtained in hardening.

Another principle, or method, that has not yet passed the experimental stage, except for treating tungsten and tantalum for electric lamps, is the vacuum furnace. These metals absorb oxygen and nitrogen very readily, when heated in the air, and become too hard and brittle for practical use. By heating them in a vacuum, however, they expel the oxygen and nitrogen, as well as any hydrogen that may have been absorbed, and are rendered quite ductile. This ductile tungsten has made the tungsten lamp a commercial success. It is comparatively easy to construct and operate an electric furnace inside a vacuum chamber and it is also known that less current is then required to heat metals to a given temperature. This is due to the fact that the loss of heat by radiation is reduced to a minimum and that the furnace retains its heat for a long time. The vacuum thermos bottle is a good example of this kind.

It is a well known fact that all metals absorb gases during melting and this reduces their physical properties. That steels give off these gases when heated in a vacuum has also been proved by many experiments, and some have shown that the higher the carbon content of steel, the larger will be the amount of these gases that is absorbed. Hydrogen, carbon monoxide, nitrogen, carbon dioxide, and methane are the gases expelled, in quantities according to the order in

which they are placed, the percentage of methane being very small and practically nil in many kinds of steel. At the transformation point of steel a new crystalline structure is formed, and the greatest quantity of the gases is given off at that time. As this is also the correct temperature at which to harden steel, it shows the benefit that could be derived by allowing the metal to "soak" for some time, in this degree of heat, when hardened in a vacuum furnace. The evolution of hydrogen begins at temperatures between 300 and 600 degrees F., according to the kind of steel; oxygen,

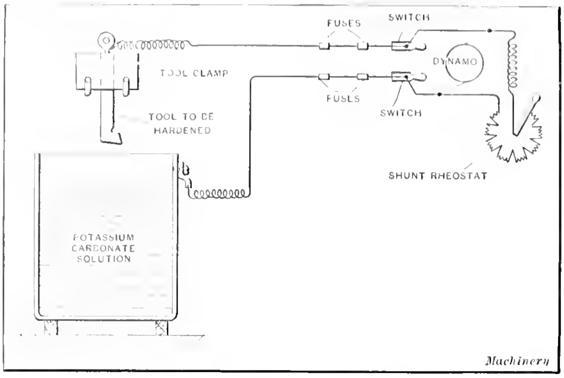

Fig. 8. A Rapid Method of hardening Steel

in the form of CO, at about 750 degrees; and nitrogen at from 1000 to 1200 degrees. Thus if an electric vacuum furnace could be constructed in a way that would make it useful for hardening tools, or commercial work of other kinds, it would doubtless increase the physical properties of the steel so hardened and especially its resistance to fatigue. Electricity is the easiest, quickest, and therefore the cheapest fuel to use in a vacuum furnace and its construction would be much simpler than if any other fuel were used. The results look so promising that it may be developed for shop use in the near future.

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SOLDERING FLUXES FOR SOFT SOLDER*

Among the many familiar metallurgical processes with which we have to do, the process of soldering is perhaps the most familiar. As ordinarily defined it is a process whereby two pieces of metal are joined by another metal or alloy, having a lower melting point than the metals joined.

In order that metals soldered together may be securely held, it is necessary that there be more than mere adhesion between the solder and the metal. There must be an alloy formed between the metal and the solder. In order that this alloy may be formed, the surface of the metal must be entirely free from any foreign substances, as oxides, oils, or various solid matter. Since it is not always convenient, or we may not care to take the time to clean the surfaces to be soldered, we resort to the use of various chemicals to clean the surfaces.

The flux selected, in any particular case, is determined by the nature of the work. If ordinary tin-plate, galvanized iron, sheet copper, or brass is to be soldered, the common fluxes, as ammonium chloride, zinc chloride or rosin, may be used. But if the work is something more delicate, as the soldering of 10 by 20 mil zinc wires, in fuse plugs, the effect of the corrosion of zinc chloride on the zinc wires must be considered. It is necessary in many instances to use a non-poisonous flux, as a poisonous flux should not be used in soldering fruit or meat tins. In many operations it is impossible to keep the soldering flux from coming in contact with the operator's fingers, or occasionally spattering in his face.

The rapidity with which a flux acts is an important factor in its usefulness. If the flux be in the form of a dry salt, a comparatively large amount of heat may be necessary to melt it. If an aqueous solution be used, an additional amount of heat must be used to evaporate the water, thus slowing the rate of action by cooling the parts to be soldered. This effect is negligible in most instances, but where it is necessary that the solder attach itself within a fraction of a second it becomes quite important. If the flux does not require melting, but is a liquid, the action is much more rapid, as no time is required for the surface to be covered, and no heat is used in fusing the salt. Further, the excess flux, which should always be present, readily flows out of the way.

Zinc chloride has several properties which make it a valuable soldering flux for most work. It is only with the greatest of difficulty that it can be obtained as a dry salt, and when exposed to the air becomes liquid in a few minutes. When used as a flux it remains a liquid even at the temperature of molten solder, thus being in a condition to act upon the oxides very readily. It possesses other properties which make it undesirable for much work. Zinc chloride is poisonous, and should not be used in soldering fruit or meat tins. It is exceedingly corrosive to the skin, and when left upon it for a few minutes produces severe burns. It also has an action on zinc which makes it useless for soldering small zinc wires in fuse plugs. If low capacity fuse plugs be made, using zinc chloride, as a flux, small zinc wires will be found to be completely eaten through within a few weeks, and sometimes in a few days.

An aqueous solution of ammonium phosphate was tried as a flux and worked quite well on tin, copper, brass or zinc, (but not on iron), where delicacy of operation and speed are not to be considered. But where a quick fluxing is necessary, it is not successful, as too much heat is necessary to evaporate the water and melt the salt. It has the advantage, however, of being non-poisonous and non-corrosive.

Lactic acid and ammonium lactate were tested as to their fluxing qualities, and were found to be splendid fluxes, equal in every particular to zinc chloride, but in a few hours showed a tarnish if used to solder brass or copper. The reason for the ready tarnishing is that lactic acid and ammonium lactate react with copper oxide in the cold. Neither of these fluxes is corrosive or poisonous in any way.

Rosin, either as a powder or an alcoholic solution, is a splendid flux where speed is not required. But it has the undesirable property of leaving a sticky, gummy mass after the evaporation of the alcohol, which is a hindrance in some kinds of work. Quite often a quantity of carbon and half decomposed rosin is left where the solder is to follow. For ordinary work, where a non-poisonous flux is desired, rosin is perhaps the most desirable. An aqueous solution of citric acid is a good flux, having properties very similar to ammonium phosphate. Ammonium chloride is a widely used flux, and is non-poisonous, and does not tarnish copper or brass; but when used on zinc, it forms zinc ammonium chloride and causes more or less corrosion of the zinc.

* Abstract of paper presented by W. Arthur at the annual meeting of the American Institute of Metals in Chicago, October 13-17.

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The Tower Building, 50 Broadway, New York City, which is notable for being the first of the modern skeleton steel frame buildings, is to be torn down. It was erected in 1889 on a narrow lot and is eleven stories high. If it had been built with stone or brick walls, the building laws in force would have made necessary walls so thick that the available space on the lower floors would have been too narrow to be profitable. To meet the situation, the architect, B. L. Gilbert, devised the skeleton steel frame type in which the posts and beams support the entire weight of the floors and side walls and transmit it to the foundations. By resorting to this expedient he was able to erect a building with comparatively thin walls and thus make valuable space available for renting. The building is to be torn down because it is no longer profitable to maintain. A larger building covering the plot and adjacent plots will be erected.

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The British Engineering Standards Committee has adopted the following standard for marine boiler stays: The Whitworth form of thread is to be used and the number of threads per inch is to be nine for stays above $1\frac{1}{4}$ inch diameter; for longitudinal stays above 2 inches diameter, six threads per inch will be used.

ALTERNATING-CURRENT MACHINERY TROUBLES—2

BRIEF AND CONCISE ANALYSIS OF THE DIFFICULTIES MET WITH AND THE REMEDIES TO APPLY

BY E. A. LOF*

TRANSFORMERS

Excessive Heating and Burn-outs

Short-circuits—The development of an actual short-circuit in a transformer in service causes a large current to flow in the short-circuited path. When a short-circuit develops in the primary winding, practically destroying it, the secondary coils are likely to remain in fairly good condition. If the trouble starts in the secondary winding it is likely to be localized in that part, and the primary coil may not be injuriously heated.

Short-circuits caused by defective winding of the coils may be due to rough, imperfectly welded joints, to improperly insulated wires, or to extreme pressure or pounding of the insulation. They may also be caused by breakdown of the insulation due to abnormal high-voltage static strains from surges set up by lightning, high tension switching, arcing, grounds, etc., or by moisture entering the transformer.

For drying out of transformers or oil see later paragraph.

There is one class of short-circuits known as "high resistance short-circuits," which are sometimes rather mystifying. They show up as a high iron loss, and it is at times difficult to determine whether the trouble has been due to defective winding or bad iron. Such a short-circuit may clear itself after the transformer is loaded. This is done by the expansion of the coil and consequent separations of the wires which were very nearly in contact. The short-circuit can usually be developed and located by an over-potential or overload run.

When connecting transformers in parallel the polarities must be the same; otherwise there exists a dead short-circuit.

Overheating from Overload.—An excessive heating or burnout from an overload is characterized by a "roasting" of the whole winding uniformly, while a short-circuit started from moisture, for example, produces a local failure. An overload may be either intentional or due to other causes. One transformer of a bank may be accidentally disconnected by, say, a broken lead, putting the load on the remaining units, thus overloading them. It has also been observed in practice that when one transformer of a bank connected delta-delta partially fails, the other two are frequently subjected to heavy currents which are circulated on account of the change of ratio resulting from the failure. The change of ratio that usually attends a failure admits of a difference in voltage which circulates current against the impedance of the three transformers connected in delta. A small difference in voltage may result in the circulation of a heavy current. Thus it may happen that when one transformer of a delta-delta bank fails the other two may be subjected to damaging effects if the bank is not taken out of service soon enough.

In the case of the Y-delta transformation the action is different. The effect here of a change of ratio of one of the transformers, due to partial failure, is an unbalanced secondary voltage. No appreciable current circulates in the secondary delta even where the difference in ratio of the damaged transformer is considerable. Instances are recorded where transformers connected Y-delta have run several months with one of their number in a damaged condition. In this case, therefore, it is not necessary to cut the bank of transformers out of service immediately unless the one damaged should fail entirely. The treatment in this case, however, is based upon the assumption that the neutral of the Y under consideration is not connected to any other neutral. If the neutral is connected to the neutral of another bank and both banks are tied in multiple, the effect in regard to circulating current would be the same as that obtained with the delta-delta transformation.

When two transformers connected in V are operated in parallel with three transformers connected in delta, one of the transformers will take more than its share of the load. The one transformer in the delta which has no corresponding multiple transformer in the V bank will then be carrying full load when each of the other four transformers is carrying only 76.15 per cent of the normal load. It is evident, therefore, that this transformer must be watched carefully to see that it is not too heavily overloaded.

When two transformers are connected in V on a three-phase circuit, the capacity is not two-thirds of a corresponding delta-connected bank consisting of three similar units, but only $1 \div \sqrt{3} = 58$ per cent. This is due to the fact that for the delta connection the current and voltage of each transformer are in phase with each other, while for the V-connection the current and voltage of each transformer are 30 degrees out of phase with each other.

Wrong Connections.—Transformers having series-parallel connections are sometimes so connected as to give double voltage on the windings. For instance, a transformer having a ratio of 2000 or 1000 volts primary to 110 or 55 volts secondary may be installed on a 2200 volt circuit with the primary connected for 1100 volts and the secondary connected for 55 volts. The transformers will give the desired 110 volts secondary, but since the windings are subjected to double the normal insulation strain and a large amount of the magnetizing currents would flow through the primary windings, insulation breakdown will probably occur sooner or later, and unless the connections have been carefully inspected the burnouts will be attributed to defective insulation.

Another wrong connection was a case where the transformer was connected up for 2200 to 220 volts and 1100 volts was impressed on its primary winding, giving 110 volts on the low tension winding. If such a transformer were loaded up at 110 volts to its rated capacity, it would be likely to burn out, as it would take double the current required if properly connected at normal rating. In this case the transformer would be roasted out, whereas, in the above case, its insulation would break down.

Ventilation.—Oil-cooled transformers rely upon the natural circulation of the air for preventing undue temperatures. When it is considered that with a number of large transformers of this type in one station there may be many kilowatts of energy to be dissipated, the necessity for the thorough ventilation of the station in which they are installed is realized. Since the air on becoming hot tends to flow upward, the openings in the station for the inlet of the air should be near the bottom, and those for the outlet should be near the top, all being well distributed. If the ventilation is not sufficient the transformer is bound to have a shorter life than it would have with the proper cooling. The first indications of a dangerous condition are darkening of the oil and a slight deposit on the surfaces inside the transformer. When the deposit once begins to form the tendency is accelerated because of the lessening efficiency of heat dissipation from the transformer. Where the oil has thickened to a considerable extent and a deposit has accumulated, the remedy is to thoroughly clean the transformer by scraping it and washing it out with oil under high pressure, putting in new oil after the treatment.

Cooling Water.—Excessive heating followed by burnouts may be caused with water-cooled transformers by the temperature of the cooling water being too high, or the amount of water not being sufficient. Insufficient cooling water is sometimes caused by a gradual clogging up of the cooling coils. This may be due to chemical actions from impurities of the water, or from a large per cent of organic matter or mud in suspension. Where there is any danger of the water containing lime, etc., iron cooling coils should not be used. In such cases it may be necessary to use copper pipe in order to avoid corrosion.

A very frequent cause of the clogging up of iron cooling coils in water-cooled transformers is the formation of a scaly oxide when the water contains a large amount of air. It is customary in some locations, where the water supply is lim-

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ited, to cool the water by discharging it into an open basin or tank. Sometimes, to facilitate the cooling, the water is sprayed as it goes into the basin. In either case, and especially in the latter, the water is sure to have an unusual amount of air in it, and consequently will have a very strong oxidizing action. In such cases, therefore, copper coils should be used instead of iron coils.

To clean out a deposit inside the cooling coil the water is first blown or siphoned out, after which the coil is filled with a solution of equal parts of hydrochloric acid and commercially pure water. Let the solution stand about one hour in the coil and then flush out thoroughly with clean water. Usually one treatment of this nature is sufficient, but more may be used. The treatment is effective for removing all sorts of accumulation from coils of the various metals used. In applying the treatment it is not necessary to remove the coil from the tank, but extreme care should, of course, be exercised in order to prevent any acid from coming in contact with any part of the transformer winding.

A deposit of oil is sometimes accumulated on the outside of the cooling coils on account of allowing the oil to reach a high temperature. Such deposits act as excellent heat insulators, and unless they are removed will cause the condition to become worse, resulting in dangerous overheating of the transformer.

With excessive overloads there is sometimes danger in water-cooled transformers that their windings will reach a higher temperature than is indicated by the oil temperature, especially where the amount of cooling water is increased for the overload condition. A thermometer located in the tank near the cooling coil indicates a temperature considerably lower than the actual oil temperature.

Oil Troubles.—Burnouts are sometimes due to neglect to put any or sufficient oil in the transformer case. At other times oil leaks out, owing to a faulty case, or excessive evaporation takes place after a long period of service, resulting in excessive temperature rise and finally in insulation breakdown.

The presence of moisture in the transformer oil, even in the most minute quantities, very seriously affects the dielectric strength of the oil. Moisture may enter from the outside or be formed by condensation on the inside of the transformer. In the former case the transformer should be made air tight by providing the top covers with gaskets, and breathing chambers through which the entering air can be dried should be installed. Condensation takes place when the temperature of the transformer is allowed to fall below that of the surrounding air. It may be prevented by reducing the amount of cooling water at times of cold weather, or by using the cooling water over again several times. The cooling water should also be shut off when the transformer is out of service.

Oil may be dried by blowing heated air through it at a temperature that will vaporize moisture, either at atmospheric or a lower pressure, such as is obtained in the vacuum process. The adaptation of the filter press with blotting paper to the treatment of oil has, however, proved to be most satisfactory. There is no danger of injury from excessive temperature, and both the moisture and sediment are removed. In case it should be found desirable, the oil may also be treated by means of the filter press without taking the transformer out of service.

Oil Testing

It is necessary that extreme care be taken in sampling oil. The sample must be drawn from near the bottom of the barrel or tank containing the oil to be tested, after the oil has been undisturbed for a period of not less than 24 hours.

In drawing samples from barrels, a long glass tube of considerable diameter, thoroughly cleaned and dried, with the lower end drawn to a 1/4-inch diameter may be used. Closing the top end of the tube with the hand, the tube is thrust to the bottom of the barrel and the hand is then removed, thus permitting the tube to fill. Again place the hand over the top end of the tube and quickly withdraw it from the barrel, letting the oil run into the sample bottle. The receptacle of the oil-testing outfit that receives the sample should be dry and clean. Ordinarily, it will be sufficient after each test to wipe the receptacle and the terminals with a clean cloth that leaves no lint. The high potential wires should be connected to the proper terminals of the sample receptacle through fuses of such capacity as will protect the testing transformer under short-circuit. The adjustable terminals should be gaged to exactly 0.2 inch and the sample poured into the receptacle, which should be slightly less than full of oil. Bring the voltage up slowly and continuously until snapping sparks pass at short intervals. This is called the "breakdown at short intervals," or the B.D.S.I. point. The voltage that causes a continual passage of sparks is the puncture voltage and may be considerably higher than the B.D.S.I. If the source of the test voltage is one of considerable power, there may be only a puncture voltage, which ordinarily would represent the B.D.S.I.

Oil for transformers of 40,000 volts and over should be dried before using if it punctures below 35,000 volts. For transformers having voltages less than 40,000 volts, the oil must be dried if it punctures below 25,000 volts. Where oil is dried it may easily be brought to a puncture of 40,000 volts. If a sample contains sediment, it will puncture at a lower voltage than it would without the sediment.

Transformer Drying

When transformers are shipped without oil in the tanks it is necessary to dry them out first. This may be done in several ways, the external and the internal heat methods being mostly used. The first of these methods should always be used for transformers having voltages of 40,000 and above, while for voltages less than 40,000 the second method may be used if facilities for applying the first are not available.

The "external heat" method requires the circulation of heated air through the transformer in its tank. In using this method the caps on the ends of the cooling coil should be removed to prevent the development of dangerous pressure in the coil, which might result from vaporizing the liquid put in it to prevent bursting due to freezing. The transformer having been cleaned, inspected and returned to its tank, the sources of heated air should be connected to the base valve and the manhole cover removed. In order to maintain a sufficiently high temperature inside the transformer, it will be found necessary to partly close the manhole, thus restricting the flow of air. The temperature of the heated air as it enters the transformer should not exceed 90 degrees C. (194 degrees F.). An outfit which is especially adapted for furnishing hot air for this purpose consists of an electric air heater, blower and air strainer. The air heater requires 20 to 25 KVA at 110 or 220 volts to operate it. The blower is designed to run at 3300 to 3500 R. P. M. and requires 2 H. P. to drive it at normal output. The blower may be driven by means of a gasoline engine, motor or any other prime mover which may be available. The air strainer, when in operation, should be wrapped with cheesecloth to prevent the dust from entering the blower and being blown into the transformer. This cloth should be changed from time to time as the dirt accumulates on it.

Drying with the "internal heat" method is preferably done with the transformer out of its tank; but if the transformer is in its tank, the manhole cover should be removed and the valve in the base opened to give as great a circulation of air as possible under the conditions. Short-circuit one winding, and apply such voltage to the other that sufficient current will flow in the windings to raise the temperature to approximately 80 degrees C. (176 degrees F.). The amount of current necessary to effect this temperature ranges between one-fifth and one-third of the full load current, depending upon the room temperature and the design of the transformer. The impedance volt necessary to give the specified range in current varies from 0.4 to 1.5 per cent of the rated voltage of the winding to which the impedance voltage is applied. In every case, however, the current admitted must be so regulated that the temperature of the windings does not exceed the 80 degrees specified.

The duration of the drying run depends upon the voltage

and size of the transformer and also upon its condition as to moisture at the time it is dried. For transformers under 20,000 volts the drying should be continued not less than 24 hours; 20,000 to 30,000 volts, 48 hours; between 30,000 and 40,000 volts, 72 hours. Transformers of higher voltages may require a longer time. It is obvious that some consideration must be given to the capacity of the transformer. Transformers of less than 100 KVA may only require 24 hours. For transformers between 200 KVA and 500 KVA the process may be limited to 36 hours; between 500 KVA and 1000 KVA, to 48 hours; between 1000 KVA and 2000 KVA, to 60 hours; for all larger capacities the process should be carried on for at least 72 hours. In case there is no evidence that the transformer is unduly moist, discretion may be used in slightly decreasing the limits given for the voltage. A transformer of 20,000 to 30,000 volts, for instance, having a capacity of 200 KVA or less may be dried in only 24 hours. The limits given for the capacities, however, should be rigidly adhered to, and in no case should the process be carried on for less than 24 hours.

Parallel Operation

In order that several transformers be able to operate successfully in parallel, that is divide the load properly, it is necessary that they have exactly the same voltage ratio of high-tension to low-tension turns, the same resistance and approximately the same impedance drop. Where the impedances differ, the load on the transformer with the smaller impedance will increase and the one with the larger impedance decrease until the two impedance drops become equal. It is generally a difficult matter, therefore, to secure a perfect parallel operation where the sizes vary greatly, and for this reason transformers intended for parallel operation should preferably be of the same size and with exactly the same characteristics.

SYNCHRONOUS CONVERTERS

Excessive Heating

Overload.—This may be due to incorrect compounding which makes a converter take more than its share of the load. The compounding can be changed by adjusting the series field shunt.

Incorrect Excitation.—Synchronous converters should always be operated at the voltage for which they are designed. However, it appears to be a common weakness among operators to run converters with a 5 to 10 per cent over-voltage on the direct current side. This is done, of course, by increasing the shunt field excitation to such an extent that the shunt field alone draws a leading current at no load, over and above which the series field adds additional leading current as the loads come on. The result of such operation is to practically double the average heating in the armature conductors at full load above that of unity power-factor, on which the converter guarantees are based. More than this, such an operation increases the heating of certain bars near the collector ring taps to three or four times the normal value, this being in addition to the heating resulting from increased core loss in the armature due to over-voltage. The result is to practically cut down the capacity of the converter some 30 to 50 per cent. In other words, a customer purchases a converter at, say, 750 K. W., with the usual guarantees and so operates it as to make it only a 500 or 400 K. W. converter on the same heating basis. In most cases, the average load is so low that no trouble is experienced, but as systems grow and load factors improve the difficulty is likely to appear. The proper cure for this evil is to utilize proper taps in the transformers so as to impress an alternating voltage sufficiently high, and to compel the operators to adjust the direct voltage for sufficiently low value to cause the converter to draw a considerable lagging current at no load, as was previously explained.

Short-circuit in Armature Winding.—This is at once manifest by a burning out of the short-circuited coil, which should be removed and replaced by another one.

Short-circuit in Field Winding.—This renders a portion of the field winding inactive, decreasing the resistance of the same, and causes a greater field current to flow. This in turn may cause a circulating current to flow in the armature and hence a flow of current through the equalizer circuit to balance up the potentials. It may also cause an unbalancing of the current in the alternating current line, resulting in overheating of the armature and the equalizer rings. By means of a voltmeter, readings should be taken across the terminals of each field coil; the one giving the least drop in potential is the defective coil.

Poor Regulation

Compound-wound Converters with Reactances.—If the voltage on the direct current end is too low, a higher voltage is best obtained by changing the connections from the transformer secondary winding to a tap of higher potential. A failure to obtain regulation is usually caused by an open-circuit in the field system, in which case an excessive current is drawn from the alternating current side. It may also be caused by a short-circuit in the regulating rheostat, which would cause the direct current volts to be normally high. Trouble in obtaining a sufficient range of voltage control on a compound-wound converter with reactance coils can be corrected in two ways. The excitation produced by the series field may be increased by increasing the resistance of the shunt across the series field so as to make more current go through the latter. If no shunt is used the amount of reactance in the lines of the converter may be increased, as the amount of raising or lowering of the potential is proportional to the reactance in circuit over a given adjustment of the series field.

Shunt-wound Converters with Induction Regulators.—If satisfactory regulation is not obtained with this combination it may be due to a short-circuit of a portion of the series winding of the regulator or to an open-circuit in the primary winding. A short-circuit in the secondary or series winding would probably result in heating up and burning out of that winding, while an open-circuit in the primary would cause a heavy voltage drop across the regulator, and thus bring down the direct current voltage.

Sparking

Sparking at the commutator may be due to a number of causes similar to those described in the first installment under dynamo and motor troubles. The principal causes are: Distortion of field; reversed field coil; short-circuited coil in armature; open-circuit in armature; reversed armature coil; incorrect brush spacing; high bars in commutator; uneven air gaps.

Starting Troubles

Failure to start.—This may be caused by an open-circuit in one phase of the compensator or line, in which case the machine would be on single phase and thus unable to start. It may also result when too low a voltage is applied, the starting torque being proportional to the square of the applied voltage. To remedy, change connections to a higher voltage tap on the transformer. Excessive bearing friction may sometimes keep large machines from starting, especially if they have been standing still for a long time.

Excessive Starting Current.—It sometimes happens that when six-phase converters are started from the A. C. side an excessive current is drawn from the line in one phase. This may be due to a wrong connection, in that one phase of the machine would be 180 degrees out of phase with one of the line phases and would hence be on short-circuit. This would be indicated on the ammeters and the phase in which the heavy current is flowing should be reversed. If the supply voltage is too high an excessive starting current may result and it may be advisable to try out a lower voltage tap on the transformers.

Parallel Operation

In order that it be possible for two or more synchronous converters to operate satisfactorily in parallel and divide the load properly, it is necessary that they have the same voltage regulation from no-load to full-load. This can be obtained by changing the initial settings of the shunt field rheostat, by adjusting the series field shunt resistance and by inserting resistance in the equalizer connections where necessary. Synchronous converters operated in parallel should

not be connected to the same transformer secondaries. Such a connection would form a closed local circuit in which heavy cross currents would flow, when any difference in the operating conditions of the machine occurs, as, for example, when the brushes of one of the machines are slightly displaced relative to the other.

If for some reason, a short-circuit, for example, the alternating supply voltage should drop considerably, the synchronous converters operating on the system would not drop out of step, as the direct voltage and load would be correspondingly reduced. If other direct current generators or storage batteries were operating in parallel on the same system, however, these would tend to maintain the direct voltage and in such a case the direct current would reverse and flow toward the converters, running them as motors. Care should be taken in such cases, therefore, to provide the synchronous converters with proper speed limiting devices and reverse current circuit breakers.

Hunting

The most common reason for hunting is the variation in the angular velocity of the prime movers of the system. A sudden overload may come on the converter, or the frequency of the supply current may be increased due to a momentary increase in the speed of the prime mover. The current in the converter will increase and the position of the armature with respect to the field may be changed so as to produce a greater torque, which tends to increase the speed of the converter. As the armature has considerable weight, it will take some time for this to occur, and as the synchronizing force may have been more than sufficient to increase the speed corresponding to the frequency which existed at the time of the impulse, the armature will be pushed ahead of the synchronous position. While this is taking place, the angular velocity of the prime mover may drop, thus reducing the frequency and causing a still greater displacement of the armature. In this case the converter is sometimes ahead and sometimes behind the proper phase position and the speed is constantly fluctuating above and below the synchronous value. The remedy is obviously to make the rate of rotation of the prime mover more uniform by providing sufficient flywheel capacity. With the stipulation impressed upon the engine builders this case of hunting is not now so serious and does not exist when the alternators are turbine driven.

Hunting is also produced by a variation of the alternating supply voltage as caused, for example, by the drop due to a relatively high resistance and reactance in the line. This fluctuation in impressed voltage will react in the synchronous converter and, if the magnetic circuit is not very sensitive, causes a state of unstable equilibrium which leads to hunting. It is obvious that if the E. M. F. supplied to the armature varies suddenly the flux must also vary at the same relative position of the armature and field. If the magnetism is lagging, the armature must take a different position from what it would otherwise, thereby setting up a pulsation in speed and causing the converter to hunt.

Hunting will cause a shifting of the magnetic lines of force across the pole faces of the converter. At one instant the alternating current reaction will be too great and the lines will be crowded to one pole corner; then it will be weakened, and the direct current reaction will crowd the lines to the other corner. This causes a shifting of the lines of force across the interpolar space and produces sparking. In order to prevent this the armature teeth and the pole corners are generally worked at a high saturation, and dampening collars of copper are placed at the pole faces so that any incipient shifting of the field produces a powerful reaction. The collars consist of several copper rods placed in ducts in each pole face and short-circuited together at the ends by cross bars. A variable armature reaction can cause but slight distortion of the field and what shifting of the field takes place causes large currents to flow in the copper collars and these will at once prevent the distortion. With the copper rods placed in this manner, all of the currents induced are in a direction to produce useful results and no energy is unnecessarily lost.

HORSEPOWER OF CRANE MOTORS

BY R. H. CREVOISIE*

The following formula gives the horsepower of the motor required to give an electric overhead crane its longitudinal or bridge travel:

$$F = \frac{Lfd}{D}$$

$$\text{Horsepower} = \frac{FV}{33,000}$$

in which V = velocity of crane in feet per minute;
F = force of traction;
L = total load in pounds;
f = coefficient of friction = 0.08 to 0.12;
d = diameter of track wheel axle in inches;
D = diameter of track wheel in inches.

The pressure on the track wheel axle bearings should not exceed 500 pounds.

The use of these formulas will be better understood by showing their application to a practical problem. As an example, consider a 25-ton crane equipped with a 5-ton auxiliary hoist and having a span of 50 feet. Assume the load to be 50,000 pounds; weight of trolley, 24,000 pounds; weight of two girders, 25,000 pounds; weight of lineshaft, brackets and foot walk, 8000 pounds; weight of motor, 2000 pounds; and weight of end carriages, 6000 pounds. This makes the total load L 115,000 pounds.

Applying the formula for F, for a crane with track wheels 24 inches in diameter mounted on axles 5 inches in diameter:

$$F = \frac{115,000 \times 0.10 \times 5}{24} = 2396 \text{ pounds}$$

Substituting this value for F and assuming a speed of 250 feet per minute,

$$\text{Horsepower} = \frac{2396 \times 250}{33,000} = 18$$

A short method of finding the approximate diameter of the bridge shaft that is required to transmit this horsepower, is given by the following:

$$\text{Diameter of bridge shaft} = \frac{\text{H. P.} \times 120}{\text{R. P. M. of motor}}$$

To illustrate the use of this formula, assume the case of a crane in which the motor makes 575 revolutions per minute. The diameter of the shaft would then be found to be:

$$\text{Diameter of bridge shaft} = \frac{18 \times 120}{575} = 3\tfrac{3}{4} \text{ inches}$$

In designing a foot brake for this bridge, nine square inches of brake surface should be allowed for each horsepower required for the motor. The available brake surface is usually taken as three-quarters of the circumference of the brake wheel multiplied by its face width.

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RISING PRICE OF PLATINUM

The cost of platinum is, at the present time, $670 a pound, as compared with $290 a pound five years ago. This great increase in price is due to the increased demand for platinum in the industries and for purposes of ornament while the production of platinum has increased but little. The world's total production of platinum during 1912 was, approximately, 21,500 pounds, which was practically the same as the production during 1911 and only 2000 pounds more than the production in 1910. Of the total annual production of platinum all but about 1000 pounds comes from Russia. Columbia produces nearly 1000 pounds per year. The imports of platinum into the United States in 1912 aggregated $4,503,682 in value. The total output of platinum from the United States during 1912 was only 50 pounds.

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There is no power, however great, that can stretch a wire, however fine, horizontally straight provided the wire is of considerable length. Why?

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FORGING AND MACHINING AUTOMOBILE FRONT AXLES

METHODS OF THE WILLYS-OVERLAND CO. IN FORGING AND MACHINING FRONT AXLES MADE FROM SQUARE STOCK

There are several different methods employed in the forging of front axles for automobiles. The Ford front axle, as described in the article "Machine Forging—5" in the September number of MACHINERY, is made in one piece from a $1\frac{3}{8}$-inch round bar of vanadium steel. Another method, used especially for large axles, is to make them in two pieces welded in the center. The front axle to be described in the following is made from a $1\frac{1}{2}$-inch square bar of high-carbon steel. The use of any of these methods, of course, depends largely on the number of axles to be made and the facilities at the disposal of the manufacturer. Judging this proposition from an economical standpoint, it would seem that a one-piece front axle would be the easiest to make and would be superior to that made from two pieces welded together.

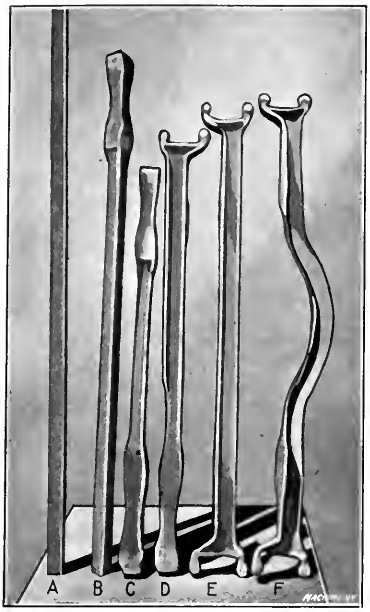

Fig. 1. Sequence of Forging Operations on Willys-Overland Front Axle

Upsetting the "Overland" Front Axle

The first operation on the front axle is to cut off a bar of high-carbon steel $1\frac{1}{2}$ inch square by 59 inches long as shown at *A* in Fig. 1. This is put in the furnace and heated on one end to a "white" heat. The next operation is performed in the four-inch Ajax upsetting and forging machine shown in Fig. 2, which is equipped with sliding dies of a type somewhat similar to those shown in Fig. 62 of the article previously mentioned. In this case, however, the impressions in the dies are made to suit the square stock, whereas in the other case a round bar was used. The method here described also differs in that the upsetting plunger does not rough-form the ends of the bar, but merely upsets two bosses as indicated at *B* in Fig. 1. The end of the bar is upset to form two bulges, which contain sufficient metal to form the axle ends and spring pads. The boss at the end is increased from $1\frac{1}{2}$ inch to $2\frac{1}{4}$ inches square, while the boss for the spring pads is increased from $1\frac{1}{2}$ inch to $2\frac{1}{2}$ inches square.

Forging under the Steam Hammer

After one end of the bar has been upset in the forging machine, it is thrown down in the sand to cool off, and the same operation is repeated on the batch of bars. After this the bars are again placed in the furnace and the other end upset in the same manner. The top impressions in the forging dies are used to rough-form the bosses, while the lower impressions bring them to the required size. Two blows are struck in each position. From the forging machine the upset bars are taken to the steam hammer shown to the left in Fig. 3.

It will be noticed by referring to *C* in Fig. 1 that the bar has not nearly reached the final shape of the axle and requires a considerable amount of drop-forging to bring it to shape. Two sets of dies are used roughing and finishing. The roughing dies are held in the steam hammer shown to

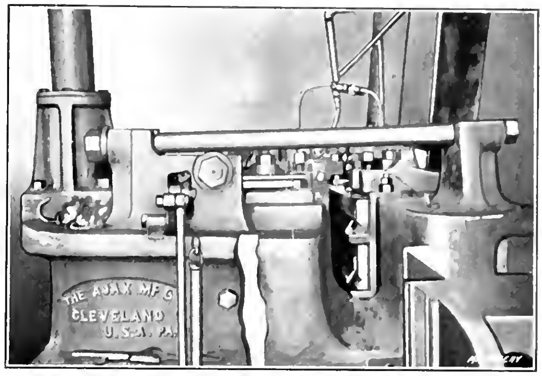

Fig. 2. Ajax Forging Machine used for upsetting the Ends of the Axle

the left in Fig. 3, while the finishing dies are shown set up in the hammer in the center of the engraving, and in the closer view, Fig. 4. The roughing dies only break down and rough-form one end of the front axle, these dies having two impressions. The breaking-down impressions in the dies simply "throw out the stock" into the desired positions, thus enabling the axle to be formed to the rough shape in the roughing die impressions. Two blows are struck with the breaking-down portion of the dies and seven blows in the roughing impressions.

The bar is now taken to the furnace, and upon reaching the proper heat is removed and placed under the finishing

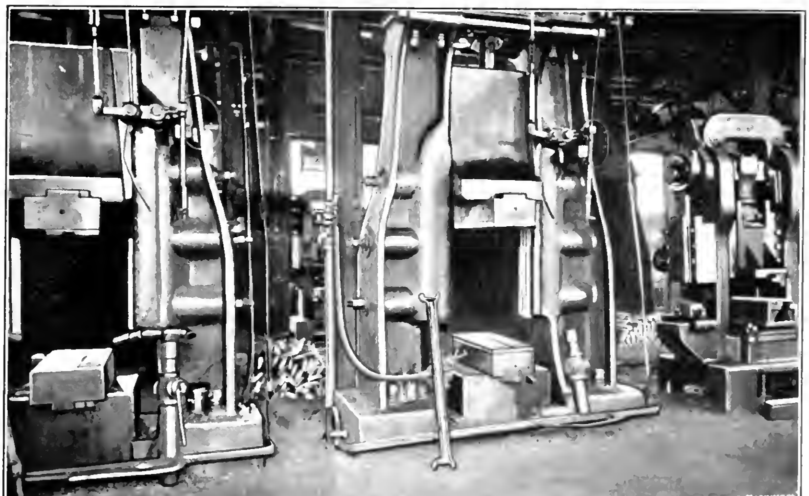

Fig. 3. Steam Hammers and Trimming Press used in performing the Final Forging Operations on the Axle

dies shown in Fig. 4. Here nine blows are struck, and as the axle is brought to its final shape a considerable amount of fin or flash is thrown out around the form. This is removed by the trimming punch and die shown to the extreme right of Fig. 3, which is held in a Toledo No. 57 punch press. After the fin has been removed, the forging is brought back to the same hammer and given a final blow. As shown at *D*

in Fig. 1, only half of the front axle is completed at a time. After one end of the axle has been formed, it is thrown down in the sand to cool off, and upon the completion of the batch the bars are again placed in the furnace and the other end handled in a manner similar to that described.

Stretching and Bending Automobile Front Axles

After both ends of the front axle have been forged, bringing the axle practically to its final shape, it is then placed in a furnace and heated for the final operation—stretching to the proper length and bending to shape. This is accomplished in the Toledo No. 56 punch press shown in Fig. 5, which is equipped with a stretching and bending die of interesting construction. The bending portion of this die consists of a base *A* fastened to the base of the press, in which two slides *B* and *C* are held. Fastened to the top of these slides are two brackets *D*, only one of which is shown, that serve to hold the front axle in position.

In operation, the front axle, after being heated in the center to the proper temperature, is placed between these projecting brackets *D*; then the wedges *E* are placed in the grooves formed in the axle and a square tapered wedge *F* is driven in on top of wedge *E*. This combination of wedges clamps the front axle rigidly in position, and as the ends bear against the outside projecting bosses of the brackets the axle is prevented from shifting when the stretching operation is taking place.

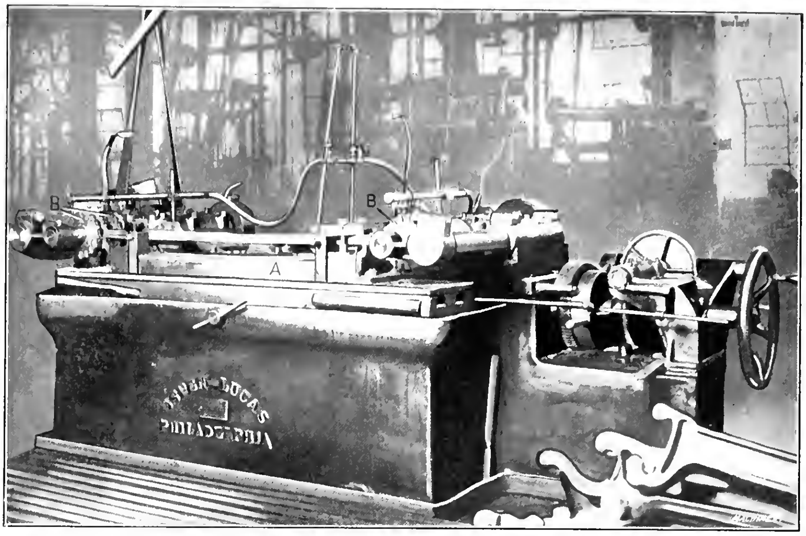

Fig. 6. Milling the Axle Ends in a Special Horizontal Milling Machine

The stretching operation is accomplished by a tapered

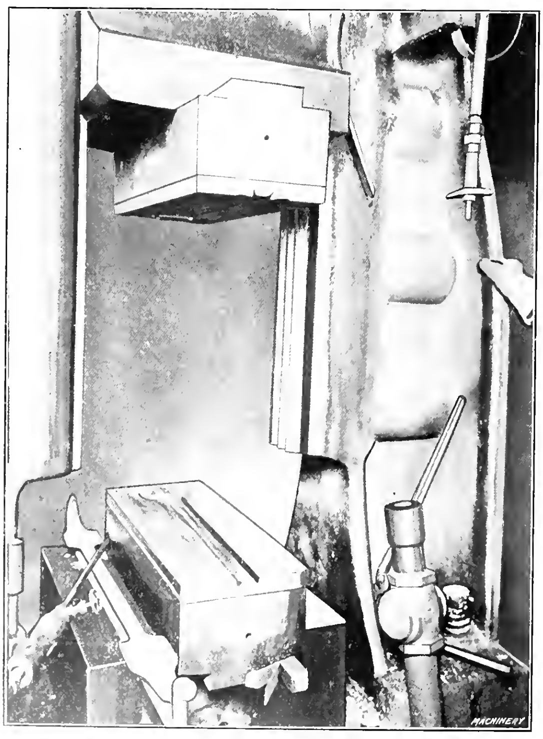

Fig. 4. The Final Drop-forging Dies

plunger *G* held in the ram of the press and operating between two rollers *H* and *I* which are held in projecting bosses formed on the two slides *B* and *C*. As the ram of the press descends, this tapered plunger comes in between the rollers, forcing the slides apart and stretching the axles to the required length. A maximum error of 1/16 inch is allowed in the length of the front axle. After stretching, the tapered wedges are knocked out and the axle removed and placed in the bending die *J* shown to the left. Here the axle is held in grooves formed in this die and is located by the stop *K*. The bending is accomplished by the impressions in the lower die in conjunction with the bending punch *L* held in the ram of the press. The condition of the front axle after this operation is shown at *F* in Fig. 1.

Milling Automobile Front Axles

Two milling operations are required on the front axle after

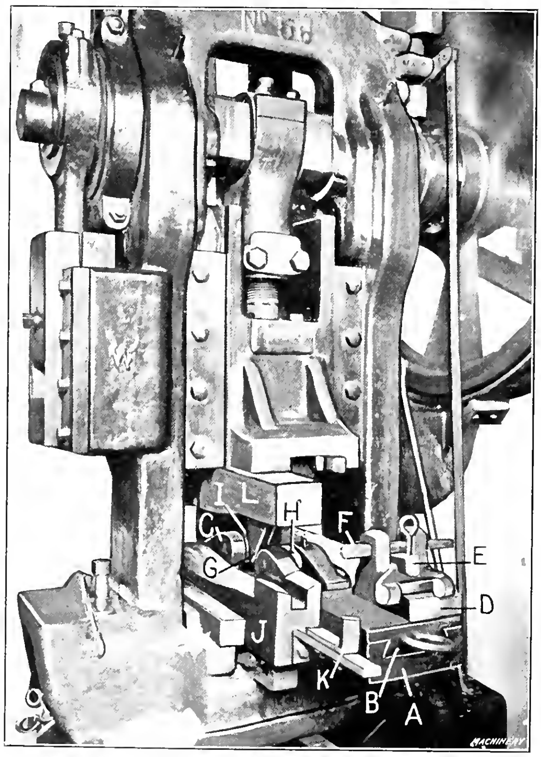

Fig. 5. Stretching and bending the Axle to its Final Length and Shape

it has been forged to the final shape—milling the ends and the spring pads. As the milling of the spring pads is a simple operation it will not be described here. The milling of the axle ends is accomplished in the Espen-Lucas horizontal

milling machine shown in Fig. 6. Two axles are held in the fixture A by set-screws and clamps. The milling of the ends is accomplished with eight inserted-tooth high-speed steel milling cutters B, which finish them in one cut. On an average 5/32 inch is removed from the surface of each axle end and 135 axles are completed in nine hours.

Drilling the Holes in the Spring Pads

After the spring pads have been milled, the ten holes for fastening the springs to the front axle and the two holes

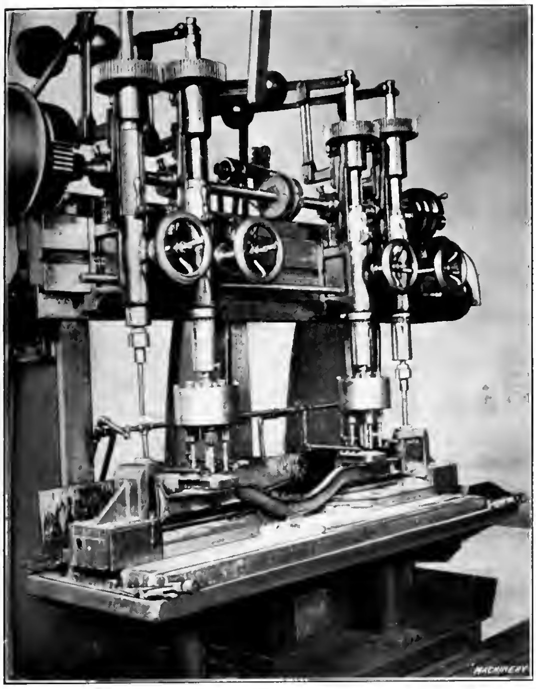

Fig. 7. Drilling and Reaming the Holes in the Axle Ends and Spring Pads

for the universal joints are drilled and reamed. This operation is accomplished in the Foote-Burt multiple-spindle drilling machine shown in Fig. 7, the twelve holes being completed in one setting. The ten holes for holding the springs to the spring pad are produced with the two-center drill heads, each of which carries four 15/32-inch and one 9/16-inch drill. The two end spindles carry 39/64-inch drills which produce the holes in the axle ends. These holes are also reamed with a 5/8-inch reamer after drilling. The axle, when being drilled is located from the ends by lugs and knurled nuts in the fixture shown. Fifty of these front axles are completed in nine hours.

* * *

THE SPEED KING

BY DONALD A. HAMPSON*

Conspicuous among a number of men hired during our busy season last fall was one Bud Cook of Philadelphia, who had been employed to run a boring machine in the locomotive works, but the water disagreed wtih him so that he had to leave the city. His tools and outfit had been delayed in transit but he had a four-inch scale in his pocket and thought that he could get along until Saturday, if we could lend him a few things.

Bud stated that he was a good "all-around man," and as the days went by he lived up to this estimate of his ability; he was at home on all classes of work, and what was even better, he was a rapid worker. Very few of the boys could set up a job on the boring mill, for instance, as quickly as he—he invariably had the first cut going. The apprentices dubbed him the "Speed King," and most of the men were secretly jealous of him, for although they tried to equal his production they always fell behind. When talking things over among themselves they were quite frank in making insinuations about the quality of Bud's work.

But Bud continued to make good. "My work speaks for itself," he would say, and after he had been in the shop for a month he looked like a real find—rapid, capable and willing—and he was trusted with many pieces of work of the class that usually goes to the old hands. It was along toward the second month Bud had been with us that a complaint came in about a job he had done. The slide he had fitted up on a punch press had worn loose in remarkably short order, but Bud promptly excused himself on the ground that he had done the work at night and might not have got a full bearing on account of the poor light. As a matter of fact, it looked as if he had scraped the entire bearing low and then fitted up a little 1/4 inch rim around the edge.

About a week later the cement mill 'phoned for a man to come down and look over a job that Bud had done a little while before. The work consisted of putting in a new slide on a pulverizer, and when the man who went to investigate returned he reported that the plate was held on by twelve head screws and the first step he had taken was to tighten up these screws, but an hour later the plate was loose again. An investigation showed that only five screws were holding it down, although twelve bright screw heads showed on the outside of the plate. Seven of these screws, however, were heads only, which Bud had ingeniously cut off and riveted on the reverse side of the plate. Six holes in the frame were filled by old screws which it would have been impossible to get out except by drilling, and the seventh hole contained the end of a new 1/2 inch tap.

Needless to say, Bud was fired for that little job in double-quick time. The cement people were too good customers for us to lose without showing that we meant to do the right thing by them. The climax came, however, the next morning. We had all the work we could handle and were making pretty good headway when the engine knocked out a cylinder head at about ten o'clock. Bud again. The Sunday previous he had been given the job of fitting new cylinder studs to replace the old ones which had become loose. The engineer reported that the job looked first-class, and although Bud had put in a time slip for twenty hours, it was O. K'd because he had done such a good job. Looking at the thing in the light of later experience, it appeared that when Bud took the cylinder head off, he found the studs were still tight in the cylinder, so removing them, he sized them down until they fitted nicely in new nuts, and also took particular pains to face off the nut end of each stud so that it looked like new. Then he replaced them in the cylinder in the reverse position, so that the worn ends went into the holes. By screwing the studs down until they bottomed, they appeared to be quite solid, but as may be readily imagined, it did not take many hours of running with the gage standing at 110, to tear those worn threads from their seats.

The "I-told-you-so" boys in the shop had a day of rejoicing and the stock of the slow men went up several points in the office. It was learned some time afterward that Bud had always been that way. A few weeks of hard conscientious work was all that his nature could stand, and then the spirit of unrest so got the better of him that he seldom stayed in the same place for more than a month or two before taking the short cut routes, to which his undoubted talent lent full aid. His ability had put him in a number of responsible positions, but the result was invariably the same, and Bud is probably even now wondering whether a north or south-bound freight will take him to a place where the water is better.

* * *

Sir Robert A. Hadfield, in a paper presented before the September meeting of the British Iron and Steel Institute, reports the results of experiments with a manganese steel whose heating and cooling curves do not show the characteristic points of recalescence and decalescence. Extensive experiments have been performed on this steel but in all cases no points of recalescence or decalescence showed in the heating and cooling curve.

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THE USE OF HEAT-TREATED GEARS IN MACHINE TOOLS*

FROM THE STANDPOINT OF THE MACHINE TOOL MANUFACTURER

BY ANDREW C. GLEASON†

It is, of course, impossible to cover thoroughly such a broad subject as the heat treatment of gears, within the limits of this article, so only such points as are probably of interest to the average machine tool builder, will be considered.

At the outset, it should be explained that the methods of heat-treatment described here are those best suited to the requirements at the Gleason Works and it is not claimed that they represent general practice. In fact, it is rather hard to say what is the general practice, as the heat-treatment of steel gears is largely a matter of individual requirements. Methods vary considerably even among manufacturers of a certain class of automobile gears which are of a standard shape and designed for one purpose, so that hardened gears for machine tools may well be considered a distinct proposition. Looking at this subject from the viewpoint of the machine tool builder, the principal points to be considered are:

(1) The advantages to be gained by the use of heat-treated gears.

(2) The selection of steel to suit the purpose for which the gears are intended, and the design to suit hardening conditions.

(3) The methods of hardening and the necessary equipment and materials.

(4) The cost of heat-treated gears.

The advantages in the use of heat-treated gears properly made are greatly increased strength and hard tooth surfaces which resist wear. These points are certainly of vital importance in modern machine tool design, and it seems inevitable that hardened gears will very soon be in general use in this class of machinery. The failure of soft metal gears to stand the wear and tear in machine tools is too frequently the cause of breakdowns, and in spite of the rapid development in design in other ways such gears are still commonly used. They are a serious source of weakness and the logical remedy is heat-treated gears. Heat-treated gears with their increased strength and ability to withstand wear offer almost unlimited opportunity for compact design. For example, the automobile transmission suggests what can be accomplished with such gears in making machine tools more convenient in operation and more durable.

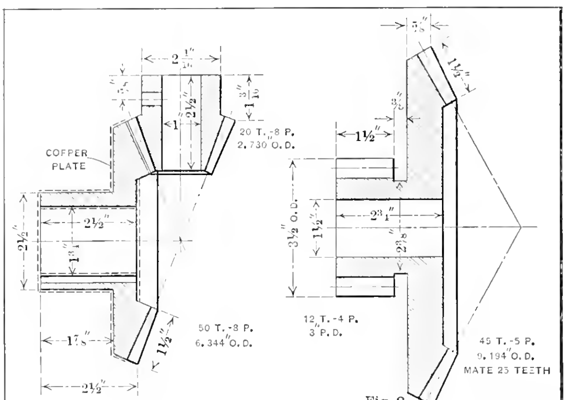

Fig. 1. Gear with Light Hub kept Soft by copper plating

Fig. 2. Gear having Small Pinion Integral with Hub

Steel to be Used

The question of the steel to be used depends not only upon the purpose for which the gears are intended but also upon the design. When the gears are subjected to severe shock or heavy overload at times, a steel which will show the greatest tensile strength possible, without sacrificing toughness, is plainly the most desirable; but steel which will show these qualities has certain limitations for use in machine tool construction, and it will be interesting to note the value of a straight tempering steel as compared with the more commonly used casehardening steels. Straight tempering steels for gears are invariably alloy stock and most of our experience has been with the chrome-nickel alloy. With several different makes of stock of this kind, we have found an increased tensile strength of 150 per cent after heat-treatment. The analysis varies considerably in different makes, requiring a corresponding difference in the heat-treatment, but manufacturers making a specialty of alloy steels now furnish them carefully graded with instructions for hardening which can generally be relied upon.

There are frequent exceptions, however, to the rules for hardening any kind of gear steel, and the only safe method is to experiment with every change in design. It is not sufficient to cut a piece off the bar and harden it, regardless of the shape of the gear being made, as the sample piece should be practically the same as the gear in order to produce the same effect. Take, for example, a pinion solid on a shaft. The teeth will chill much more quickly than the solid section under them, and in order to avoid shrinkage strains special heat-treatment is required to suit this shape and the quality of steel that is used. If a sample pinion of this size were made separate from the shaft, the effect of the same heat-treatment would be radically different owing to the fact that the center would cool almost as rapidly as the teeth.

Our experience leads us to recommend the use of as few grades of steel as possible. If the steel is selected to suit exactly each different shape of gear and the purpose for which it is intended, it would necessitate a large variety for the varied requirements of the machine tool builder. There are some steels which are more adaptable to different conditions in hardening than others, and considering the comparatively small quantities and the variety of sizes and shapes in gears for machine tools, it is well to keep this in mind. "Fool-proof" methods in the heat-treatment of gears, are far from possible, but by the selection of a few grades of steel which show good average results, the work can be greatly simplified.

Tempered vs. Casehardened Gears

On account of the great strength and toughness of chrome-nickel tempering steel and the fact that it hardens clear through, it is well adapted for automobile transmission gears and any similar purpose in the construction of machine tools. Gears of this kind do not chip on the edges of the teeth and will stand almost unlimited hardship in sliding in and out of mesh. Chrome-nickel tempering steels tend to keep their shape in hardening better than the low-carbon casehardening steels, but they do warp somewhat and they cannot be straightened without sacrificing the hardness almost entirely. Gears made of this stock do not show as hard a bearing on the surface of the teeth as those made of casehardened steel. The cost of machining alloy tempering steels will average at least twice as much as that of casehardening steels, and the cost of the steel itself varies from fourteen to sixteen cents per pound, as compared with less than half that price for high-grade alloy casehardening steels.

The chief advantage in the use of casehardened gears is the file-hard tooth surfaces. The easy machining qualities and low cost of the stock are also important advantages, but the superior wearing qualities of casehardened gears make them the best at any price for average conditions in machine tool construction. In designing a machine tool there may often be occasion to make the gears as small as possible and it then becomes a question as to the choice of tempered steel or alloy casehardening steel. The use of 5 per cent nickel low-carbon casehardening steel, will give the best results pos-

* Paper read before the National Machine Tool Builders' Association, New York City, October 23, 1913.

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sible if strength and wearing qualities are considered, although if strength is the main consideration, tempering steels, as previously explained, should be the choice.

Of the alloy casehardening steels, we are more familiar with the three principal grades of nickel than any other. The writer believes that these have become standard to a large degree in the trade at the present time. These are 5 per cent open-hearth nickel alloy; $3\frac{1}{2}$ per cent open-hearth nickel; and 1 to $1\frac{1}{2}$ per cent nickel natural alloy. The principal characteristics of these steels are a higher tensile strength than straight-carbon steel, and a correspondingly higher strength after casehardening. The carbon case has a close bond with the core and is less likely to chip than the ordinary machinery steel. In fact, a number of manufacturers of the higher grade automobiles use the 5 per cent casehardening nickel steel in their change speed transmissions, where tempering steels might be regarded as more favorable.

When it comes to substituting casehardened gears for soft steel or cast-iron gears, in machine tools, it will generally be found that a straight-carbon casehardening steel will answer every requirement, and unless the original gears have been considerably overloaded the more expensive alloy steel gears would be an extravagance. In straight-carbon steels for casehardening, we recommend 0.15 to 0.25 per cent carbon. A lower degree of carbon than this is likely to produce a laminated case which will crack or chip under heavy pressure. Nickel alloy steel for carbonizing should not have over 0.20 per cent carbon; 0.10 to 0.20 per cent carbon suits us the best. The nickel alloy has practically the same effect in hardening as an increase in carbon of about ten points. We have found that 0.25 per cent carbon nickel alloy steel, casehardened, will generally harden clear through very much the same as a straight tempering steel.

The teeth of soft steel gears in machine tools seldom break or strip until they have worn quite thin, and our experience goes to show that durability is generally of more importance than excessive strength in gears of this kind. Casehardened steels show an increased tensile strength ranging from 30 per cent in standard carbon steel, to 75 per cent in high-grade nickel alloy steel. The straight-carbon casehardening steels are not as uniform in analysis as the alloy steels and we cannot always get the same degree of hardness in the case as with the higher grade steels. This is particularly noticeable in gears of heavy section hardened in oil, but it rarely happens that the hardness will drop as low as that of tempering steels.

Selective or Local Hardening of Gears

A strong point in favor of casehardening steels for machine tool gears is that certain parts can be kept soft readily where subsequent fitting is found desirable. Hub projections, web surfaces, etc., can be copper-plated or enamelled with various preparations so as to exclude the carbon in the carbonizing heat, leaving these parts soft for final machining operations. Present-day design of casehardened gears for machine tools often makes it necessary to keep certain parts soft in order to avoid shrinkage strains in the hardening process. In a gear with light hub projections, as shown in Fig. 1, the carbon case would extend almost through the thin section of the hub at the keyseat, making it quite likely to crack on account of the uneven shrinkage in hardening. We advise making gears for hardening of even section throughout, but where it is necessary to use light hub projections like the one shown, they can be made safely by the method of selective hardening.

In selective hardening, we have found that copper-plating the surfaces which are to be kept soft is the most satisfactory method. Generally the parts to be plated can be immersed in the solution, leaving the teeth clear, or the blank can be copper-plated all over, so that when the teeth are cut the bearing surfaces will be free to carbonize. It should be borne in mind that wherever this plated surface is marred, carbon will enter and leave a hard spot after the gears are hardened.

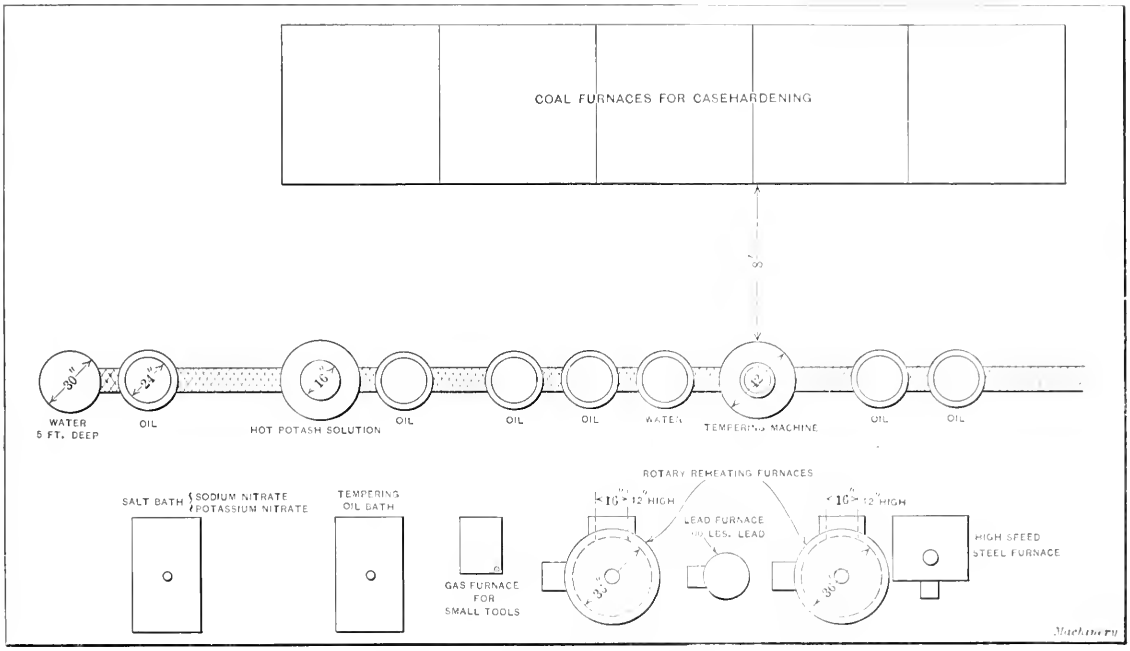

Fig. 3. Plan of Gear Hardening Department—Gleason Works

Some Points in Gear Design

Other points for criticism in the design of the pair of gears shown in Fig. 1 are the extremely long face in proportion to the cone distance and the long backing or overhang of the pinion on its bearing. The chances are all against getting a full bearing of the teeth throughout the length of face, after the gears are hardened and the bores are ground to size. We would advise cutting down the length of face to not more than one-third of the cone distance and using a coarser pitch with a smaller number of teeth for the same diameters.

Another condition which it is necessary to guard against in gears of this kind occurs where a small pinion is made solid with the gear in place of the light hub, as shown in Fig. 2. There would be still greater risk on account of shrinkage strains in hardening this piece. The pinion section would be weak when worked out of the center of bar steel and it would be far better to make it separate from the gear.

All established rules for the horsepower transmitted by gears, as far as I know, are based on the use of soft steel or cast iron. They usually allow a stress for steel of two and one-half times that of cast iron. This may be correct as far as strength is concerned, but it certainly is not right if wear is to be taken into account. We have found that gears of a good mixture of cast iron showing 35 to 40 on the scleroscope test for hardness will withstand wear fully as well as open-hearth cast-steel gears of the same size. Consequently, we have compromised on one-half this difference in stress for steel, making it one and one-quarter instead of two and one-half times that for cast iron.

This brings up the subject again of wearing qualities of casehardened steel gears as compared with soft gears. We have equipped a number of electric motor drives with casehardened gears, making them very much smaller than the soft steel gears formerly used, with most satisfactory results, and judging by these records, we recommend a stress of four times the usual standard allowed for cast iron in standard horsepower rules such as the Lewis formula.

For example, in a 30 horsepower electric drive in connection with a positive pressure blower which we have in use, the original soft steel gears, computed according to our standard rule for horsepower, required a pair of gears having, respectively, 49 and 16 teeth, of 3 diametral pitch, 3¼ inch face, and the casehardened steel gears which have been in use now for several years have 49 and 16 teeth, of 4 diametral pitch and 2¼ inch face. We consider that this rating (four times greater than cast iron) is conservative, as the gears which we have based our calculations on are considerably larger than automobile bevel driving gears transmitting more power. As evidence of the advantage of casehardened gears over alloyed tempered steel gears, we may cite the standard automobile practice in bevel driving gears. I do not know of a single exception to the rule that automobile manufacturers use only casehardened steels for such bevel driving gears at the present time. Their requirements, as is well known, call for the greatest possible combined durability and strength.

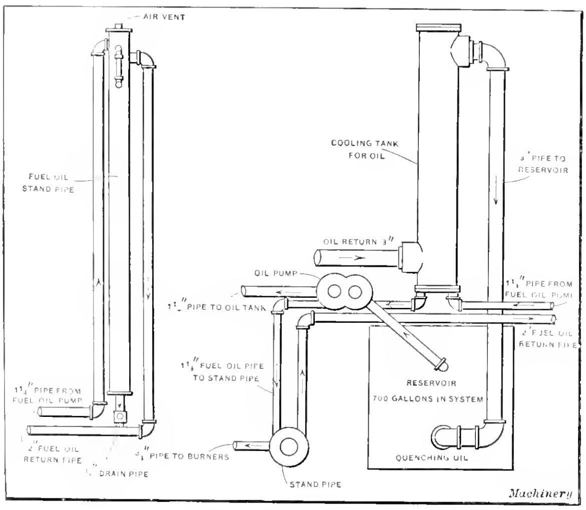

Fig. 4. Diagram showing Quenching Oil Reservoir and Cooling Apparatus

We recommend quenching casehardened gears at the lowest heat possible to produce the required degree of hardness; this in combination with slow carbonizing heats gives excellent results with one quenching heat. In the use of steels suitable for casehardening, we strongly advise against drawing after hardening. We find that casehardening steels allow of a much wider range in the heat-treatment than tempering steels, and we consider casehardened gears the best for general purposes in machine tools, "clash gears" excepted.

Equipment for Heat-treating Gears

We are using coal-burning furnaces for carbonizing in preference to oil or gas (see plan of heat-treating department, Fig. 3). For continuous use with the slow soaking heats which we recommend, we find coal to be the most economical, and with very little attention to the fires, there is no difficulty in maintaining and controlling the heat. The fact that the coal-burning furnaces require practically no attention when run after working hours, and that no power is required for air pressure such as is necessary in the oil or gas burners, is an argument in their favor; the very low cost of fuel is also an important consideration. Furnaces of this kind, however, must be used continuously, day after day, to produce the best results, since it requires about twenty-four hours

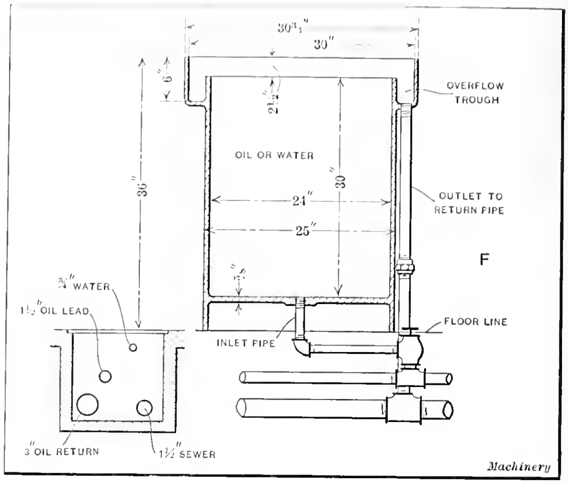

Fig. 5. Oil or Water Quenching Tank

from the start, to bring them up to a carbonizing heat. On the other hand, there is no delay whatever in getting the required heat with oil or gas, and where there is not sufficient work to keep a furnace running continuously, the oil or gas furnace would undoubtedly prove the most satisfactory. An oil or gas furnace is necessary in any case for reheating, so that the same furnace can often be used to advantage on carbonizing as well. Aside from the cost of fuel, the objections we have to the use of oil or gas for carbonizing gears, are that furnaces of this kind require constant attendance when run after working hours and that extra power is needed for air pressure in the burners. There is always the danger of an interrupted flow of the gas or air to be guarded against.

Most of our work requires the use of large carbonizing boxes and these naturally require a longer heat to penetrate than smaller sizes. In regard to the depth of carbon case in gears, we recommend ⅛ the thickness of teeth at the pitch line, and not more than 1/16 inch deep in the coarsest pitches in machine tools. According to this rule, ½ inch pitch should have 1/32 inch carbon case.

At the present time, there are several makes of carbonizing compounds extensively used which have proved much more satisfactory than bone or charred leather. Care must be taken to keep these compounds perfectly dry, not only in the packing of the boxes but also after they are taken out to cool; if any water is allowed to leak in when the material is hot, a chemical action sets up which has the effect of blistering the casehardened surfaces of the gears, the same as if they were overheated. Short pieces of common machinery steel about ½ inch square are generally placed in the top of the boxes for test pieces, and before the work is taken out of the box these pieces should be hardened and broken to make sure that the depth of case is right.

It is a well known fact that nickel alloy steels require a longer carbonizing heat than straight-carbon steel, and in order to determine the proper depth of case, test pieces of the same material should be used with the plain carbon steel test pieces so as to make a proper comparison. We find that it does not pay to use plain cast-iron carbonizing boxes. Semi-steel is better and cast steel is the best.

We use mineral oil for quenching which has a 310-degree

flash test and viscosity of 74 inches at 104 degrees. It is a thin petroleum oil which can be bought for 17 cents per gallon by the barrel. With tempering oils like this we find that a safe rule is to quench one pound of steel to a gallon, every four hours, where no special arrangements are made for cooling the oil. With our cooling system, Fig. 4, we are able to quench 3000 pounds of steel in eight hours with 700 gallons of oil. The tempering oil, as shown, is circulated through the inside of a radiator and we circulate our fuel oil through the outer jacket. The radiator is simply a powerhouse water heater which is adapted for this purpose without change. We use the fuel oil for cooling because of its convenience. Greater efficiency, of course, could be obtained by having a flow of water for the purpose or by increasing the radiating surface. Our radiator has thirty feet of cooling surface. We have never had any difficulty with overheating of the oil with this system, no matter how fast the work is put through; occasionally the temperature is as high as 120 degrees but never any higher. Quenching can be done about twice as fast as without the cooling system.

Cost of Heat-treated Gears

In leading up to the final cost of heat-treated gears, we submit herewith an itemized form—our actual cost of labor and materials in the heat-treatment of chrome-nickel tempering steels as compared with casehardening in general.

Cost data for 1000 pounds of gears made of chrome-nickel tempering steel:

Labor (one working foreman and two assistants, wages)	$ 9.85
Fuel oil (two hardening furnaces, 60 gallons)	3.00
Quenching oil, 1½ gallon	0.25
Tempering oil, 2 gallons	0.50
Pyrometer ends	0.10
Gas for drawing temper, 1500 cu. ft	1.45
	$15.15

$\$15.15 \div 1000 = \$0.0152$ per pound

Cost data for 1000 pounds of casehardened gears:

Labor (one working foreman and two assistants, wages)	$ 9.85
Coal (3 furnaces, 200 pounds each)	2.00
Carbonizing compound	1.00
Fuel oil (two hardening furnaces, 60 gallons)	3.00
Quenching oil, 1½ gallon	0.25
Pyrometer ends	0.25
Carbonizing boxes (average)	2.50
Wear and tear on 3 carbonizing furnaces	0.30
	$19.15

$19.15 \div 1000 = \$0.0192$ per pound

No account was made of the cost of power or other overhead expenses as they are the same in either case.

Following is a tabulated account of the actual cost of labor and materials in making up a small lot of miter gears complete from bar stock using the various grades of steel referred to:

Taking a miter gear having 18 teeth of 4 pitch, 1⅛ inch face, 1½ inch bore and an ordinary hub, the weight of the rough bar stock is 11 pounds and the finished gear, 5½ pounds. Our labor cost for machine work would be practically the same for this gear, in any of the standard steels for carbonizing. The only difference in the complete cost would be in the stock. According to this, and taking the labor cost at $1, the cost of the gear complete would be as follows:

Straight carbon steel at 3 cents	$1.44
1 to 1½ per cent natural alloy steel at 4½ cents	1.61
3½ per cent O. H. nickel steel at 6 cents	1.77
5 per cent O. H. nickel steel at 8 cents	1.99
Our labor cost for machine work of the gear in chrome-nickel crucible tempering steel, would be	2.00
Heat-treatment	0.09
11 pounds at 15 cents	1.65
	$3.74

We have found the cost of machine work practically the same in either casehardening straight-carbon steel or any of the nickel alloy casehardening stock. Heat-treated gears in machine tools are on the side of superior quality and greatest efficiency; therefore, they represent the standard and aim of American manufacturers. It is safe to say that within the next few years, soft steel gears in machine tools will become a thing of the past, just as gears with cast teeth were abandoned twenty years ago.

* * *

GRINDING THE FACES OF POLE-PIECES

In making electrical instruments, the Weston Electrical Instrument Co., of Newark, N. J., has large numbers of small cast-iron pole-pieces to be machined. It is essential that the outside dimensions of these pieces be finished perfectly square and true, and they must all be accurate to size. One of the pole-pieces is shown full size in Fig. 1. The machine used for doing this work is the Blanchard vertical surface grinder. The pole-piece castings are held upon the magnetic table about 150 at a time, as illustrated in Fig. 2, being placed in regular rows with finished parallel strips between them. After one face of each of the blocks has been ground, the blocks are reversed, and the opposite faces finished exactly to the size required. The grinding is facilitated by means of the continuous reading caliper with which the Blanchard machine is equipped—this may be seen directly over the work-table in Fig. 2. After two faces have been finished, the pieces are turned so that the finished surfaces come in contact with the sides of the parallel strips. The strips are then firmly pressed together, and a second set of faces ground. Similarly, the third pair of faces is finished, leaving the pieces perfectly square and finished to size. C. L. L.

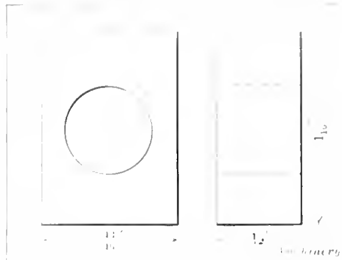

Fig. 1. The Pole-piece (shown Full Size)

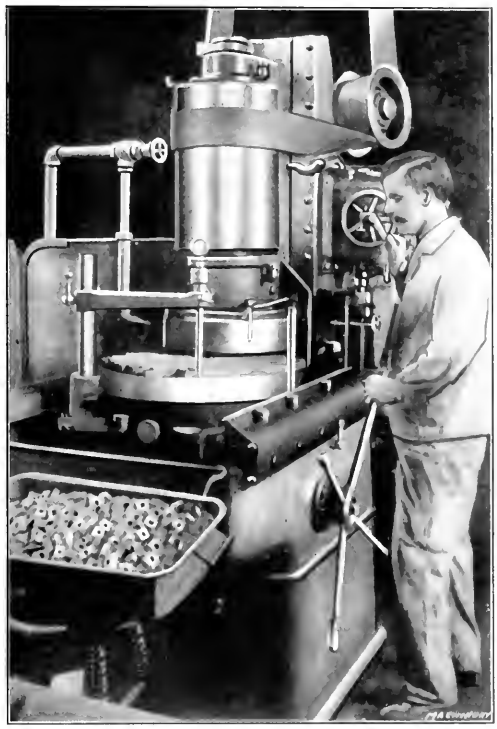

Fig. 2. Grinding the Faces 150 at a Time

* * *

Lots of purchasing agents make a good showing by saving a few cents a gallon on oil. The wearing out of the journals of costly machines is not charged on that side of the ledger.

THE USE OF HEAT-TREATED GEARS IN MACHINE TOOLS*

FROM THE STANDPOINT OF THE MATERIAL MANUFACTURER

BY J. HEBER PARKER†

In the earlier days of machine tool construction, when carbon tool steel was used for cutting, and relatively light work was the order of the day, cast-iron gears were used for transmitting power. With the advent of air-hardening tool steel and heavier work, the use of mild steel gears became necessary, while to-day, with tools of modern high-speed steel the use of heat-treated alloy steel gears is well nigh imperative. Gears of this last class may be divided into two general groups—casehardened gears, with a low-carbon soft center or core and a high-carbon hard exterior or case, and tempered gears which are of the same composition and hardness throughout. The characteristics, heat-treatments and merits of these two groups, as viewed in the light of a fairly wide experience with gears used in motor-car construction, will be discussed briefly in the following:

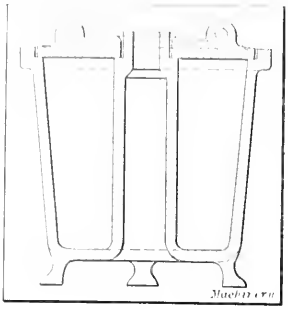

Fig. 1. Cored Pot or Box for casehardening

Casehardened Gears

Case-carbonized gears may be made from four general classes of steel, *viz.*, straight-carbon, nickel, chrome-vanadium and chrome-nickel steel, and of each of these classes several modifications will be found in the market. On the whole, the steels containing chromium are to be preferred, for they are freer from the tendency to lamination shown in nickel-steel (especially 3½ per cent nickel steel) and they also absorb carbon more easily, thereby lessening the length of time and expense of carbonizing. Before carbonizing, the carbon content of each of the steels mentioned, should be about 0.20 per cent, and never more than 0.25 per cent, to avoid brittleness in the teeth. The carbon in the case should be raised to about 0.90 per cent, which can readily be done by the proper selection of carbonizing material and by using the proper temperature for carbonizing.

The temperature for carbonizing, in general, should be about 1600 to 1650 degrees F. for all the classes of steel previously referred to. Lower temperatures do not give sufficient depth of "case," unless the heating operation is much prolonged. On the other hand, higher temperatures result in a case of excessive carbon content and in a core of such large grain-size that it will not respond to the subsequent heat-treatment as readily as if a temperature of 1600 to 1650 degrees had been used.

The heat-treatment after case-carbonizing is the most important part of the process, and upon it depends the physical properties of the finished work. As already stated, after carbonizing we have a piece of steel with a 0.20 per cent carbon core, and a 0.90 per cent carbon case, and the object of the treatment is to put both the core and the case into the best possible physical condition. Both need refining to correct the large-grained structure developed by subjecting the steel for many hours to the carbonizing temperature. Since the refining or hardening temperature of the core is about 200 degrees F. above that of the case, this difference determines the most approved method of heat-treatment.

The old method consisted in quenching the piece in oil or water at the end of the carbonizing operation, right from the box, at the temperature used for carbonizing. This resulted in a large-grained core that was neither strong nor tough, and an overheated granular case which was hard, but which would not stand up in service any better than an overheated piece of tool steel. The first improvement on this old method was to allow the piece to cool in the box after it was removed from the carbonizing furnace, and then to re-heat it to the proper temperature for hardening the case and quench in a suitable fluid. This procedure, however, did not develop a strong tough core.

The proper heat-treatment for casehardening gears is the so-called double treatment by which the pieces are first allowed to cool in the box after carbonizing, next re-heated to 1550 to 1625 degrees F. and quenched in a suitable medium to refine the core, then re-heated to 1350 degrees to 1425 degrees F. and again quenched in a suitable medium to harden the case, and finally drawn in oil at not above 400 degrees F. to further increase the strength and toughness of the casehardened gear. The temperatures given are approximate only; for exact information concerning any particular steel, the user should consult the steel-maker.

There are many case-carbonizing compounds on the market and most of them have some merit. Those of bone are probably the least desirable owing to their lack of uniformity which results in uneven carbonizing. The most desirable are those consisting of definite mixtures of carbon and carbonates; they carbonize uniformly, and most of them can be used repeatedly without losing their power of giving up carbon to the metal.

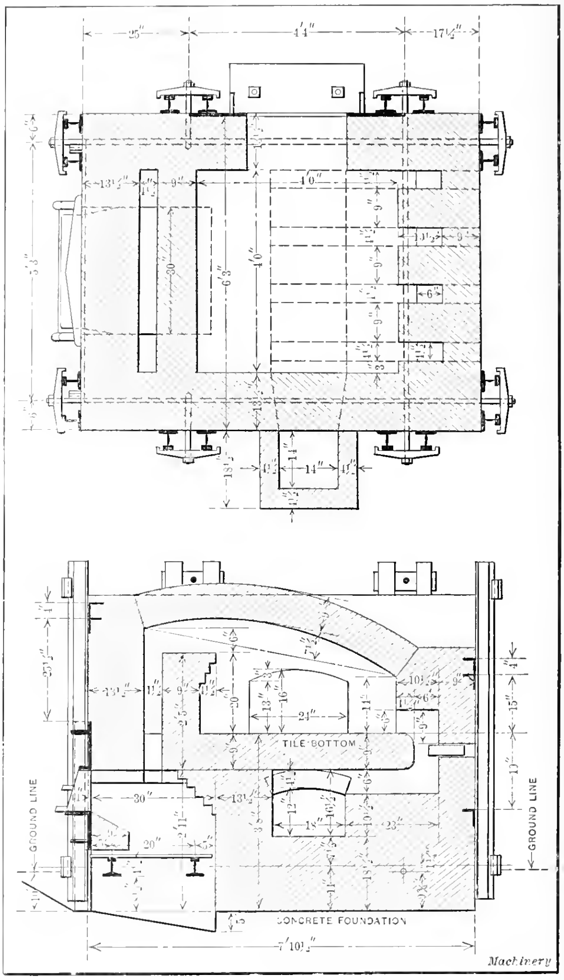

Fig. 2. Coal or Coke Furnace for heat-treating Gears

* Paper read before the National Machine Tool Builders' Association, New York City, October 23, 1913.

† Metallurgist, Carpenter Steel Co., Reading, Pa.

The wear and tear on carbonizing furnaces, the fuel consumed, and the expense of the boxes are three important items in the cost of casehardening. In many cases it is possible to reduce all these items by the use of a cored instead of a solid box, as shown in Fig 1. The proportion, of course, will vary with the work to be done, but if the general idea is worked out for each specific instance, it will be found not only that the cost of carbonizing is diminished, but also that the carbonizing is more uniform.

Tempered Gears

Unlike casehardened gears, tempered gears are of uniform carbon content throughout, and, when hardened, have a uniform hardness throughout the tooth-section. The steels used for tempered gears are of three general classes, *viz.*, silico-manganese, chrome-vanadium and chrome-nickel steel—the last-named, in its several modifications, being by far the most used. The carbon content varies for the different classes from 0.40 per cent to 0.60 per cent. The heat-treatment of all these steels is very simple, consisting merely in heating the gear slowly and uniformly to the hardening temperature, which is usually about 1500 degrees F., quenching in oil, and afterward drawing in an oil bath. The result is strong, tough, dense-grained steel gears; these have been used with marked success in motor-car work, and are fast replacing soft steel and casehardened gears in machine-tool construction.

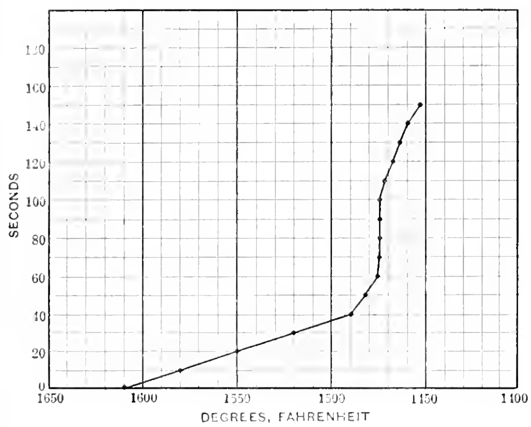

Fig. 3. Diagram showing Calibration of a Pyrometer which is Correct

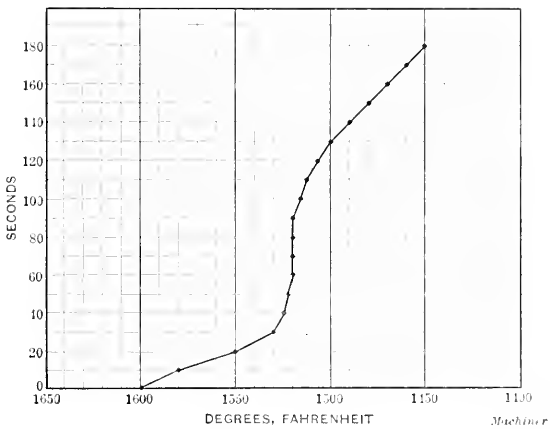

Fig. 4. Diagram showing Calibration which gives Readings too High

Viewed from the standpoint of physical properties in the finished gear, the evolution in gear material from cast iron to tempered steel, may be seen in the following figures:

Material	Elastic Limit pounds per sq. in.	Hardness— Scleroscope	Toughness Guillery Impact Kilogrammeter.
Cast iron	20,000	25	Negligible
Soft steel	40,000	35	2
Casehardened steel; (Average test of alloy steel)	120,000	35	2.5
Tempered steel; (Average test of alloy steel)	225,000	75	5

Tempered vs. Casehardened Gears

For machine tools, tempered alloy-steel gears appear to be preferable to casehardened gears for a number of reasons:

(1) Physically they are stronger and tougher and should therefore be better able to resist sudden impacts and extraordinary loads. Tempered gears do not show by file and scleroscope test the same degree of hardness as casehardened gears, but, nevertheless, with proper design, the dense-grained tempered gear-tooth resists wear most satisfactorily, as was demonstrated recently by the examination of a motor-car transmission that had covered over 100,000 miles. The tempered gears in this car still showed the original tool-marks. Not long ago a designer of machine tools commented on the apparent softness of some tempered gears, but found after several months of hard service that they still showed tool-marks, thus proving hardness ample for wear.

(2) In service, especially for "clash gears," the superiority of tempered gears is most marked. On the clashing faces, casehardened gears are likely to have the hard case chipped off, thereby exposing the soft core to the impact of clashing The hard chips fall into the gearing and may find their way into bearings, thus causing trouble. Tempered gears with a uniform hardness throughout do not chip, nor do they "dub over."

(3) The heat-treatment of tempered gears is much simpler than that required for proper casehardening. It is shorter, less costly and produces a more uniform product, and as the gear is heated but once for hardening, as compared with three times for casehardening, the finished gear is certain to be freer from warpage. The cost of proper casehard-ning is not generally appreciated, but it has been found that a casehardening steel must cost three to four cents per pound less than a tempering steel, if finished gears made from both materials are to cost the same.

With all heat-treated gears, little points in design are important. The gear-teeth should not be undercut, for if the section at the root-line is smaller than at the pitch-line, greater hardness and brittleness is produced where least desired. Great differences in section should be avoided wherever possible, so as to do away with excessive warpage. Sharp edges and angles, even in keyways, are the cause of internal hardening strains which frequently result in failures; hence wherever possible a fillet should be used in place of a sharp angle.

Furnace for Heat-treating Gears

When heat-treated gears are suggested to the machine-tool builder as a remedy for some of his troubles, and as a means of eliminating an excessive item for replacements and repairs, one of his first questions naturally is, of what does a heat-treating equipment consist? Usually the second question is, what will it cost? The first item in equipment is a furnace. There are offered for sale a number of types of gas-and-oil-fired furnaces, but few are located in natural gas districts, and the price of fuel-oil has almost driven the oil-fired furnace from economic use. Coal and coke, however, are available everywhere, and a furnace using fuel of this kind is shown in Fig. 2. Anthracite, bituminous coal, and coke work equally well. When bituminous coal is used, the consumption with ordinary firing should not exceed 500 pounds in a twenty-four hour day. The cost depends somewhat upon the price of labor, but should not exceed $300.

Quenching Baths

The next item is a proper quenching medium. Running water with a suitable tank is always necessary in a hardening room. To take the chill from the water in winter, or to

raise the temperature a little at any time, a jet of live steam in the incoming water pipe will be found very convenient. The heat-treatment of alloy gear steels requires an oil bath, the size of which depends entirely upon the amount of work to be quenched and the facilities for keeping the oil cool. The kind of oil best suited for oil-hardening was the subject of an investigation conducted by the laboratory of the Carpenter Steel Co., with the following results, comparison being made with water as a standard:

Hardening Medium	Hardening Quality
Water	1.000
Mineral No. 1	0.2409
Mineral No. 10	0.2304
Corn	0.1927
Mineral No. 2	0.1607
Cotton-seed	0.1606
Fish	0.1490
Rosin	0.1350

For hardening, several of the mineral oils are more effective than fish and cotton-seed oils, which for a long time were looked upon as the best oils for this purpose. Mineral oil No. 1 has a specific gravity of 0.860, a flash point of 420 degrees F., and a viscosity of 170 seconds at 100 degrees F., as shown by the Saybold viscosimeter. A mineral oil to this specification can be bought very cheaply.

Oil can be cooled by blowing cold air through it, or by pumping the oil through a coil of pipe immersed in cold running water, thus maintaining a circulatory system which admits cool oil at the bottom of the hardening tank and pumps the warm oil from the top through cooling coils back to the bottom. When air is used, care should be taken to avoid an excess during the quenching of a piece, for if air instead of oil were to strike the piece constantly uneven hardening might result.

Drawing or Tempering Bath

The next equipment item is a drawing bath. This may consist of oil, lead, or a combination of salts, contained in a cast-iron or steel vessel. The container is usually of very simple design and may be fired by gas, oil or coal. The oil should be a mineral oil with a flash point of not less than 600 degrees F., this temperature usually being sufficient for all temper-drawing purposes. If higher temperatures are desired, a mixture of two parts potassium nitrate and three parts sodium nitrate may be used. This mixture melts at 450 degrees F. and may be used for temperatures up to 1000 degrees F., or lead, which melts at 630 degrees, may be substituted. To indicate the temperature of the bath, a mercury thermometer should be used rather than a pyrometer, for most pyrometers will show considerable error at drawing temperatures under 800 degrees F.

Application and Calibration of Pyrometers

The last item is a pyrometer. There are a number of good thermo-electric pyrometers on the market, and more depends upon the care of the instrument than upon the selection of any particular make. Following are a few rules for the use of the pyrometer and a simple method of calibration:

(1) Keep the hot end of the thermo-couple as near the work as possible; do not put it through the furnace wall or roof, exposing the end to the direct heat of the flame, but place it so that it will attain, as nearly as possible, the same temperature as the work.

(2) Keep the cold end of the thermo-couple protected from the direct or radiating heat of the furnace; that is, keep it cool.

(3) Protect the volt-meter by a dust-proof case, and place it on a support free from vibration.

(4) All switches should be of the wiping-knife type. Improper contact at the switches is a prolific source of error, and such errors are not readily located.

(5) Carefully check all thermo-couples as soon as they are received from the manufacturer and before putting them into service. Adhere closely to this rule, instead of assuming that new thermo-couples are sure to be correct. New thermo-couples should not be used in blind faith for checking, since they occasionally show a considerable error, and any one making use of them as standards will sooner or later come to grief.

(6) Carefully standardize each pyrometer at definitely stated intervals—at least once a week, and as much oftener as possible. Frequent calibration is a matter not of convenience, but of necessity.

How can the calibration of a pyrometer be accomplished readily and accurately without the use of an extensive laboratory equipment? To this question of immediate interest in every hardening-room, the answer is that the easiest and most convenient method is based upon determining the melting point of common table salt (sodium chloride). Chemically pure salt, which is neither expensive nor difficult to procure, should be used where accuracy is desired. The salt is melted in a *clean* crucible of fire-clay, iron or nickel, either in a furnace or over a forge fire, and is then further heated until a temperature of about 875 degrees to 900 degrees C. (1607 to 1652 degrees F.) is attained. It is essential that this crucible be clean, because a slight admixture of a foreign substance might noticeably lower or raise the melting point. The thermo-couple to be calibrated is then removed from its protecting tube and it s hot end is immersed in the salt bath. When this end has reached the temperature of the bath, the crucible is removed from the source of heat and allowed to cool, and cooling readings are taken every ten seconds on the volt-meter. A curve is then plotted by using time and temperature as coordinates, and the temperature of the melting point of salt, as indicated by this particular thermo-couple, is noted at the point where the temperature of the bath remains temporarily constant while the salt is freezing. The length of time during which the temperature is stationary depends on the size of the bath and the rate of cooling, and is not a factor in the calibration. The true melting point of salt is 801 degrees C. (1474 degrees F.), and the needed correction for the instrument under observation can be readily applied. The accompanying curves (Figs. 3 and 4) illustrate the calibration of a correct and incorrect pyrometer.

Cost of Equipment

The cost of this equipment, including a coal-fired furnace, as shown in Fig. 2, five to seven barrels of hardening oil, one barrel of drawing oil, the tanks for holding these oils and a pyrometer, should be about $500 to $600. The equipment just noted is the one necessary for tempered gears. When case-hardened gears are heat-treated, there is necessary, in addition to this, case-carbonizing boxes and carbonizing compound. A second furnace may also be necessary, depending upon the quantity of casehardened gears to be treated. It is thus seen that for casehardened gears, the heat-treating equipment is more expensive than that required for tempered gears.

Heat-treated gears are bound to appeal to the progressive machine-tool builder. They will make possible the use of gears of smaller section, and while this may not be necessary from the standpoint of weight, as is the case with the motor-car builder, an economy of space is frequently desirable. Their greatest advantage is the elimination of repairs and replacements. In an interview with a machine-tool builder not long ago, the fact was developed that about fifteen per cent of his productive capacity was taken up in the making of repairs and replacing parts. This is a condition which is neither economic nor desirable in view of the commercial alloy steels now on the market, the heat-treatment of which is extremely simple.

* * *

In a paper read before the September meeting of the British Iron & Steel Institute, F. Rogers takes exception to the common assertion that machine members and other parts of iron or steel have broken as the result of becoming "crystallized through fatigue." The writer has made an extensive study of this subject and reached the conclusion that seldom, if ever, does the structure of the metal become more coarsely crystallized as the result of a load applied intermittently. It appears probable that this idea has arisen from the fact that the fracture of test samples subjected to fatigue tests are frequently of a crystalline character, but an examination would generally show that this crystalline structure is no more pronounced at the point of fracture than it would be at other points in the bar which were not subjected to fatigue.

"STELLITE" AS A CUTTING TOOL*

CHARACTERISTICS THAT MAKE IT HIGHLY EFFICIENT AS A CUTTING TOOL FOR HIGH-SPEED WORK

BY DOUGLAS T. HAMILTON†

One of the characteristics of "stellite," the new alloy for metal cutting tools invented by Elwood Haynes of Kokomo, Ind., is that it cannot be forged but must be cast or ground to the required shape. This characteristic, instead of being a disadvantage, is one that causes the alloy to excel the ordinary high-speed steel as a cutting tool. If it could be forged it would become soft when heated to a high temperature in operating on the work, and hence would lose its keen edge. As

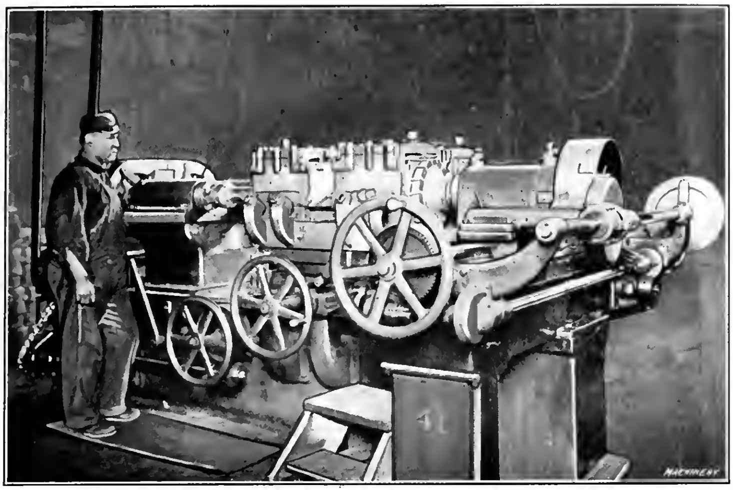

Fig. 1. Increasing the Production of Automobile Cylinders by the Use of Stellite Tools

a matter of fact the high temperature incident to cutting at high speed does not affect the cutting qualities of the stellite tool. Stellite is not a steel, as it contains no iron whatever, but is composed of cobalt, chromium and molybdenum, chromium and cobalt being the chief constituents and molybdenum being added to make the alloy suitable for various requirements. When alloyed with tungsten, the metal becomes distinctly harder, and with a content of ten per cent of tungsten produces an excellent alloy for cold-chisels and wood-working tools. A content of forty per cent tungsten makes the metal suitable for turning cast iron. Not being a steel it is natural to assume that this alloy has some properties unknown in a steel tool, which is true. For example, it can be worked at a much higher peripheral speed. In fact, a stellite tool works

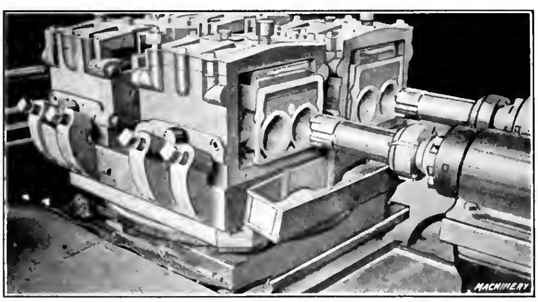

Fig. 2. Close View of Machine in Fig. 1 showing Boring Heads carrying Inserted Teeth made from Stellite

best when operated at high speed and with a comparatively light feed.

It might be mentioned that the original stellite alloy was developed by Mr. Haynes to supply the need for an incorrodible metal to be used in the manufacture of table knives, pocket knives, etc. This alloy, which is distinct from the metal cutting alloy, can be forged. It is unaffected by the ordinary acids and is untarnishable.

Points on the use of Stellite Tools

If a lathe tool, called a "bit," is 3/8 or 7/16 inch square, the best results will be obtained when cutting steel containing up to thirty points carbon by taking a cut from 1/16 to 1/8 inch deep with a feed of from 1/32 to 1/16 inch per revolution of the work. The surface speed of the work should not be less than 150 feet per minute and can be as high as 300 feet per minute. In cutting steel containing from thirty-five to 100 points carbon, the depth of cut can be the same as that just given, but the peripheral speed of the work should be reduced to from 100 to 225 feet per minute. In cutting cast iron the depth of cut, in the majority of cases, should not exceed 1/8 inch, and better results will be obtained by taking a cut about 1/32 inch deep with a higher speed. The feed used can vary from 1/50 to 1/28 inch per revolution of the work, while the speed should not exceed 200 feet per minute.

There are certain points to be borne in mind when using a stellite tool if good results are to be expected. In the first place, if the tool is to be used for turning in the lathe it should be ground to a "round nose" form. If a tool of a different form is required it is poor economy to change the shape; a much better practice is to have another piece of stellite which can be ground to the desired form and kept for that purpose exclusively. A stock of three or four differently shaped stellite bits will usually meet all requirements and will last much longer than if ground first to one shape and then to another, as occasion may arise.

The top face of the tool (when held in the tool-holder) should not, under any circumstances, be ground away to any considerable depth, as by far the best cutting edge is obtained near the surface of the bar. The reason for this is that the outer surface of the bar becomes, in a sense, chilled in casting, this being due to the hot metal coming in contact with the surface of the iron mold. Another important point to be considered is the manner in which the tool is held in the holder. It should fit closely and care should be taken to see that the holder is free from chips and rough places. The set-screw should be tightened lightly, just enough to keep the tool from pushing back in the holder. This requirement shows up an inherent defect in tool-holders as now made, in that there is no provision in the holder for backing up the tool, the only means of clamping being a set-screw which is generally tightened to such an extent that the tool is broken or bent out of

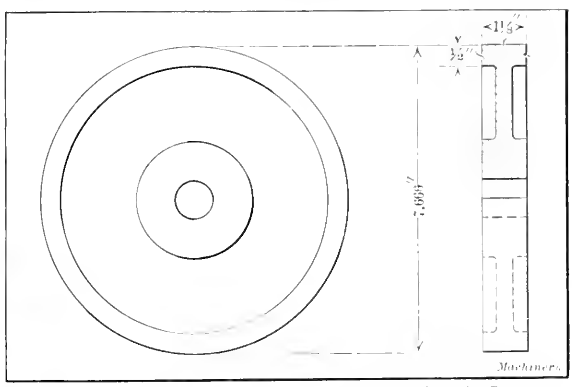

Fig. 3. Cast-iron Gear Blank machined as indicated at the Rate of Sixty-two in Ten hours with a Stellite Tool

* For articles on stellite previously published in MACHINERY, see "Tests made with Stellite Tools," April, 1913, and "New Material for Lathe Tools," February, 1913.

†Associate Editor of MACHINERY.

shape. The pressure sets up strains in the tool that lessen its ability to resist heavy thrusts or shocks. If an adjustable backing-up stop or plug were inserted behind the tool, the set-screw would not need to be tightened so heavily, but just enough to hold the tool in place, and in this way strains in the cutting tool would be avoided and it would be much more effective in removing metal.

In order to meet certain requirements the materials composing stellite and the treatment they receive are changed, so that the manufacturer in all cases should state on what class of work the tool is to be used. For some classes of work, stellite has its disadvantages. For instance, on soft iron or steel where a large amount of metal must be removed in one cut, little, if any, advantage will be gained by using a stellite tool in preference to a good high-speed cutting tool. The reason is that a high-speed cutting tool will resist a much greater pressure than a stellite tool, and while it cannot be worked at as high a speed it will remove a greater amount of metal in a given time, owing to its inherent strength. However, there are many cases in which a stellite tool shows a marked increase in production over any other type of cutting tool, as the following records show.

Increasing the Production of Automobile Cylinders by the use of Stellite Tools

Fig. 1 shows a Beaman & Smith cylinder boring machine which is used in the plant of the Haynes Automobile Co., Kokomo, Ind., for boring automobile cylinders. The cylinders, cast two *en bloc*, are made from close-grained cast iron containing a small percentage of steel, and are very difficult to machine. The bore of these cylinders is 4¼ inches in diameter by 5½ inches long (finished dimensions), and with the best high-speed steel on the market a production of twenty-eight holes (fourteen castings) in ten hours was the greatest that could be obtained under the most favorable conditions. The amount of metal removed was ⅜ inch on the diameter; two cuts were taken—one roughing and one finishing. By removing the high-speed steel blades from the boring head shown in Fig. 2, and replacing them with blades made from stellite, the production was increased from twenty-eight to sixty-two holes in ten hours—an increase of 121 per cent. Four boring cutter holders carrying inserted stellite blades are used—two for taking the roughing cut and two for the finishing cut, these being changed at the end of each cut. Another advantage obtained by using stellite tools was that they only required grinding for every twenty-four cylinders, whereas the high-speed steel tools lasted for one cut only. The large milling cutter shown at the right-hand end of the machine in Fig. 1 is also provided with stellite inserted blades; it finishes the bases of the cylinders which are 11 7/16 by 8¾ inches, taking a cut ⅜ inch deep.

Fig. 4. Doubling Production on Cast-iron Gear Blanks by substituting Stellite for a High-speed Steel Cutting Tool

Doubling the Production on Gear Blanks with Stellite Cutting Tools

Fig. 3 shows a cast-iron gear blank made from a close-grained iron containing a small amount of steel, which is finished from the rough to the dimensions given, ⅛ inch of material being removed all over. With high-speed steel cutting tools the greatest production that could be obtained on this gear blank was thirty in ten hours. By using a stellite tool, the production was increased to sixty-two in the same time without changing anything except the tool. In Fig. 4 is shown two days' work, one being the production obtained with stellite tools and the other with high-speed steel tools. This gives some indication of the enormous increase in production obtained by the use of stellite. These are only two of the many cases observed by the writer in the plant of the Haynes Automobile Co., where stellite has been used to advantage in increasing production.

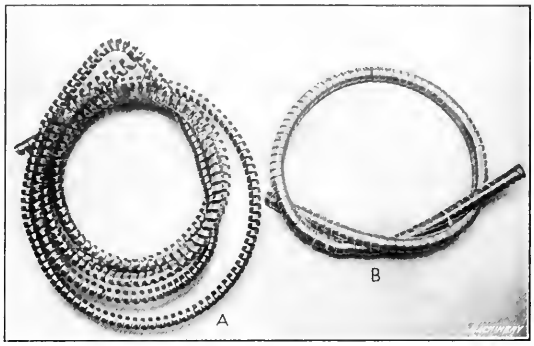

Fig. 5. Character of Chips removed with a Stellite Tool in the Lathe. Note Smooth Finish on Under Surface of Chip

Character of Chips removed by Stellite

One peculiar feature of a stellite tool is that a steel chip removed by it has a glass-like finish, even when the tool becomes red-hot. Fig. 5 shows two chips removed by a stellite tool. The long chip *A* was taken from a steel bar containing 60 points carbon, the cut being taken at a surface speed of 250 feet per minute for a length on the bar of 20½ inches. The depth of cut was 0.050 inch and the feed per revolution was 1/32 inch. The other chip was taken from a bar of chrome-nickel steel, which also shows a very smooth finish. This chip weighs 1.2 pound and was removed from a round bar of chrome-nickel steel with a ⅜-inch square stellite tool in one-half minute.

Another peculiar condition observed when using a stellite tool is that when the chip has once acquired a certain color, it keeps that color as long as the tool is under cut. This is not the case with the chip removed by an ordinary high-speed steel tool, as it changes from a very light color to darker shades and then varies in appearance, which indicates that the cutting tool itself is failing and is attaining a much higher temperature as it becomes duller. The only indication that a stellite tool has become dull is that it absorbs far more power than when sharp. The appearance of the chip does not indicate the condition of the tool, as the surface of the chip still remains smooth even when the tool is dull. A very important point to remember in using a stellite tool is to be careful in clamping it, as it has not the strength to resist shocks that cutting tools working at lower speeds have.

* * *

A method for testing cylinder oils which gives good results is as follows: Heat the oil in a current of air for one hour at a temperature corresponding to that of steam at the pressure at which the oil is to be used. The loss in weight should not exceed 0.5 per cent.

POSITIVE METHOD OF SETTING BEVEL GEAR CUTTER

BY FRANK J. MOULD*

A method of setting the cutter for milling accurate and quiet-running bevel gears is outlined in the following. In using this method, two cuts are required. The set-up for taking the first cut is shown in Figs. 1 and 2, while Figs. 1 and 3 illustrate the set-up for the second cut. As the illustrations show, the cutting angle equals the pitch cone angle of the gear. The gear-cutter is set by a pointer P which is adjusted so that the end coincides with the apex of the pitch cone.

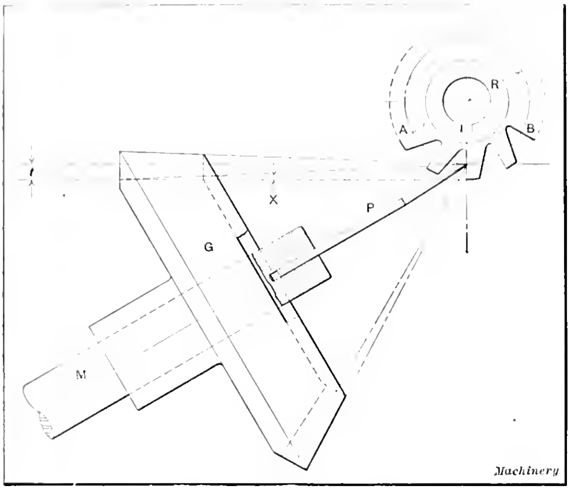

Fig. 1. Method of setting Bevel Gear Cutter

After this pointer is set, the gear-cutter is adjusted until a line on the side of the tooth, representing the pitch circle, coincides with the end of the pointer. The required number of tooth spaces is then milled, after which the lateral position of the cutter is changed as shown in Fig. 3; that is, the pointer is set to coincide with the pitch circle on the opposite side of the cutter. The teeth are then finished by taking a second series of cuts, as explained later.

In order to locate the pitch circle on the cutter, a little blue vitriol is placed on one of the cutter teeth and a pair of dividers is used to mark the arc of the pitch circle AB on this tooth, after a centering plug has been inserted in the bore of the cutter. The radius R of the pitch circle is obtained by subtracting $2t$ from the outside diameter of the cutter and dividing the result by 2. (The distance t or depth of space below the pitch line equals 1.157 divided by the diametral pitch).

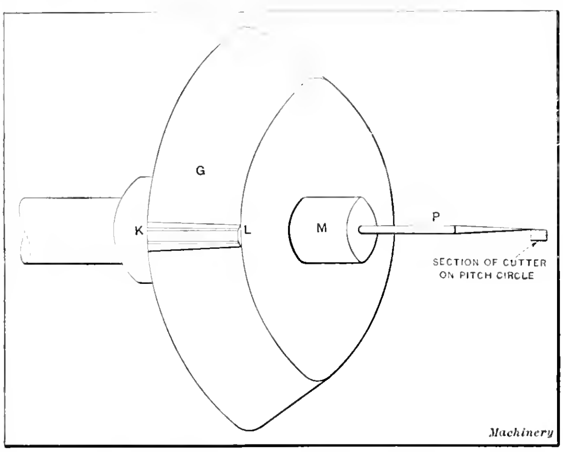

Fig. 2. Gear Cutter set for taking the First Cut

After marking the pitch circle on the cutter, the latter is mounted on the arbor of the milling machine. The gear blank G is next mounted on mandrel M of the dividing head and is inclined to the pitch cone angle. There is a hole 1/8 inch in diameter and about 1 inch deep in the center of the mandrel M and pointer P fits into this hole. The pointer can be moved in and out by hand, but is tight enough to remain in any position. By placing a straightedge against the face of the gear blank, in two or three different positions, and sliding pointer P in or out, as may be found necessary, its sharp end can be made to coincide with the axis of the cone.

The milling machine table is next adjusted vertically, to the right or left, and laterally until the end of the pointer coincides with the pitch line on one side of the milling cutter, as indicated in Figs. 1 and 2. When this has been done, the table is moved to the left and the pointer removed from the mandrel, after which the first cut is taken. When the cutter has been located by this method, the pitch line of the tooth face KL coincides with an element of the cone. After the first tooth has been cut, the succeeding teeth are cut by indexing the gear blank in the usual manner.

The pin is now reinserted in the mandrel and its sharp end again located at the apex of the cone. The table is then moved until the relative position of the pin and cutter are as shown in Figs. 1 and 3, the cutter being set on the opposite side of the center line. In Fig. 3, the dotted trapezoid shows the position occupied by the cutter during the first series of cuts, and the full line its position for the second or finishing cuts.

The table is now moved to the left, the pin removed and the dividing head turned to the left through an angle corresponding to one tooth space or 180 degrees divided by the number of teeth. The machine is now ready for taking the second cut, which is usually very light, seldom exceeding 0.012 to 0.015 inch. With the work located in this way, the pitch line of tooth face ON also coincides with the surface of the pitch cone. Fig. 1 shows the amount X by which the cut taken by this method exceeds the correct depth at the inner ends of the teeth.

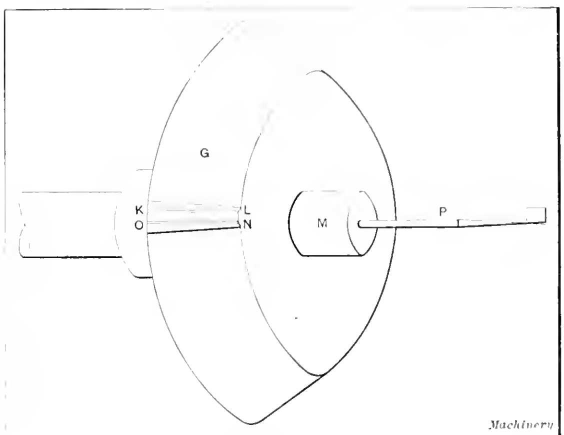

Fig. 3. Gear Cutter set for taking the Second Cut

* * *

For some time a commission has been at work in Germany preparing a new patent law. The commission has concentrated its work upon three points, namely, the regulation of the right of employes to inventions made by themselves; a reduction of the patent fee; and a simplification of the patent procedure. As regards the right of an employe to an invention made by himself, the commission seems to have taken but little account of the rights of the individual and his comparatively unfavorable position as compared with that of his employer with respect to patents. It appears that about all that the commission recommends to safeguard the inventor's rights is that he shall have a right to have his name appear on the patent specifications. With relation to the change in the patent fees, it is proposed to increase the initial fee, partly with the idea of preventing applications for worthless patents; but the annual fees charged to keep a patent in force will not be as high as in the past

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CLAMPING WORK IN JIGS

A COLLECTION OF METHODS APPLICABLE FOR USE IN JIG AND FIXTURE DESIGN

BY SERVER

The methods of clamping work in jigs and fixtures presented in this article may be regarded as supplementary to those shown in MACHINERY'S Data Sheet No. 134, contributed by Mr. H. E. Wood, and Data Sheet No. 124, contributed by Mr. Lucien L. Haas. Most of the devices described in this article may be quickly operated, the purpose being to show a collection of efficient designs that will hold the work securely. They possess the further advantage of being relatively simple, so that the jigs can be made at a moderate cost in all cases where there are a sufficient number of pieces to be machined to warrant making a good tool.

A method of holding a piece of work with an oval shaped flange is shown in Fig. 1. It will be seen that this piece is held between V-blocks, one of which is stationary while the other is moved by a screw. Referring to this illustration, it will be seen that a pilot on the end of the adjusting screw enters a hole in the V-block, the two members being held together by a pin which fits in a groove in the pilot. The movable V-block is held to the body of the jig by two steel straps. Fig. 2 illustrates another method of attaching a screw to a sliding clamp member. In this case, the sliding piece is used for forcing the work down into place. It will be seen that this screw runs in a tapped hole in a stationary part of the fixture, while the collar at the end of the screw fits into the movable wedge to push it forward or draw it back. Fig. 2-A shows a movable clamp member that has a tapped hole to receive the adjusting screw. Here it will be seen that two collars on the screw are located at each side of a boss on the fixture and the adjustment is obtained by the screw turning in the tapped hole.

The use of hinged covers that can be swung out of the way when removing work from a jig or fixture is found convenient in numerous cases. Such covers are frequently used for clamping the work in place or for carrying bushings which guide a drill or other tool. Two examples of this kind are shown in Figs. 3 and 4. The cover shown in Fig. 3 is held in place by a locking screw, while the work is secured by a set-screw carried by the cover. The hinged cover illustrated in Fig. 4 is provided with a floating stud that secures the work, the cover which carries the stud being held in place by an eccentric binder with a hook which slides under the pin *A*. This provides a very quick-acting jig. The lug *B* at the opposite end of the cover prevents it from swinging back too far and breaking the hinge.

Fig. 5 shows the application of a bell-mouthed bushing, which is screwed down onto the hub of a lever, thereby locating the work and at the same time providing a guide for the drill which is to operate upon it. A rather unusual method of clamping is illustrated in Fig. 6, where it will be seen that the hand-knob has the thread milled out to the edge to give a "slip over and twist" motion for clamping the work. Practically the same idea is illustrated in Fig. 7, except that a wrench handle is provided in this case to facilitate tightening. Both of these arrangements enable work to be tightened in the fixture with great rapidity. Fig. 8 shows a special nut for a box wrench, the purpose of which is to permit lifting the wrench off the "hex," and moving it back for a new grip. The round part of the nut serves to keep the wrench in place to be slipped back onto the "hex," while the pin at the top of the nut makes the wrench an integral part of the fixture so that it cannot get lost.

Two unusual examples of jig and fixture design are illustrated in Figs. 9 and 10. The distance that the clamp has to be raised in removing the work from between the vees of these fixtures made it desirable to provide some method of releasing the clamp more quickly than by turning the screw back through the necessary distance. The way in which this was accomplished is clearly shown in the illustrations, and will be seen to consist of loosening the screw and then swinging the block which carries the screw on the pivot *A*, the direction being indicated by the arrow. This moves the screw off its bearing on the casting in the case of the jig shown in Fig. 9, while in Fig. 10 the binding screw is removed from the clamp. It will be noticed that the clamp shown in Fig. 10 has been cut away at *B* to permit the point of the screw to clear it; a spring pin holds the clamp against the screw at all times.

Fig. 11 shows a hinged cover with the clamp attached to it. This is a convenient arrangement to remember when considering the design of jigs and fixtures. It will be seen that the clamp and cover are held by the same pin and that both parts are swung out of the way at the same time by means of the corner of the clamp, which catches on the hinged cover at *B*. The design is such that the fixture has sufficient clamping range when the cover is held in place by the screw *C*. The clamping is effected by means of the screw in the cover which forces the clamp down on the work. A little "stunt" is illustrated in Fig. 12 which is often used when it is desirable to keep the clamp out of the way of the cutter. This is simply a clamp beveled at the end to pull the work down flush and push it into the vee at the same time. It will be seen that the clamp is tightened by a screw and a spring forces it open when the screw is loosened.

Two examples of the use that can be made of cams are shown in Figs. 13 and 14. The device shown in Fig. 13 is simply an eccentric stud operated by a handle; this device pushes the clamp against the work, and it will be seen that a hole is drilled in the clamp to slide over the guide pin mounted in the frame of the jig. Fig. 14 shows a cam for operating a sliding vee, the method being evident from the illustration. Another form of quick-acting clamp is shown in Fig. 15. This device consists of a bar that is hinged on a stud at one end and has a slot cut in the opposite end to slip under a second stud. The screw that clamps the work also serves to secure the clamp in place.

A simple form of gang milling fixture is shown in Fig. 16, where it will be seen that the different pieces are clamped by separate screws held in a bar that can be swung out of the way to enable the work to be removed from the jig. This also makes it possible to brush the chips out at the side of the jig.

Although these examples of clamping devices may be used in a great variety of cases, it is well to remember that the tools for any particular job must be built up to suit the work that is to be machined in them. In all cases, the designer uses the method of clamping which experience has shown to be the most suitable. As an example of jig and fixture design, consider the tool shown in Fig. 17. This illustration shows a fixture for holding the two bracket shoes that are to be milled. After studying the requirements of this case, the designer decided to machine these pieces in pairs and the following gives a description of the device which was finally developed. One of the brackets is laid in the fixture, as shown in the plan view, the work resting on the three supporting points *A*. The reason why three points of support were used is that the designer would not be sure of having four or more points of support in contact with the work, owing to slight irregularities in the castings. After being laid in the fixture, the work is pushed back against the locating points *B* and *C* which locate it in the desired position. The second bracket is laid in the opposite side of the fixture in the same way. The work is then held against the stops with one hand and the wedge shaped clamps are tightened with the other hand to hold the work securely in place. There is still one corner of the work left unsupported and the next step is to release the screws *D*, which allows the springs *E* to force the pins *F* up against the unsupported corners of the work. The screws *D* are now re-tightened, thus holding the pins *F* securely in place so that the required support is obtained.

A similar construction was followed out in the design

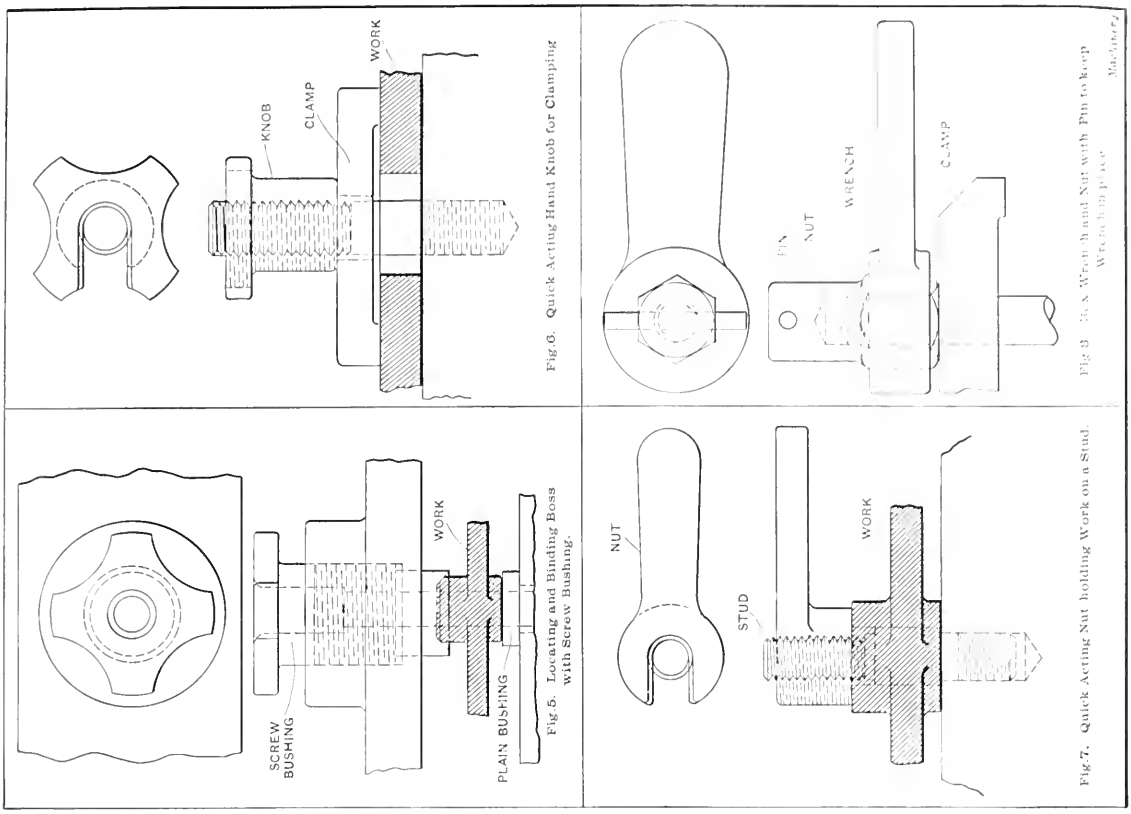

Fig. 6. Quick Acting Hand Knob for Clamping

Fig. 5. Locating and Binding Boss with Screw Bushing.

Fig. 7. Quick Acting Nut holding Work on a Stud.

Fig. 8. Box Wrench and Nut with Pin to keep Wrench in place

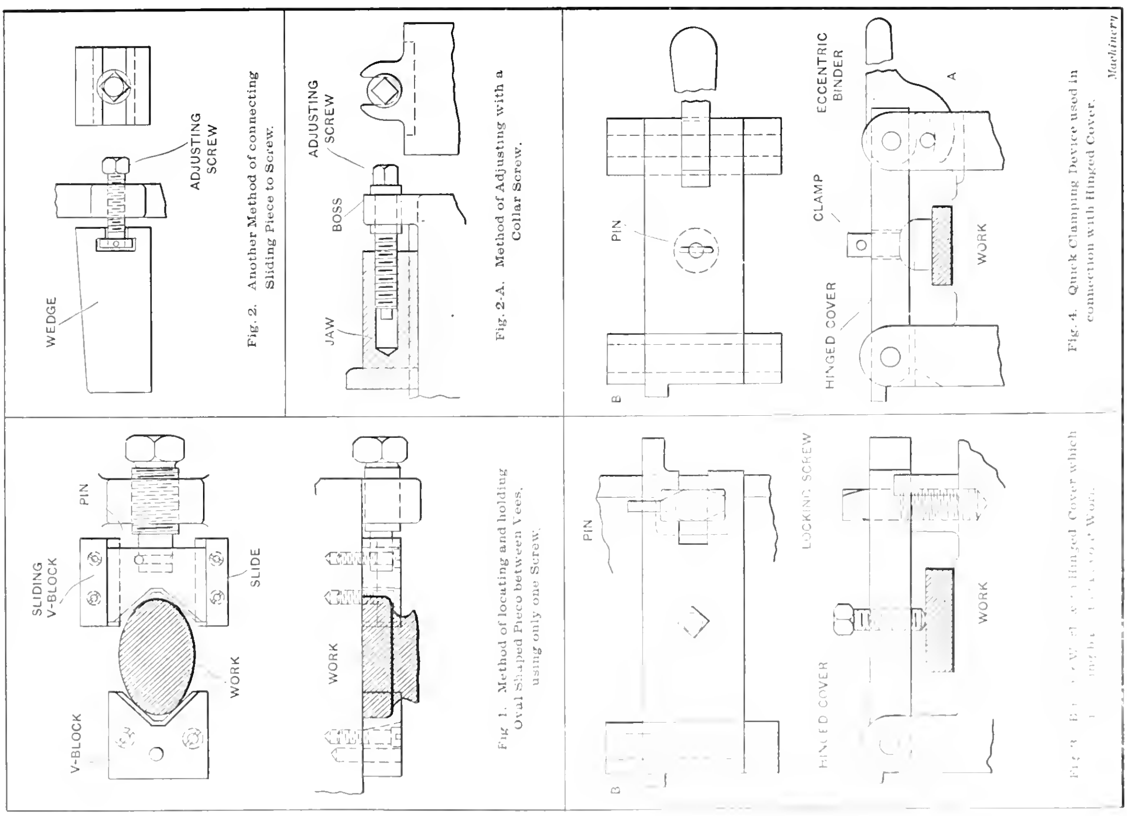

Fig. 2. Another Method of connecting Sliding Piece to Screw.

Fig. 2-A. Method of Adjusting with a Collar Screw.

Fig. 4. Quick Clamping Device used in connection with Hinged Cover.

Fig. 1. Method of locating and holding Oval Shaped Piece between Vees, using only one Screw.

Fig. 3. [illegible] Hinged Cover which [illegible] Work.

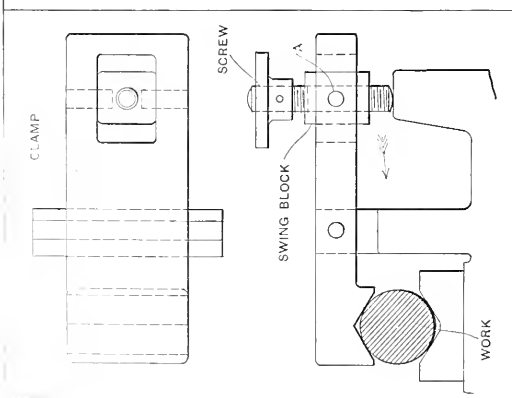

Fig. 9. Quick Acting Clamp, Swing Block and Screw.

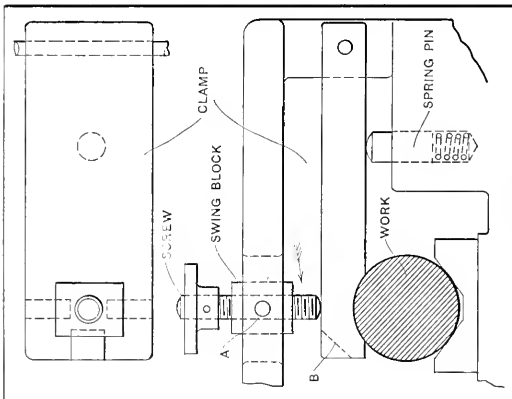

Fig. 10. Another application of the Screw and Swing Block Principle.

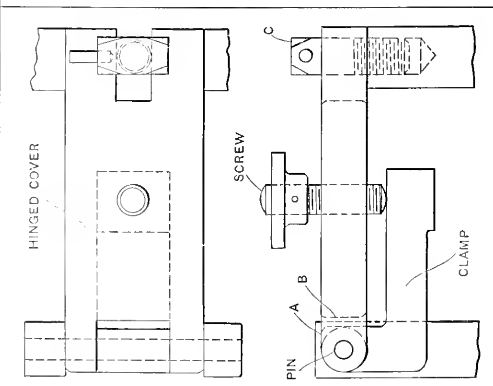

Fig. 11. Example of Jig Design with Clamp attached to Hinged Cover.

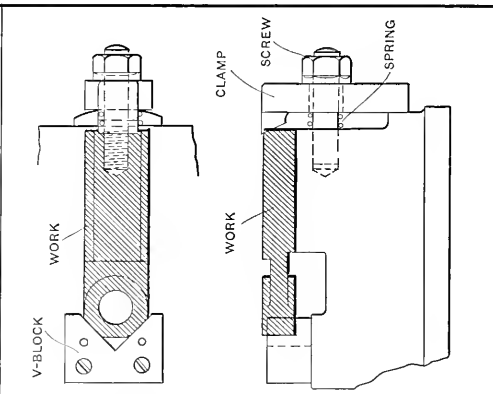

Fig. 12. Method of Holding Work in a Vee with the Clamp out of the way of the Cutter.

Machinery

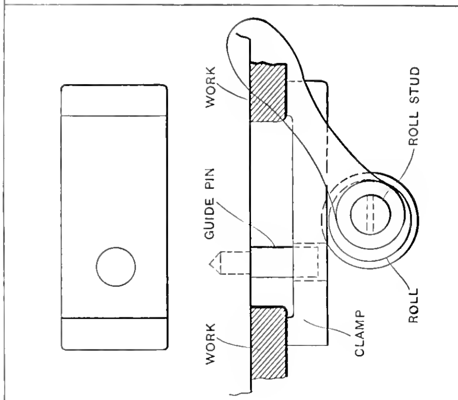

Fig. 13. Eccentric Roll and Handle for tightening a Clamp.

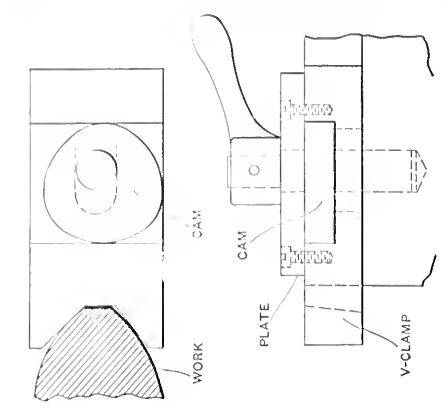

Fig. 14. Quick Acting V-block operated by a Cam.

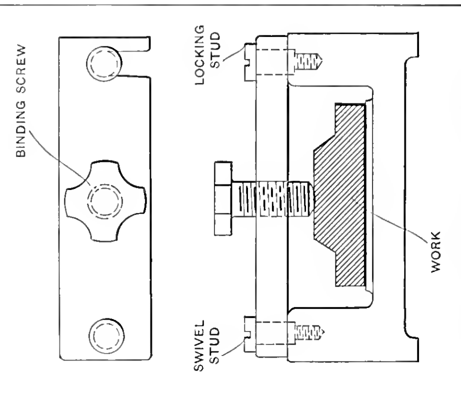

Fig. 15. Quick Method of holding Work with a Screw and Swivel Clamp.

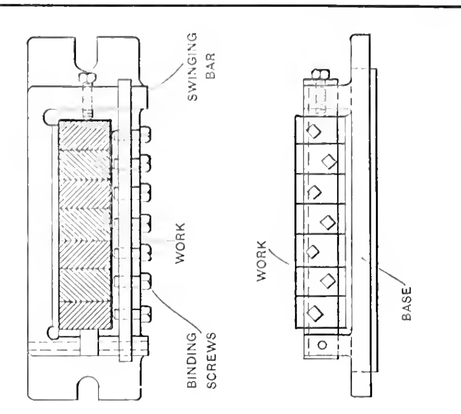

Fig. 16. Gang Fixture with Common Form of Clamp adapted for holding Seven Pieces simultaneously.

Machinery

of the fixture shown in Fig. 18. In this case, the work is laid in the fixture on the three supporting points *A* which are placed under parts of the work that afford ample strength.

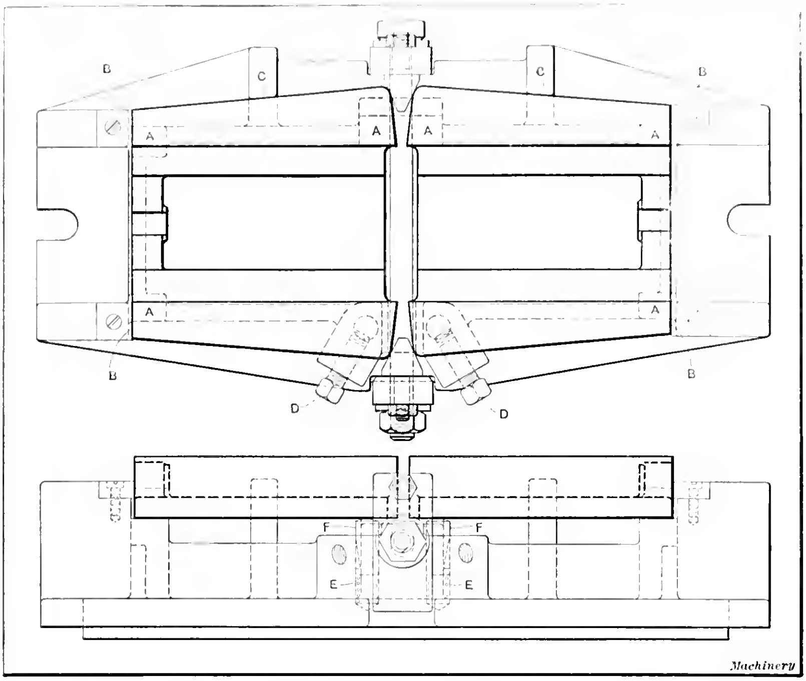

Fig. 17. Method of supporting Work in a Jig that insures a Uniform Bearing

The work is located in the following manner: Two screws *B* come into contact with a boss on the work, which is pushed against these screws by a third screw *C*. The screw *E* also pushes the work back against the locating stop *D*, thus bringing the piece into the desired position. In this case, there are two additional points of support provided by the pins *F* which are raised by coil springs and tightened by screws in a manner very similar to that which was described in connection with the fixture shown in Fig. 17. The work is held down in the fixture by means of two clamps *G* and a hinged cover which carries a binding screw for holding the work while the surfaces marked *f* are being milled. All subsequent operations on this piece are located from these finished surfaces. The accuracy obtained in this operation depends largely upon the judgment of the designer in selecting the proper locating positions and using the most satisfactory combination of clamps and supporting members for the work in hand.

* * *

COOLING GAS ENGINES

In a paper read before the British Institution of Mechanical Engineers, Prof. Bertram Hopkinson presents the results of experiments in cooling gas engines by means of water sprayed into the cylinder, instead of by using the customary form of water jackets. It is claimed that several important advantages are obtained through this method. In the first place, the design and production of the castings is simplified, as it is unnecessary to provide water jackets and cored out pistons for the cooling water. It is also believed that the water-jacket method is responsible for many cases where gas engine cylinders break, due to the strains produced by having a great difference of temperature between the inside and outside.

The idea of introducing water into the cylinder of an internal combustion engine is not new. It is a common practice to introduce water along with the oil used in oil engines in order to enable the compression to be raised. Water has also been sprayed into gas engines for the purpose of preventing preignition. The idea of cooling engine cylinders by spraying water into them has been considered, but none of the devices tried for this purpose have met with any degree of success, apparently due to the fact that their originators did not appreciate the conditions which must be fulfilled if the water is to be effective as a cooling agent. The results of the present investigation appear to show that the water must be injected in comparatively coarse drops and directed against the surface to be cooled, so that it reaches the metal in a liquid form. The water must also be distributed properly so that each portion of the surface receives an amount of water which is proportional to the amount of heat it receives. If the water is turned into steam before reaching the metal, it will not exert any cooling effect except by indirectly lowering the temperature of the flame and this means a loss of efficiency.

The method of injection consisted of spraying water through a hollow casting projecting into the combustion chamber and provided with a number of small nozzles about 1/32 inch in

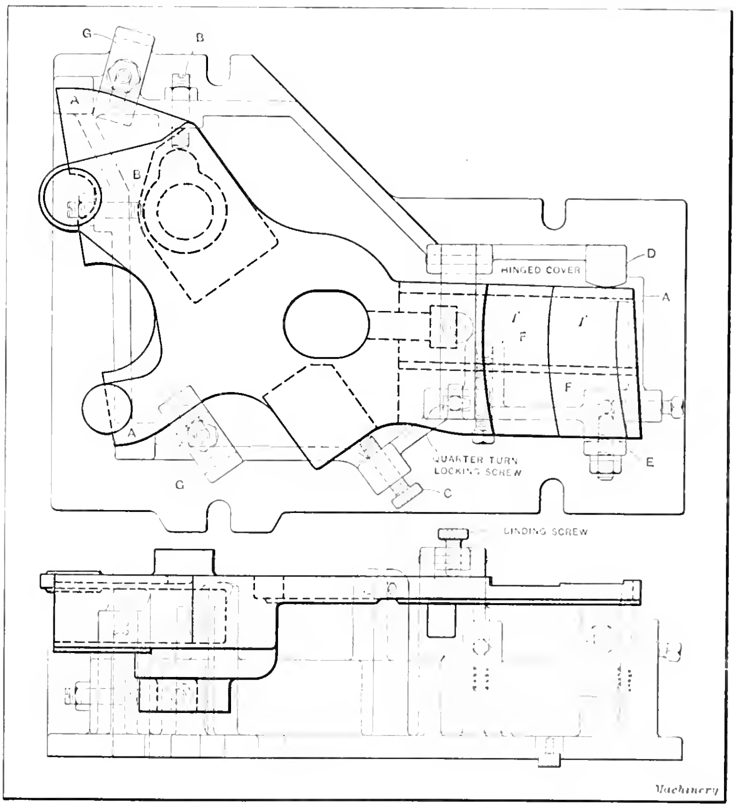

Fig. 18. Method of Support shown in Fig. 17 adapted for milling Seat *f*

diameter. The jets so formed are comparatively coarse so that even when projected into the flame, the water reaches the wall with relatively little evaporation.

HARDENING THE HEADS OF FORGE TOOLS

BY JAMES CRAN*

In the interests of safety and economy, it is advisable to harden the heads of all forge tools, such as sets, chisels, fullers, swages or any other tools made of high carbon steel, that are used by being struck upon their heads with a hammer. Upon the face of it, this may not appeal very strongly to a great many users of such tools, as it is common practice to leave the heads just as soft as possible. Some have even recommended annealing the heads from time to time to keep them soft, the idea being to prevent burrs breaking off and flying around when the heads get battered down from use. The writer considers this a mistake, for when soft steel is subjected to hammering for any length of time, it not only begins to batter down and burr over on the edges but also becomes crystallized. This makes the metal very brittle—although it is quite soft—with the result that the burrs begin to break off and fly around when the tool is in use. This shortens the life of the tool.

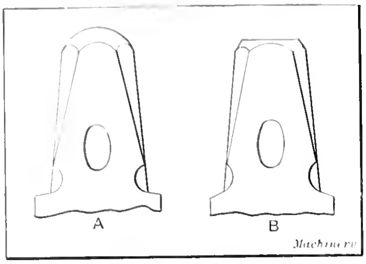

Fig. 1. Approved and Objectionable Types of Heads for Forge Tools

Experience has proved that high carbon steel can be hardened and tempered to make it suitable for any purpose from cutting tool steel in an annealed condition to withstanding the impact of blows. Therefore, theory, as well as the results of practical experience which will be given later, favors hardening the heads of tools. The best and safest type of head to use, either in a soft or hardened condition, is dome-shaped without a single sharp corner. By referring to Fig. 1, a head of this kind will be seen at *A*, and if used soft it will be in service for some time before the center becomes flattened, and burring does not commence until the head of a tool is more or less battered. Such a tool is much safer to use than the flat headed type shown at *B* which will commence to burr almost as soon as it is put in service. When hardened, the dome shaped head will last for years without showing wear, while the flat headed one is likely to chip off in splinters.

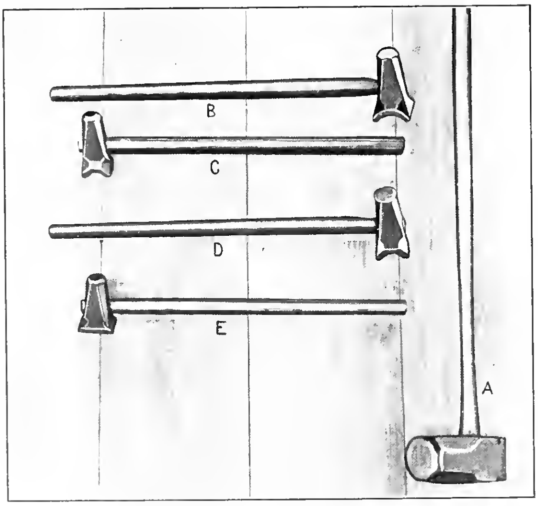

Fig. 2. Tools with Hardened Heads which show Little Wear after being used Several Years

For a number of years, the writer has made a practice of hardening forge tools on both ends with very good success. An idea of how these hardened tools will wear may be obtained by referring to Fig. 2, which shows a few tools that have been in constant use for upwards of eight years. The sledge *A* was made and hardened by the writer nearly nine years ago; it has been in use practically every working day since it was made and is still in perfect condition, not having even been reground on the face. The 1⅞-inch swage *B*, which is about eight years old, has been in constant use the whole time and is still without perceptible signs of wear. The 1¾-inch swage *D* is about the same age and belongs to the same set of tools; it has begun to burr slightly and needs grinding. A 1½-inch swage *C* from the same set has been ground once, as will be seen by the light colored band around the head. The rectangular set *E*, which is one of the tools that a blacksmith uses the most, is about five years old, and like the sledge it is still in perfect condition.

The writer's method of hardening a sledge or hammer of any kind is to first heat the peen to as near the point of recalescence as possible and then quench it in water in an ordinary slake tub, until the heat has been so far withdrawn that it will "carry water." The tool is then polished with a piece of wood covered with emery cloth and the temper drawn with the back heat until it shows a light copperish color, after which it is cooled off. The face is next heated in the same manner as the peen but it is cooled in a stream of water rising straight from the bottom of the quenching tub and striking the center of the face, as shown in Fig. 3. This insures the center being equally as hard as the edges, if not harder, as steam cannot generate and form a cushion as it may do where the tool is immersed in the water. When the face is fairly cooled to a depth of about 1 inch, it is polished and laid in a hot fire, which in a very short time draws the temper on the outer edges to a blue color, leaving the center just as hard as possible. When a hammer has been properly hardened in the manner described, there is practically no danger of its cracking or burring, as the hard center is supported on all sides by the softer and tougher metal around the edges.

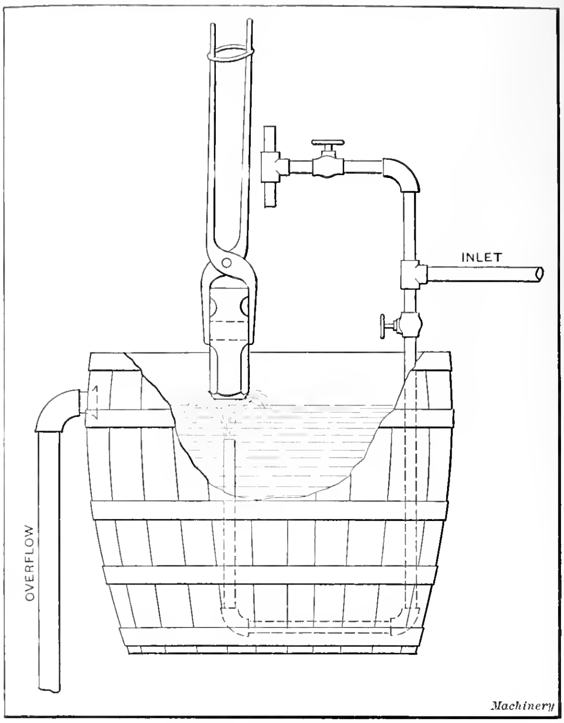

Fig. 3. Arrangement of Piping in Quenching Tank used for hardening Forge Tools

The faces of fullers, swages, sets, etc., are hardened in exactly the same manner as the face of a hammer, but the heads are heated slightly under the critical point and are quenched to a depth of about ½ inch. They are then polished and the temper drawn by the back heat until the color has all but disappeared. What color is left may be described as light seagreen. Another gage for drawing the temper of the heads of tools is to let the temper run until the piece is hot enough to freely ignite thin scrapings of hickory wood; it is then dipped in water, just enough to prevent the temper running any further and allowed to cool in the air.

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LETTERS ON PRACTICAL SUBJECTS

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BROACHING KEYWAYS IN GEAR BLANKS

An interesting fixture for holding a gear blank while broaching two keyways in it, applied to the J. N. Lapointe broaching machine, is shown in the accompanying illustration. This gear blank is made from a vanadium steel drop-forging, and the broaching length is 1⅜ inch, two keyways which are 5/16 by 5/32 inch being cut in one pass of the broaches. In cutting these keyways it is not necessary to remove the broaches, which are held in the head, as the operator simply allows the head of the machine to advance toward the fixture, then grips the two broaches, closing them together, and slips the work over.

Fig. 1. J. N. Lapointe Broaching Machine which turns out 800 Broached Gear Blanks in Ten Hours

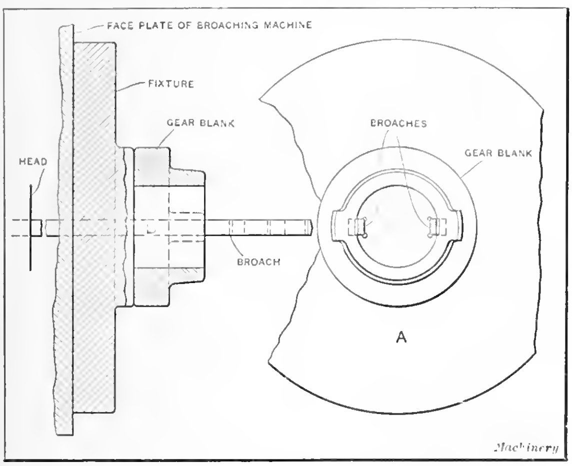
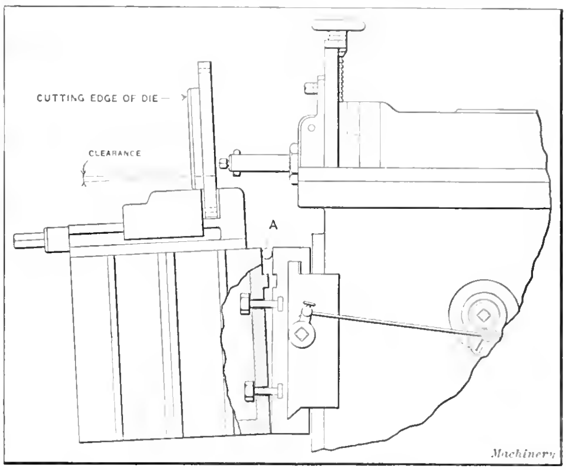


Fig. 2. Fixture used for holding Gear Blanks while broaching Two Keyways in One Stroke

The broaches *B*, as shown clearly in Fig. 2, have no teeth for a distance of about 2½ inches from the face of the fixture, so that when these are held together it is a simple matter to slip the work over them and locate it on the fixture *A*. It is evident that when the head of the machine travels away from the fixture, the broaches are drawn in, and as they are made thicker toward the outer ends, they cut the keyways to the correct depth. Fig. 2 also shows how these broaches are guided when in operation on the work. Holding the broaches in the manner illustrated, enables a large production to be obtained, the time generally taken in removing and replacing the broach being saved. On an average, 800 gear blanks are broached in ten hours, which means that 1600 keyways are cut in this time. The possibilities of broaching when suitable fixtures are provided are almost unlimited, and the job described in the preceding illustrates the adaptability of the broaching method to the cutting of keyways in gears. D. T. H.

MACHINING CLEARANCE IN DIES

When it is required to machine dies in a shaper, I have noticed that the usual method employed to get the proper clearance is to place a thin strip of metal between the vise jaw and the die. However, this is not a very satisfactory plan because it is almost impossible to get a uniform clearance. By referring to the accompanying illustration, the method I employ will be readily understood. The angle of the shaper apron shown in the illustration is somewhat exaggerated in order to illustrate the principle more clearly. In practice, it will be found that a cold-rolled rod *A* of ¼ or 5/16 inch diameter will be about right for producing a clearance of one degree. The angle which is obtained by any size rod can be readily determined by means of a bevel protractor. The gap caused by the rod should be carefully filled with waste in order to keep out chips, thus avoiding trouble when it is desired to draw the apron back into the original alignment. This method has the advantage of enabling a standard clearance to be obtained on a number of dies without causing trouble in setting up successive pieces.



Method of setting Shaper Apron for machining Clearance in Dies

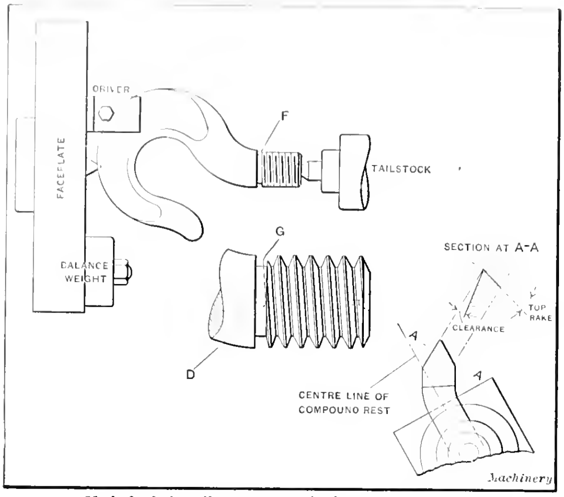
Delphos, Ohio. A. J. BRICKNER

THREADING CRANE HOOKS IN THE ENGINE LATHE

Large crane hooks are generally fitted with ball or roller thrust bearings which are held in place by collar nuts. The usual practice of crane shops in machining such hooks is to first bore and thread the nut, and then turn and thread the hook so that it has an accurate fit in the nut. There are two points in connection with the latter operation which require careful attention, as they affect the quality of the work produced and also the time occupied by the machining operation.

In order to explain the method of procedure, let us assume that the crane hook has been properly centered, balanced,

turned and grooved on the shank as shown at *F*, so that it is ready for the threading operation. In order to save time in threading and produce a good finish, the tool used should have top rake on only one side, such a tool being shown in the illustration. The compound rest is set over and the tool fixed in the toolpost in the usual way. For the roughing cut, the tool is fed into the work in a direction parallel to the center line of the compound rest. When used in this way, it cuts freely because the cutting edge has a suitable top rake. After the bulk of the metal has been removed, the



Method of threading Crane Hooks in the Engine Lathe

thread is finished by feeding the tool in at right angles to the axis of the work. By so doing, both edges of the tool work on the finishing cut and produce a thread which will fit accurately in the nut. When performing this part of the operation, care must be taken to cut away the thin fin *D*, which will form at the point where the tool runs into the groove at the inner end of the thread. If this precaution is not taken, the fin will spring away from the tool, as indicated by the dotted line at *G*, and after the tool has passed, the fin will still be left and result in a badly fitting screw which will bind at the end of the thread.

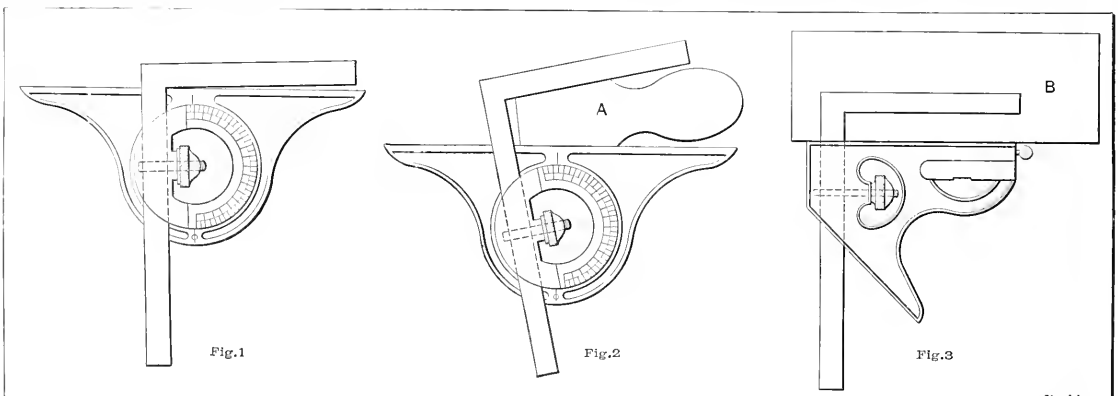
Wilkinsburg, Pa. T. PILKINGTON

ATTACHMENT FOR COMBINATION SET

There is hardly a machinist who does not feel disappointed, after buying his first combination set, when he tries to use the protractor head for laying out a small angle on work such as shown at *A* in Fig. 2. The smaller the angle he is trying to get, the less satisfactory the protractor becomes, until it is practically useless at angles of 20 degrees and under. This is due to the fact that when the head is set for such angles, there is practically none of the straight edge of the head above the blade.

To overcome this difficulty, I made a skeleton square for use in the combination set, the design and method of using this attachment being clearly shown in the illustrations. With this tool, it is possible to handle angles from zero to 180 degrees with equal facility, and also to use the combination set for a number of purposes for which it is not available without this attachment. Fig. 1 shows the protractor set for laying out a 1 degree angle. Fig. 2 shows the use of the protractor for obtaining the required angle on a sheet-steel gage *A*. In Fig. 3, the skeleton square is set for scribing lines on the block *B* parallel with its edges.

Dallas, Texas. GEORGE AKSBAN



Figs. 1 to 3. Attachment for the Combination Set, and Three Purposes for which it can be used

CONCERNING RING OILING BEARINGS

Mr. A. De Signer's inquiries concerning the design and operation of ring oiling bearings which appear in the October number of MACHINERY, seem to cover most of the interesting points in connection with this branch of machine design. In reply to his question as to why the two ends of the oil reservoir had to be connected in order to get the bearing to operate properly, the writer would suggest that "windage" may have been the cause. Windage is the name given to the movement of air which results from the operation of some classes of high-speed machinery, and under certain circumstances it may be necessary to provide some sort of wind checking device in order to obtain proper lubrication of a ring oiling bearing.

The great variety of rings that are in successful use would appear to indicate that the section of the ring that is adopted, has little to do with its efficiency. It can be seen that a ring of relatively heavy section will be less likely to be stopped by the oil than one of small section and correspondingly light weight. Rings and oil that do acceptable work after being started often fail to start satisfactorily because the oil is stiff enough to overcome the very slight friction that exists between the shaft and the ring. This is at least a partial answer to Mr. De Signer's question concerning the size of the oil reservoir and the kind of oil that gives most satisfactory results. If the reservoir is made large enough to provide sufficient oil storage to reduce the necessity of frequently renewing the oil, and the ring hangs deep in it, there will be a tendency to retard the ring when the reservoir is filled to its capacity. Large rings have a smaller area in contact with the shaft, and have a tendency to assume a position oblique to the shaft and to swing laterally; consequently the diameter of the rings should not be too large.

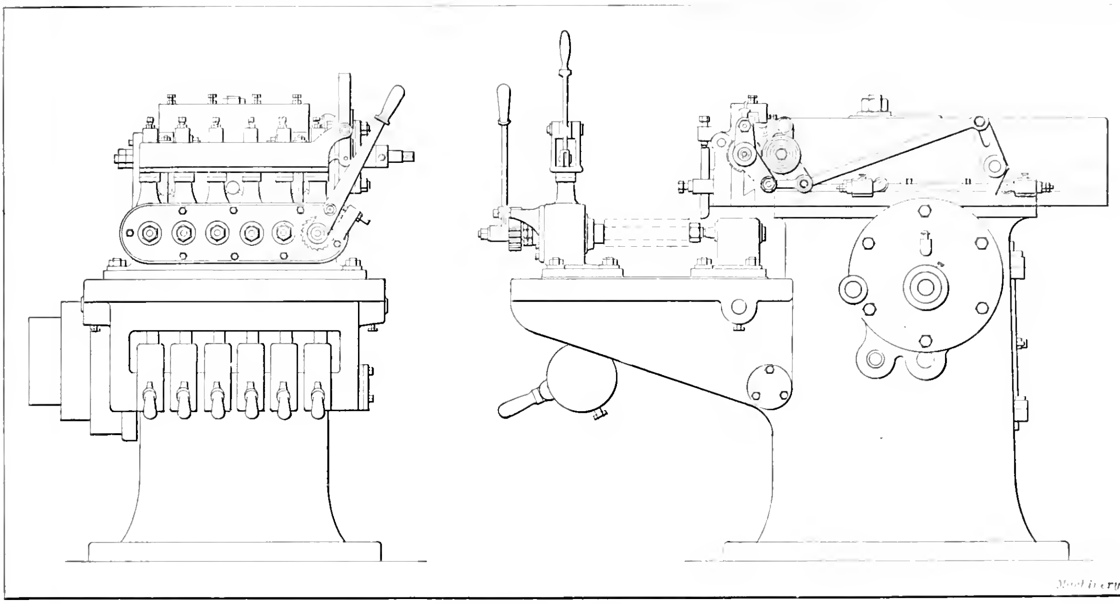
Chain oiling seems to offer many advantages over ring oiling, but the cheapness of rings and the fact that they give satisfactory service in millions of bearings, appears to be sufficient commendation to insure keeping them in use. Some large producers of ring oiling bearings make all their rings below 5 inches in diameter out of seamless brass tubing. The only objection to this material is that a tube is occasionally found that is eccentric enough to prevent satisfactory action. If the ring is very slightly out of balance, it will not move properly and fails to carry oil to the bearing in a satisfactory manner. By way of conclusion, the writer desires to join

Mr. De Signer in his request for more and dependable information on the design of ring oiling bearings.

Hamilton, Ohio. WILLIAM S. ROWELL

SEXTUPLE NUT PLANING MACHINE

The machine shown in the accompanying illustration is used for planing the six sides of hexagon nuts. The method of operation is similar to that of a shaper, except that six tools are employed instead of one. In order to provide for mounting six tools, the machine is designed with a wide guide upon which the ram slides; this ram has cross-feed and a clapper with grips for all six tools. The rough nuts are held on six horizontal mandrels mounted between two chairs which are carried by an extension of the bed. These mandrels are held by bushings in the front chair and are supported at the rear by tail-centers. The arrangement is such that all six mandrels are held exactly horizontal and parallel to each other and to the ram guides, thus providing for the production of accurate work. It will be seen that six weighted levers are located under the extension of the bed which carries the mandrels. By lifting each of these levers, the tail-center which it controls is moved back so that the mandrel may be removed to take off the finished work and put on fresh blanks. When the mandrel is put back into position, it is merely necessary to drop the lever in order to allow the weight to move the tail-center forward against the end of the mandrel. This method of operation adds materially to the rapidity with which the machine can be operated.



Sextuple Nut Planing Machine for the Rapid Production of Nuts

All six mandrels are indexed by means of a single lever mounted on the front chair. This lever turns all of the mandrels simultaneously through an angle of 60 degrees. The transverse feed of the ram and tools takes place automatically in both directions, but this feed can be controlled by hand if so desired. When the ram returns, the tools are automatically raised out of contact with the work in order to preserve their cutting edge as long as possible. A small chain-driven pump delivers cutting compound to the tools, the supply being contained in a reservoir within the column of the machine. The cutting compound is returned to the reservoir through a system of channels and pipe.

The stroke of the ram is about 9.75 inches so that six nuts 1½ inch in height may be mounted on each mandrel. The drive is through a three-step cone pulley and gearing, and a slotted crank disk. The ram is actuated by a wrist-pin carried in a centrally located fork. The speed of the return stroke is several times that of the cutting stroke. The cross-feed and the lift of the tools are effected by means of a ratchet and pawl which are driven from the ram through a system of levers and dogs.

Dresden, Germany. ROBERT GRIMSHAW

MUSICAL ORGANIZATIONS IN MANUFACTURING PLANTS

Some time has elapsed since the entrance of the "general welfare man" into many of our leading and successful business institutions, and the general welfare movement has been pronounced a success by many. A musical organization, of course, would come under this head, or department, and I am of the opinion that too few concerns realize the value of such an organization in connection with their business. *Esprit de corps* is one of the keynotes to success in business organizations.

An atmosphere of goodfellowship, harmony and concord can probably be created quicker and better and be more lasting among employes, and between employe and employer, by a musical organization, be it a band, glee club or orchestra, than by any other medium. Get a group of strangers together, get them to sing, and behold the fellowship that reigns in a very short space of time.

In suggesting an organization of this kind I would place a band of from twenty-five to forty pieces at the head of the list. A band could appear at shop-outings, base-ball games, etc. Then from a strictly business point of view, can you imagine a better "ad" for a going concern than to have its employes march in a body to the opening base-ball game in a major league city, headed by the company band? Or an automobile concern entering an industrial parade with its section headed by the factory band?

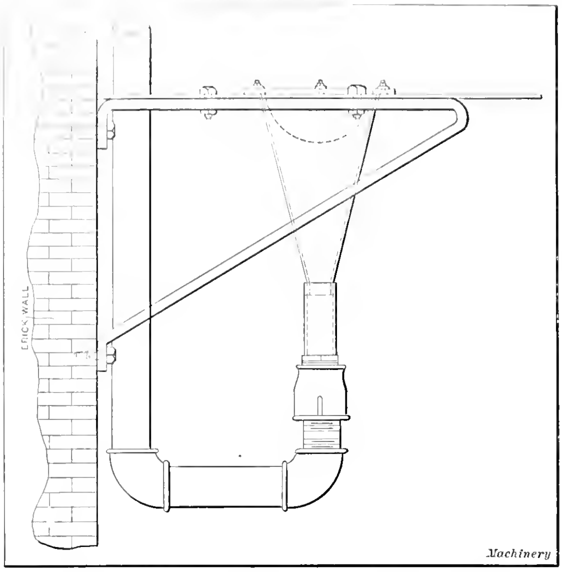
Next, in order, I would suggest a glee club. In many instances it would be possible to organize a glee club where a band would be out of the question. There is plenty of good material for glee clubs throughout the factories and offices of this country. Some surprisingly good material is to be found wherever Welshmen abound.

Picture a convention program being opened by an address of welcome by the mayor of a city, followed by a good stirring male chorus number by a Live Co.'s glee club, or a musical program at the foremen and superintendents' club some winter night, by the same club. It is a well known fact that a musical organization in a school creates "school spirit." Why will not a factory or office musical organization create—what shall I call it—well, the right spirit?

Cleveland, Ohio. JOHN W. VICKERMAN

AIR HARDENING FIXTURE FOR TOOL DRESSERS

The tool dressers in the shop where the writer is employed often asked for some arrangement that would provide for air-hardening tools and other parts. After the subject had been given a little study it was found that there was an overhead air exhaust which could be used by the hardening department. For this purpose a pipe was connected with this exhaust and carried down the wall to connect with the fixture illustrated herewith. It will be seen that this fixture is funnel shaped, the top of the funnel being covered with a wire mesh and provided with a steel shelf around its edge.



Fixture connected with Exhaust Pipe for Aid in hardening Tools

The steel shelf can be conveniently used for holding a variety of tools of all sizes, and the wire mesh not only prevents tools from falling off the shelf into the funnel, but is also used to support the smaller sizes of tools. Such tools can be laid directly upon the wire mesh, where they are exposed to the air blast until cool. The larger tools are either held in the blast or arranged on the shelf in such a way that the ends that are to be hardened are exposed to the action of the blast. M. W. W.

CASEHARDENING AND TOUGHENING PROCESS FOR GEARS, STUDS, ETC.

In order to obtain the best results by the casehardening and toughening process referred to in this article, it is necessary to give careful attention to the small details. A few degrees difference in temperature, or careless packing of the parts to be hardened, may cause the loss of the finished product. The equipment and materials used should also be selected with care. The furnace we use for heating the parts is a No. 8 Franklin gas furnace (capacity 24 inches by 27 inches) and a Franklin oil or drawing furnace to impart toughness. A good pyrometer should be used for the temperature readings and a good thermometer for the oil bath.

The carbonizing materials used are selected with reference to the results desired. We use a No. 1 rawbone, supplied by Rogers & Hubbard, of Middletown, Conn., and a charred leather which we prepare ourselves. This is obtained, if possible, by buying the scraps from shoe factories, using sole leather. To char the leather, it is placed in a box which is sealed with fire-clay. After the fires are turned out at night, the box is placed into the furnace and allow to remain there over night; the leather is then in good condition for use.

The boxes in which the work is packed are of cast iron. The walls are about ½ inch thick, and a flat iron plate forms a lid. Most of the boxes are round to conform to the general shape of the parts to be treated. This shape permits more uniform packing and heating than the square box.

The gears are cut and machined before hardening, sufficient allowance being left for grinding the holes to size after hardening. These allowances are determined by experiment. When heat-treating gears, a layer of the rawbone and charred leather, about two inches deep, is placed on the bottom of the box in the proportion of three parts bone to one part leather. A gear is then placed in the box and the mixture is securely packed around it with a layer of about one-half inch above. Another gear is then packed in the same way, and this is continued until the box is filled, allowance being made for two inches of bone over the top gear and a space of one-half inch below the top of the box. A mortar is next made by mixing together fire-clay, fine iron borings and salt, and a layer of this mortar is put over the top of the bone, flush with the top of the box; the lid is then put in place.

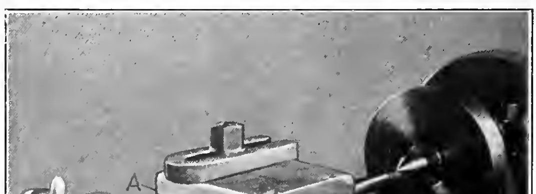
The heat-treatment is as follows: The temperature of the furnace is slowly raised to 1100 degrees F.; then the box is placed in it and the temperature is increased to 1650 degrees F. This increase should also be gradual about two hours being required to heat the box and its contents thoroughly. The temperature should remain at 1650 degrees for four hours. The box is then removed from the furnace and set in a dry place to cool. After cooling, the work is removed and again placed in the furnace, the temperature of which is gradually raised to 1550 degrees. The parts are then removed from the furnace and quenched in a good fish oil at the normal temperature. They are then placed in the oil bath of the drawing furnace and the temperature is raised to 475 degrees, after which the parts are removed and allowed to cool in the air. This process will produce a "case" about 1/64 inch deep, and the rest of the gear will be very tough so as to resist shocks.

To harden studs, pack them the same as described for gears and seal the box. Then place the latter in a furnace heated to 1100 degrees F., and slowly raise the temperature to 1600 degrees F. After the temperature has remained at this point for about eight hours, remove the box and let it cool until the next day. Then take out the studs and place them in the furnace loose or unpacked and heat to 1550 degrees F., then remove and quench in clean water. Finally, replace the work in the furnace, reheat to 1450 degrees and quench in water. This will produce a case of 1/16 inch depth and give the studs a tough center.

CASEHARDENER

MAKING A BRASS TUBE

Some time ago I required a brass tube about 6 inches long and 1.25 inch outside diameter, the bore to be true and straight and the shell about 1/32 inch thick. No tube answering the requirements could be obtained, so I made one as follows: Stock was selected about 1/16 inch thick, from which a blank of suitable width was filed up, bent round a mandrel so that the joint butted, and silver-soldered, no spelter of a low enough melting point being at hand. To bore it I used the device shown in the illustration. The fixture *A* was made from a piece of soft pine plank about 2 inches



Method used in making a Special Brass Tube

thick. This was gripped in the toolpost of the lathe and a hole rather smaller than the outside diameter of the tube drilled through it. This hole was then enlarged by using a boring-bar between centers and a single-point cutter, till the tube could be twisted through. The clamp was then split with a saw, as shown, and two small bolts put through to close it.

The tube was gripped sufficiently tight in this way to hold it while boring. As it had been rounded pretty well with a mallet on a smooth bit of shaft before clamping, it was not likely to become distorted by this mode of holding. The same boring-bar that was used for finishing the hole in the clamp was used to clean up the bore, the cutter being adjusted to the required diameter. To finish the outside to size, the tube was put on a parallel mandrel by hand pressure, stuck at one point with a drop of solder and then turned in the usual way.

Christchurch, New Zealand. JOHN PEDDIE

ATTACHMENT FOR DRAFTSMAN'S PEN

Fig. 1 illustrates an attachment for a draftsman's ruling pen or bow-pen which enables him to make either dotted or full lines with equal rapidity. In addition to the increase in speed, dotted lines can be ruled with the dots of exactly the same length. Making dotted lines that look well is one of the slowest tasks a tracer has to do. This is particularly the case when a bow-pen or compass-pen is used, as great care must be exercised in order to make the dots of uniform length. If such care is not taken, the general appearance of the tracing is ruined. Fig. 2 shows examples of dotted lines made with pens fitted with this attachment. As such lines can be produced when working at a high speed, the advantage is evident.

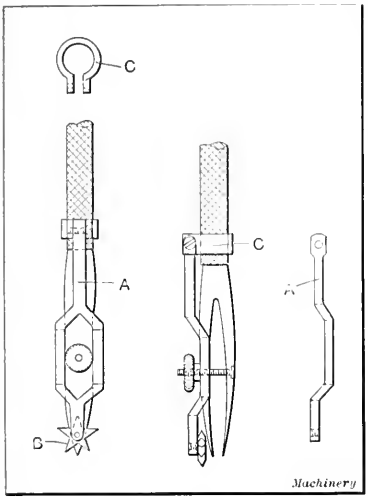


Fig. 1. Attachment for Draftsman's Ruling Pen

Referring to Fig. 1, it will be seen that the attachment consists of a bracket *A* which has a small star-wheel *B* mounted at one end of it. The bracket *A* is secured to the

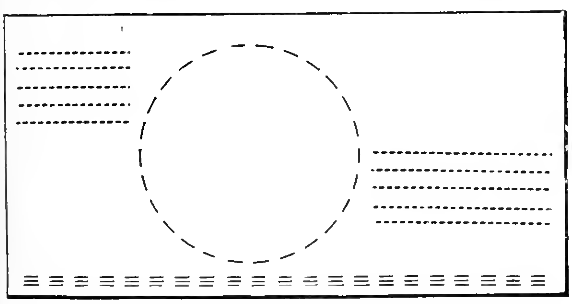


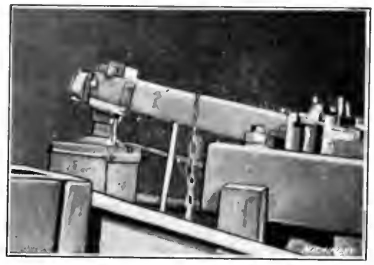
Fig. 2. Examples of Work done with Pen fitted with Ruling Attachment

pen by a collar *C* and can be swung back out of the way when the pen is ruling full lines. When dotted lines are being drawn, this star-wheel raises the pen from the paper as each point on the wheel passes the the center, thus producing a dotted line. Several star-wheels can be made and arranged to screw on and off the same bracket. By having different numbers of teeth on these wheels, dots and spaces of different lengths can be obtained. The same idea could be applied for producing dot and dash lines and other combinations. In this case, a larger sized wheel would be used and its periphery would be cut to control the movement of the pen point to give the desired ruling.

Chicago, Ill. C. W. HINMAN

OLD TILT HAMMER

The illustration shows a primitive tilt hammer built almost entirely of wood about fifty years ago. The hammer has been in more or less active use until the last two years. The ram is about nine feet long. On the rear end, which is tapered, is banded a small iron projecting about one inch beyond the wood. This iron is about one inch thick and three inches wide. In the center of an arbor which is about $4\frac{1}{2}$ inches diameter is a cam wheel carrying four cams twelve inches diameter and eight inches in the center where the cams are located. On one end of the arbor is a heavy balance wheel about three feet diameter and on the other end is the driving pulley. The construction of the anvil and hammer head is shown in the illustration.


Old Tilt Hammer

New York City. P. R. GOODWIN

SPINNING TOOLS

The tool used for spinning tinned iron, sheet-iron, steel or aluminum, should not be glass hard where it presses the sheet, as is the rule in spinning brass, for this tends to produce cracks and rough places. Especially in spinning tinned iron it may be noticed that the tin layer is injured. To avoid this difficulty when using excessively hard tools, the speed can be reduced, but, of course, this reduces the output. Another way is to use tools which are softer, and hence do not tend to scratch or tear the surface of the work. Ordinary brass would be a good material for working the metals named, but presents the objection that it is difficult to give such tools the desired form. Attempts made with the so-called malleable brasses, such as Delta and Durana metal, etc., have not been wholly successful.

A German foreman has made numerous experiments in this line, and has come to the conclusion that for tinned iron and steel, iron, aluminum or zinc sheet tools of certain aluminum bronzes give the best results. The best alloy in question consists of 90 per cent copper, 8 per cent aluminum and 2 per cent iron. This material permits forging the most complicated tools at a red heat. The advantages gained by its use are as follows: In working tinned iron, no tin is torn loose from the iron or steel underlay; in spinning sheet iron or steel, the material does not get rough; zinc and aluminum may be very easily spun when using tools made of this alloy; the work can be done with a much higher speed than with steel tools. Perhaps the reason these tools give good results is that the friction of working makes them hot, instead of the part being spun.

Dresden, Germany. ROBERT GRIMSHAW

ETCHING ON BRASS AND STEEL

In the August number of MACHINERY, a request was made for formulas for resisting grounds and etching fluids for use on brass and steel. For use on brass castings, I would advise the following method: after cleaning the work with gasoline place it in clean boiling water. A pot of beeswax is melted and kept at a temperature of from 200 to 250 degrees F. by standing it on a gas plate or some other heater which will retain the desired temperature. After the work has been washed, the surface to be etched is painted with wax and the work is then hung up to cool. The surplus wax will drain

off and some sort of pan should be provided to catch the drippings. This process leaves a very thin coat of ground which adheres firmly to the metal. I believe that asphaltum would be as satisfactory as beeswax if the castings were heated before the ground was applied. This preheating tends to bind the ground firmly to the metal.

The following is a very satisfactory formula for an etching solution: nitric acid, 16 parts; muriatic acid, 4 parts; water, 100 parts. Dissolve 6 parts of potassium chlorate in 80 parts of water. The two solutions produced in this way are then thoroughly mixed and allowed to stand for a few minutes until the gases have escaped. The solution is then stirred, after which it is ready for use.

For etching steel, the etching solution is composed of the following ingredients: nitric acid, 60 parts; copper nitrate, 8 parts; muriatic acid, 20 parts; water, 100 parts; alcohol, 120 parts. Either paraffine or beeswax may be used for a ground. Where there is a quantity of work to be etched, both the work and wax should be heated according to the preceding instructions, but where there are only a few pieces, the work is heated slightly and the ground applied with a piece of sheet metal that has been heated sufficiently to melt the wax.

New Britain, Conn. W. C. Betz

BORING AND FACING SPRING SHACKLES

Having read with interest the article in the October number on a "Jig for Drilling Automobile Spring Shackle Links" by C. T. Schaefer, the writer thought that many readers of your valuable paper would be interested in the boring and facing fixture illustrated herewith. Of course, this is for a different design of shackle, and is used in a turret lathe. The shackles are bored and faced, thus completing the operation in one fixture.

The construction of the fixture is as follows: The back plate *A* is of cast iron and contains a boss *B* for locating the fixture centrally on the lathe faceplate. The plate *A* is machined to accommodate the slide *C* which is held in place by the steel V-strip *D* and the screws shown. The shackle is held between two jaws *E* having machined vees which locate it centrally. The jaws are operated by a right- and left-hand

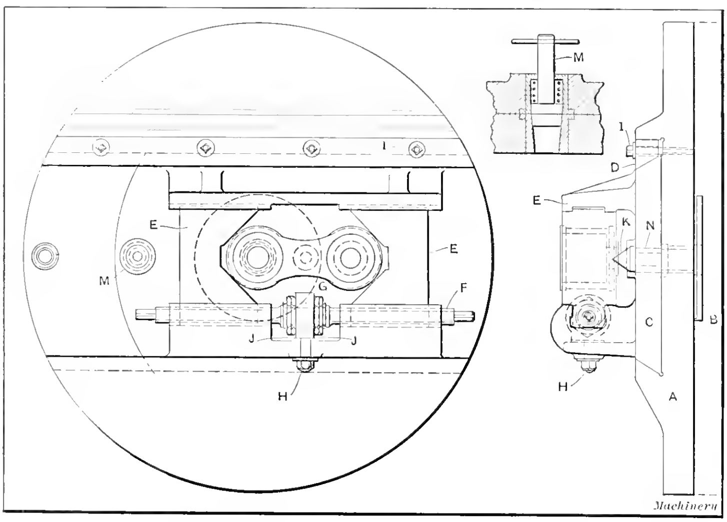


Fig. 1. Fixture used when boring and facing Spring Shackles

square-thread screw *F* which has a square on each end. These jaws, as will be seen, slide in machined grooves so as to prevent any possibility of springing. Note should be taken of the arrangement for centering the jaws. By this method the jaws can be set without any trouble by the simple adjustment of the nuts. It consists of two complete halves of a steel bushing, threaded at each end with a very fine thread. These are slipped between the two collars of the screw *F*. The bracket *G* is then put over the bushings, swung into position, and locked by the nut and washer *H*. The jaws can be adjusted to any desired position by the nuts *J* and also locked by the two end nuts. This construction saves considerable time and trouble in fitting.

When operating the jig, a shackle is placed between the jaws *E* and is pushed back to the stop. The screw *F* is then turned to tighten the jaws. One hole is then bored, after which the slide *C* is moved to the other position for boring the other hole. The slide is located in these two positions by the taper spring-plug *M* (see detail view) which engages holes in plate *A*. After the slide is in place, it is securely held by turning the screws *I*.

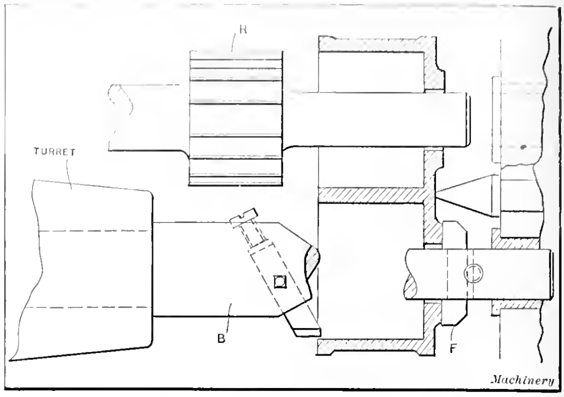


Fig. 2. Tools used for machining Spring Shackles

The shackles are steel castings and the fixture is held in a chuck or bolted to the faceplate. The first operation is to drill a hole in the bosses to allow the boring-bar to pass right through for piloting in the bushing *N* back of the fixture slide. The second operation is to swing around the turret with the boring-bar *B* (Fig. 2) set in position, and bore out the inside of the shackle to $1\frac{1}{2}$ inch diameter. The facing cutter *F* is next put in position and the boss faced. The third operation is to bring in position another facing cutter of sufficient diameter to true the large diameter at the front of the shackle. The final operation is to ream out the bored hole with the reamer *R* which also pilots in the bushing back of the slide. The slide is then moved across to the other position and the same operations are repeated on the opposite end. This fixture has been such a success that six were made for six different machines, and many thousands of these shackles are machined yearly.

Cleveland, Ohio. C. F. George

HIGH-SPEED SHAFTING

In connection with the subject of high-speed shafting which was discussed by J. E. Linabury in the September number of Machinery, it should be pointed out that while there may be a distinct economic gain by increasing the rotative speeds of lineshafts from about 200 to 600 revolutions per minute, such a course is only possible where the use of ball bearing hangers is adopted. There is at least one practical consideration which is opposed to such a rate of speed; *i. e.*, the comparatively low countershaft speeds for which machine tools are designed and the correspondingly small countershaft pulleys that are in common use. If the lineshaft speed were multiplied by three, as suggested in the article previously referred to, the lineshaft pulley, to drive a countershaft at the speed at which it should run, must be one-third of the diameter of the pulley used on the lineshaft running at the original speed. In a great many instances this would be an altogether impracticable proceeding, especially where the existing pulleys are of such commonly used sizes as 10 or 12 inches in diameter.

Looking at the subject from another point of view, it will

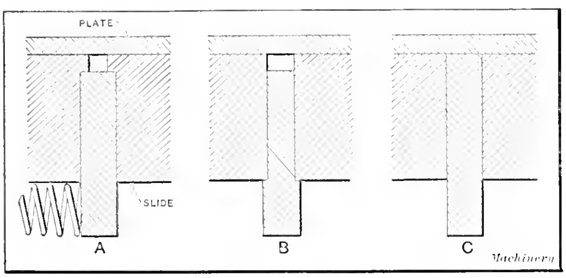
be seen that as a rotative speed of 600 revolutions per minute is far greater than the countershaft speed suitable for existing designs of machine tools, it would be necessary to make the lineshaft pulley much smaller than the countershaft pulley. As a specific case, consider a lathe driven by a countershaft running at 200 revolutions per minute. With a countershaft pulley 10 inches in diameter, the lineshaft pulley would have to be 3.33 inches in diameter for a lineshaft speed of 600 revolutions per minute. This would be a practically impossible dimension for such a case, and plainly shows that the problem is not capable of such easy solution as it might appear at first sight. This is largely due to the fact that the design of machine tools has been based on comparatively low lineshaft and countershaft speeds. This difficulty could, and doubtless will, be surmounted in the future by adapting the design of machine tools for increased speeds. In certain instances, however, such a change would require a great deal of careful study to enable it to be made with satisfactory results.

Sheffield, England. GEORGE W. BURLEY

SMALL SPRING TROUBLES—THEIR CAUSE AND CURE

The use of small spiral springs in connection with certain classes of punch and die work, is often an absolute necessity. As a rule the use of springs is avoided whenever possible, but as there are so many cases where they are essential, often there is no alternative. Quite frequently the successful operation of a punch and die depends on the proper working of the springs, so that a great deal depends on the kind of spring that is used. This is particularly true when the space allowable for the spring is limited and, therefore, a spring must be used that will give the best results. For these and other reasons, the following may be of interest and value to those who occasionally have "spring troubles of their own."

When a spring is used in a hole or slot, it must be small



Correct and Incorrect Methods of inserting Pins for Springs in Sliding Parts

enough to allow for a free action. In no case should the spring bind in the hole or on the side of a slot. When determining the kind of spring to use for working slides in forming tools, etc., a good point to remember is that springs of small diameter will not give good results if the spring wire is too thick, because they will set and become useless in a short time; moreover such springs tend to give the slides too much resistance so that they will require a greater amount of pressure to push them forward. One of the most helpful kinks in the use of small spiral springs that are expected to do strenuous work in a limited space, is to use a double spring; *i. e.*, one spring inside the other, the outside spring being wound right-hand and the inside spring left-hand, to prevent the coils from interlocking. While this is not a new kink, it is one that ought to be used more than it is, as it greatly increases the life and pushing power of the spring.

Another spring trouble is frequently due to the fact that springs are not "set" before being put into place. All small springs that are used as push springs, should be set before using. This is done by forcing the coils of the springs tightly together at least two or three times. In this way the spring will be set to its working length. For instance, if a spring is not set and is put into place, after working a short time it will become set, which means that it has shortened in length and has thereby lost much of its pushing power. On the other hand, when a spring is set, more coils can be used in a given space, which adds greatly to the working strength and durability of the spring.

Another form of spring trouble is that sometimes due to broken springs. In the majority of cases this is due to an inferior grade of piano wire, as this is the material from which most small spiral springs are made. The best way to overcome this trouble is to use an A-1 grade of piano wire, for the very good reason that a set of tools that require too frequent attention on account of broken springs not only stops the production of the article for which the tools were made, but also requires the services of a die-maker to make the repairs; hence it pays to use only a good grade of wire.

Spring troubles are often caused when springs are used in connection with spring pockets in a vertical position, by not having the spring pockets deep enough, thereby leaving so much of the spring exposed that when it is compressed the exposed part bends to one side and becomes jammed. To overcome this trouble, the upper and lower holes or pockets, should not only be in proper alignment with each other, but should be drilled deep enough to give the spring plenty of support. It is a good plan to make the mouth of holes rounding in order to prevent the edges of the holes from catching between the spring coils.

Sometimes so much work is required of a small spring, that even if a double spring is used it does not always prove satisfactory, and we are compelled to do a little experimenting in order to find out just what kind of a spring will "do the trick." After the required spring has been found, it pays to make a note of the size of wire used, number of coils, etc., as shown in the following:

Springs used for No. 1289 Forming Tools

Outside spring (wound right-hand.)
Size of wire, 0.071 inch.
Size of spring-winding arbor, 0.257 inch.
Number of coils in spring, 14.

Inside spring, (wound left-hand.)
Size of wire, 0.043 inch.
Size of arbor, 0.155 inch.
Number of coils in spring, 18.

One of the quickest and best methods of winding small springs *by hand*, that the writer knows of, is to wind the springs in an ordinary lathe on a long arbor, by using a Best spring winder. This winder is so constructed as to allow it to be held by hand, and has adjustments so that any desired space can be obtained between the coils of the springs. The lathe can be run at a fair rate of speed and the springs wound with surprising rapidity.

In winding springs it always pays to wind a few more than are required, in order to form a general spring supply, which is often convenient and time saving.

In winding a spring that must fit in a hole or over a post, a winding arbor of the right size should be used, in order to avoid winding three or four different sizes of springs before the right size is found. The size can readily be determined, by using the table published in MACHINERY'S Data Sheet Supplement, April, 1913.

When spiral springs are used in connection with slides, the stud or pin against which the spring bears, should never be made as shown at *C* in the accompanying illustration (although it often is) for the reason that the pin is liable to work up and bear against the top plate, thereby causing the slide to stick. Two good methods for fastening the spring pin are shown at *A* and *B* as the pins cannot work upward.

Waterbury, Conn. CHARLES DOESCHER

* * *

The art of advertising is many-sided, and new phases are being added all the time. Some of these have unusual and striking features. Consider the ingenuity of the designer of a non-skid automobile tire who conceived the idea of making the raised part of the tire in the form of the letters NON SKID set diagonally. Every revolution of the tire prints the trademark reversed but readable many times when running over soft roads; on paving stones the print in water, mud or oil is often plainly visible. The user pays for the tire and prints the maker's advertisement thousands of times on roads and pavements before the tread is worn off.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

TAPER FINISHING TOOL

While trying to get accurate work from an old turret lathe, I hit upon an easy way of "holding size" on slightly tapered studs, etc. Forming tools were unreliable in maintaining diameters so we fitted a box-tool with a wide blade which would take in the entire surface to be turned. This was ground to a scraping edge and was set by a finished piece to take off a few thousandths which the forming tool was adjusted to leave. The feed for a tool of this kind should be quite coarse, in order to keep the edge in the cut.

Poughkeepsie, N. Y. H. W. Johnson

DRILL FOR CORED FLANGE HOLES

A drill that will outlast any standard twist drill or reamer for use in drilling out cored holes in cylinder flanges can be made from a worn-out pipe tap. The tap is first annealed and then turned to a diameter 1/32 inch larger than the size of the cored hole. Four flutes are next milled in it, after which the end of the drill is turned to an angle of 45 degrees. This end is then ground to form a good cutting edge and hardened half way up the flutes. The writer has used a drill of this type for a considerable length of time and has found it to work with entire satisfaction when lubricated with ordinary cutting oil.

Philadelphia, Pa. C. W. Carrigan

CRANKSHAFT TURNING CENTERS

Fig. 1 shows a convenient form of centers for turning the pins of single, double, triple and right-angle crankshafts. Fig. 2 shows a single crankshaft mounted in the centers and illustrates the method used in setting up the work for machining. For this purpose the centers are placed at the ends of the crankshaft and then placed upon a surface plate. By this means, the centers automatically align themselves with each other and the crankshaft is then brought to the required position by the use of an ordinary square. When the crankshaft has been located in the centers, it is secured in place by means of two set-screws.

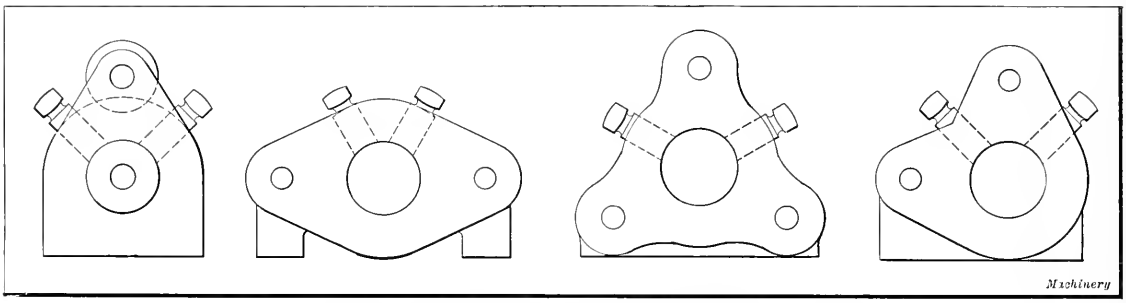


Fig. 1. Centers for turning Single, Double, Triple and Right-angle Crankshafts

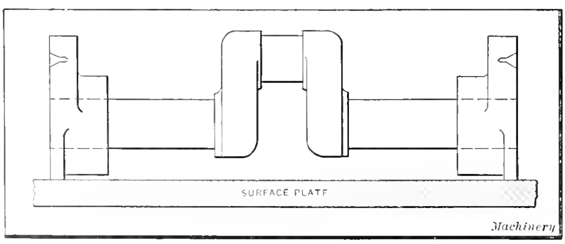


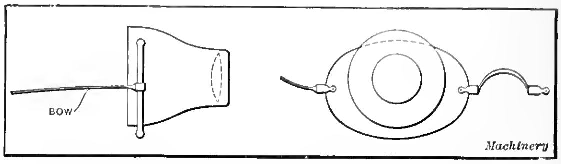
Fig. 2. Method of mounting Single Crankshaft in Centers

The square affords a satisfactory method of locating a single crankshaft in the centers, but in the case of double, triple or right-angle crankshafts a surface gage will be found necessary. Ordinarily, it is rather a difficult job to locate the centers on the crankshaft properly, but this is done automatically by the faces at the bottom which come into contact with the surface plate. If a surface plate is not available for this purpose, the table of an ordinary planer can be used with satisfactory results.

Milwaukee, Wis. Gus Luck

USE OF SPECTACLES FOR MAGNIFYING GLASS SUPPORT

Many toolmakers and machinists, who have to wear spectacles, experience more or less difficulty in putting on a watchmaker's eye-glass of the kind commonly used in the tool-room. Whenever they wish to use the eye-glass, it is necessary to first remove their spectacles or push them up onto the forehead. An easy and convenient way of avoiding this difficulty is to cut a slot of about the same width as the thickness of the spectacle lens in the rubber frame of the eye-glass. This slot is cut through to within about 1/8 inch of the opposite side, just enough rubber being left to give the necessary strength. When the eye-glass has been arranged in this way, it can be slipped over the spectacle lens as shown in the accompanying illustration, thus saving a considerable amount of trouble and loss of time.



Method of supporting Watchmaker's Glass on a Spectacle Lens

B. C.

FORMULA FOR SOLDERING SOLUTION

The following gives the formula for a solution which is very inexpensive to prepare and will be found a great improvement over the soldering acids generally used in machine shops. In addition to being an excellent soldering solution for brass, copper, tin and bronze, it may also be used as a flux for soldering galvanized iron. The union between the galvanized parts is perfect when this flux is used.

The method of preparing is as follows: Make a saturated solution of zinc chloride by dissolving as much zinc chloride as possible in water. Ammonium chloride (ordinary sal ammoniac) is added to this, the quantity being 1/10 part by weight. The solution should be thoroughly mixed before using.

A good paste for use where soldering acid would be objectionable is composed of the following ingredients: Ammonium chloride 25 per cent; alcohol (wood or grain) 25 per cent; common vaseline 50 per cent. The ingredients are thoroughly mixed before the paste is used.

East Orange, N. J. George Garrison

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PUTTY FOR EMBOSSING BRITANNIA WARE

G. P.—We are having trouble in "getting up" the detail embossing on britannia ware mirror backs which we make in large quantities. We think there is a "putty" or "slush" that is largely used in embossing such work under a drop hammer, which is placed on the reverse side of the blank to give extra pressure when struck by the force. Can anyone tell us what this putty is composed of?

RECHARGING PERMANENT MAGNETS

A. B.—I would like some information on recharging the permanent magnets of ignition magnetos for automobiles and motorcycles. Customers come to my shop to have their magnetos recharged, but I have not been able to handle the work successfully. I have wound coils for recharging and have followed the prescribed directions for magnetizing but with indifferent success. The magnetic flux would be very strong, but as soon as the current was shut off the magnet would be little or no stronger than before. I have annealed the magnets, thinking that by annealing and rehardening the original magnetic strength could be imparted again. Any information that the readers of MACHINERY can give me on this subject will be much appreciated.

TO COMPOSE THE INTEGERS FROM 1 TO 1000

H. M. L.—If given the problem of dividing $1000 into ten bags so that any integral sum from one dollar to $1000 inclusive can be paid out without opening any bag, how can the division be accomplished?

A.—Any integral sum between the limits of one and 1000 can be made up from the geometrical series 1, 2, 4, 8, 16, 32, 64, 128, 256 and the extraneous number 489. For example, compose the sum 255. $1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 = 255$. Again compose 504. $1 + 2 + 4 + 8 + 489 = 504$. The sum of the series and 489 is 1000.

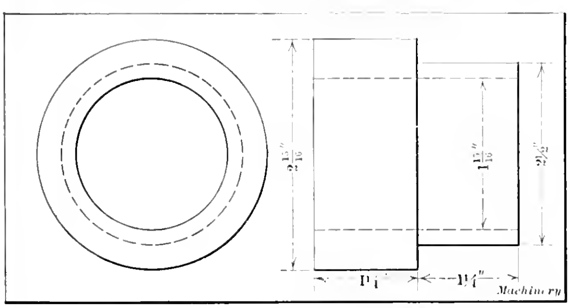
POLISHING HARD RUBBER—LAYING OUT POLISHED RUBBER PANELS

D. H. M.—(1.) Will you please tell me how to polish hard rubber to a buff or gloss finish? In turning or machining pieces for electrical work, they come from the machines in a dull finish. I would like to know how to put these small articles in a highly polished state. (2.) In laying off a highly polished, hard rubber panel, I paste a piece of plain paper on the surface and then lay out the various holes required but have trouble with the paper sticking to the rubber and injuring the polish. Will you kindly tell me what is the best adhesive to use to avoid the trouble?

A.—(1.) Hard rubber may be highly polished by the use of rottenstone and oil. (2.) Avoid the use of paper and adhesives and use instead, Chinese white diluted with water. Spread the diluted Chinese white on the rubber panel with a camel's hair brush. When it is dry, lay out your holes and lines. After the work is done, the Chinese white may be easily removed with water.

SHRINK VS. PRESSED FITS

J. B. F.—Is a shrink fit tighter than a driving fit, or is the supposed superiority of a shrink fit over a press fit only an old erroneous theory? For example, which method will fix



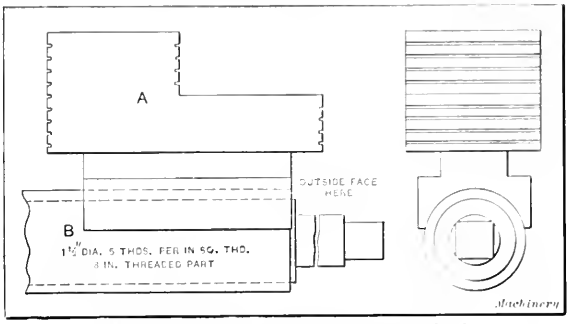
Piece to be shrunk or pressed on Shaft

the piece shown in the accompanying illustration most firmly on a shaft?

This is a practical question on which there is a difference of opinion. Discussion is invited from the readers.

COMPENSATING SCREW THREADS FOR HARDENING

W. B. T.—A lathe chuck jaw A is made of hardened tool steel and the square thread on the under side shrunk in pitch in hardening. The screw B is 1½ inch diameter, 8 inches long, left-hand pitch, five threads per inch, square thread. How



Hardened Lathe Chuck Jaw and Screw to be fitted

can I cut the thread so as to fit the hardened jaw in which the thread has shrunk 1/64 inch in pitch? I would like to have this problem submitted to MACHINERY's readers for reply.

W. B. T. evidently wants the details of a lathe compensating attachment with which he can change the pitch of a screw sufficiently to fit the shrunken hardened jaw threads. Details of such devices in use are solicited.

WORKING HOURS OF DRAFTSMEN AND MACHINISTS

J. W. B. P.—What are the standard working hours of draftsmen and machinists in American manufacturing centers?

A.—The working hours of draftsmen and machinists in representative shops in the principal manufacturing centers of the East and the West are given in the following table. The average number of working hours per week in twenty-five cities and towns is as follows: For draftsmen, 49 hours per week; for machinists, 52 hours per week.

WORKING HOURS OF MACHINISTS AND DRAFTSMEN

Locality	Draftsmen			Machinists		
	Full Day	Sat.	Hours per Week	Full Day	Sat.	Hours per Week
Baltimore, Md.	9½	5	52½	9	5	50
Bridgeport, Conn.	9	4	49	10	5	55
Cincinnati, O.	8¾	4¼	48	9½	5	52½
Cleveland, O.	9	5	50	10	5	55
Cleveland, O.	9	4	49	10	5	55
Detroit, Mich.	9	4	49	10	5	55
Dubuque, Ia.	9⅚	8⅚	54	10⅚	9⅚	60
E. Pittsburg, Pa.	8	4¼	44¼	9¾	5¼	54
Fitchburg, Mass.	9	4	49	10	5	55
Hartford, Conn.	9	9	54	9	9	54
Hartford, Conn.	8	8	48	9	9	54
Hyde Park, Mass.	7¾	7¾*	46½	9	9†	54
Jackson, Mich.	...	...	48	...	...	58
Madison, Wis.	8½	4	46½	10	5	55
Milwaukee, Wis.	8	4	44	10	5	55
New Haven, Conn.	10	9	59	10	9*	59
Newport News, Va.	8	4¼	44¼	9	5	50
Newport News, Va.	...	...	...	8	8	48‖
Philadelphia, Pa.	8¾	4	47¾	10¼	5	56¼
Providence, R. I.	9	5	50	10	5	55
Rochester, N. Y.	8	6½	46½	9	7½	52½
Rockford, Ill.	8¼	4	45¼	10	5	55
Rock Island, Ill.	8	8‡	48	8	8‡	48
Springfield, Vt.	7¾	7¾	46½	9	9*	54
Springfield, Mass.	8	8‡	48	8	8‡	48
Toledo, O.	9	5	50	9	5	50
Waynesboro, Pa.	9	9*	54	10	5	55

* During summer months, half holiday on Saturday.
† During summer months, 5 hours on Saturday, 10 hours on other working days.
‡ During summer months, 4 hours on Saturday with full pay.
¶ During summer months, half holiday without loss of pay, to men who have not lost over three-quarters of an hour during the week.
‖ Working hours for government employes.

SPRING-SUPPORTED CANTILEVER

M. M.—The following is a problem which has come up in connection with my work. I have attempted to solve it by several different methods but each method has yielded a different result. I would appreciate it if a correct solution of this problem could be published in the "How and Why" section of MACHINERY. What I desire to know is the deflection at the free end of the cantilever beam for a load of 500 pounds and also the stress at any point in the beam. Referring to the illustration, it will be seen that the cantilever is 20 inches long and supports a load of 500 pounds at its free end. The coil spring is located at a distance of 10 inches from the point of support and just touches the cantilever when the beam is unloaded. For the purpose of the problem, it will be sufficiently accurate to assume that the spring extends across the full width of the cantilever. The tension of the spring is such that it deflects one inch for each 220 pounds of load. The beam is made of steel and is 6 inches in width by 3/8 inch thick.

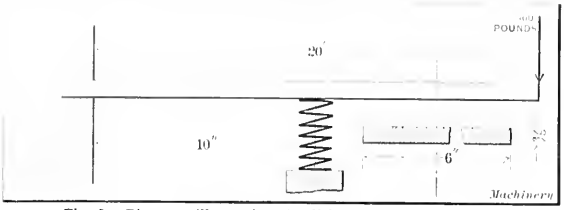


Fig. 1. Diagram illustrating Condition of Cantilever Beam supported by Spring

Answered by William L. Cathcart

A.—The neutral surface of a beam is the plane passing through the center of gravity and neutral axis of every cross-section of the beam. The elastic curve is the curve which the neutral surface assumes when the beam is bent. The deflection at any section of a cantilever beam is the vertical distance between the elastic curve at that point and a tangent to the curve at the support. For a cantilever of length l, having a load P at the free end, and taking the origin of the coordinates at the free end O, the equation of the elastic curve is:

$$6EIy = 3Pl^2x - Px^3 \qquad (1)$$

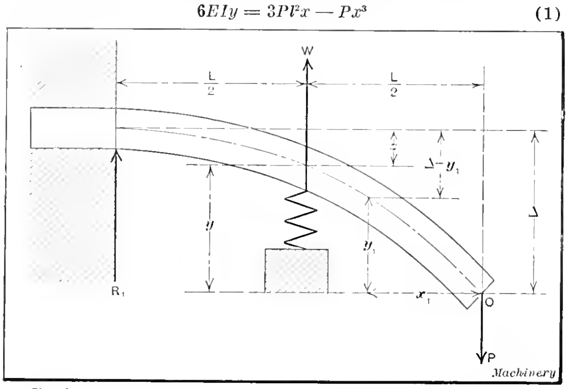


Fig. 2. Diagram illustrating Method of Procedure in solving Problem

The maximum deflection Δ, which is at the free end is:

$$\Delta = \frac{Pl^3}{3EI} \qquad (2)$$

where E = coefficient of elasticity = 30,000,000 and

$$I = \text{moment of inertia of section} = \frac{6 \times (3/8)^3}{12} = \frac{27}{1024}$$

The deflection at any other point, whose coordinates are x_1 and y_1, is determined by substituting the value of x_1 for x in Equation (1) and finding the value of y_1. The required deflection is then $\Delta - y_1$.

Let z inches be the vertical compression of the spring when the beam is bent by the load $P = 500$ pounds at the free end. Then as one inch of compression corresponds to 220 pounds of spring pressure, the upward thrust of the spring will be $W = z \times 220$ pounds. Now, if a force of W pounds acts at the middle of the beam and produces a deflection of z inches there, then a force of 2/5 W pounds = 2/5 × 220z = 88z pounds, acting upward at the free end, will also produce a deflection of z inches at the middle of the beam. This relation can be proved by comparing—by substitution in Equations (1) and (2)—the maximum deflection of a 10-inch beam, loaded at the end with W pounds, with the deflection at the middle of a 20-inch beam, loaded at the end with 2/5 W pounds. It will be found that the two deflections are equal. When P and W are acting simultaneously, the deflection due to P is downward while that due to W is upward. Hence, to find one relation for z we may take a beam having a load of (500 − 88z) pounds at the free end, and determine the maximum deflection for this load. Substituting in Equation (2):

$$\Delta = \frac{(500 - 88z)\ 20^3 \times 1024}{3 \times 30{,}000{,}000 \times 27} = \frac{256{,}000 - 45{,}056z}{151{,}875} \qquad (3)$$

From Equation (1) the value of y at the middle of the beam is:

$$y = \frac{(500 - 88z)\ 11{,}000 \times 1024}{6 \times 30{,}000{,}000 \times 27} = \frac{176{,}000 - 30{,}976z}{151{,}875} \qquad (4)$$

But $\Delta - y = z$. Therefore

$$\frac{256{,}000 - 45{,}056z}{151{,}875} - \frac{176{,}000 - 30{,}976z}{151{,}875} = z$$

$z = 0.48$ inch; $220z = 105$ pounds $= W$; $88z = 42$ pounds.

The deflection due to two or more loads acting simultaneously on a beam is equal to the algebraic sum of the deflections from these loads when acting singly. Hence, the deflection due to the load of 500 pounds acting downward at the end of the beam and the spring pressure of 105 pounds acting upward at the middle, is:

$$\Delta + \Delta' = \frac{500 \times 20^3}{3EI} - \frac{105 \times 10^3}{3EI} = \frac{(4{,}000{,}000 - 105{,}000)\ 1024}{3 \times 30{,}000{,}000 \times 27} = 1.64 \text{ inch} \qquad (5)$$

This result is subject to a slight correction, which will be referred to in a subsequent paragraph.

The stress at any section of a beam is given by the general formula:

$$M = \frac{SI}{c}$$

where M = the bending moment in the section under consideration;

I = moment of inertia of the section $= \frac{27}{1024}$;

c = distance of most remote fiber from neutral axis = 3/16 inch.

S = maximum section stress, pounds per square inch.

The bending moment M at any section of the beam is equal to the moment of the left reaction R_1 about that section, minus the algebraic sum of the similar moments of all loads to the left of the section. The left reaction, in this case, is equal to the algebraic sum of all loads on the beam or 500 − 105 = 395 pounds. For example, the bending moment at the section distant 15 inches from the support is

$$M = (395 \times 15) - (-105 \times 5) = 6450 \text{ pound-inches}$$

The stress at this section is

$$S = \frac{Mc}{I} = \frac{6450 \times 3 \times 1024}{16 \times 27} = 45{,}866 \text{ pounds per square inch}$$

Strictly speaking, the deflection at the end of the 20-inch beam, due to the spring pressure at the middle, should be increased (negatively) by the value of $kl \tan \theta$, in which $\tan \theta$ is the slope of the elastic curve at the spring and k is a fraction, in this case ½ as the spring is at the middle of the beam. With this correction, Equation (5) becomes:

$$\Delta + \Delta' = \frac{500 \times 20^3}{3EI} - \left(\frac{105 \times 10^3}{3EI} + kl \tan \theta\right) \qquad (6)$$

This gives a value of 1.58 inch instead of 1.64 inch as obtained by solving Equation (5).

The quantity $kl \tan \theta$ is here the difference between the deflection of the beam at the spring and the deflection of the end of the beam when the spring alone is acting. Its value is found thus:

$$kl \tan \theta = \frac{\frac{1}{2} Wl^3 \times \frac{1}{2}\,(1 - \frac{1}{2})^2}{EI} = \frac{1}{2} \times 105 \times 20^3 \times \left(\frac{1}{2}\,(\frac{1}{2})^2 \times \frac{1024}{30{,}000{,}000 \times 27}\right) = 0.06 \text{ inch.}$$

WOODS APPRENTICE INDUSTRIAL SCHOOL*

During the period that the Woods Engineering Co. has conducted its plant in Alliance, Ohio, an apprentice has never completed his period of indenture under the regular system. This is due to the fact that after a boy had served from one to two years of his time, he was able to obtain a more lucrative position in some other shop. This was usually done by misrepresentation, the boy claiming that he had completed his time and was a full-fledged machinist.

When a man, representing himself as a machinist, applies for a position, the foreman of the shop generally asks what class of work he is able to handle, and the answer will usually be that he is a lathe, planer or shaper hand or a fitter, erecter, etc. This shows that the majority of machinists have specialized in one line and are not in any sense full-fledged mechanics. The Woods Engineering Co. has found that apprentices from other shops who apply to them for positions have specialized or been kept on one class of work until they are reasonably proficient in that line, and often know very little of any other branch of their trade.

The Woods Engineering Company

APPRENTICE INDUSTRIAL SCHOOL

Schedule

(1) Applicants for apprenticeship must have reached the age of sixteen years and have sufficient education for entrance to first-class high school.

(2) The apprenticeship term shall cover a period of four years, during which time the apprentice must work under such shop rules and regulations as may be in force, and said four years shall be divided into eight (8) periods of 1,350 hours each, (about six months).

(3) Apprentice shall receive ten cents per hour to start and will be given an increase of one cent per hour, every period of 1,350 hours, (about six months). Apprentice shall be taken on six months trial. If at the end of six months it is agreeable to both apprentice and employer, the apprentice will be started in the shop industrial school course and will be credited with six months time on the apprenticeship term and be allowed one-half day each week on full pay to attend the Shop Industrial School. The school course is planned to extend over a period of three and one half years, but should the apprentice by aptitude and extra study complete the school course prior to the close of his apprenticeship term, he would be given credit for full school time. This would eliminate the school time for the balance of his apprenticeship term but he will be allowed double time with pay for all school time for which he is so credited, provided the time is put in in the shop.

(4) Overtime shall be counted in favor of apprentice, and all time absent shall be made up.

(5) Each apprentice shall be allowed the privilege of profiting by premium work or any other special system of pay or benefit in use in this plant.

(6) It is the pride of every first class machinist to possess a tool chest and a fine set of tools; with this idea in view each apprentice must purchase at his own expense, such small tools as he may require in the different departments, namely, a scale, calipers, hammer, surface gauge, etc.

(7) Each apprentice shall have the privilege of one week's vacation each year, without pay, at such time as may be mutually agreed upon one week in advance, and the loss of time need not be made up.

(8) Should the conduct or work of apprentice not be satisfactory to employer, he may be dismissed at any time without previous notice.

(9) To impress upon the apprentice the value of saving, the company, as agent will open a savings account with interest in the name of the apprentice, depositing to his credit $2.00 each month of his apprenticeship time in some good savings bank. No part of the bonus however, will be given to the apprentice until he has satisfactorily completed his four years apprenticeship, except that in case of death of apprentice, the full amount of the savings account on deposit at that time will be paid to his heirs or assigns.

(10) On completion of the shop school course and full apprenticeship term, the apprentice will receive the full amount of the savings account then to his credit, together with a diploma signed by proper officer of our company.

(11) The school proper will consist of a suitable school room and appurtenances, and the school course will include Technical machine shop practice. The school and shop work will at all times be directly under the supervision of a technical instructor who is thoroughly versed in actual machine shop practice.

(12) There is no charge of any kind whatever to the apprentice for school work, stationery, text books, or instruction.

....President

I have investigated the merits of The Woods Engineering Co. Apprentice Industrial School and have read the above Schedule governing same.

I approve the acceptance of the application of..........

....

and will render him every reasonable assistance in my power to complete the full course.

Signed

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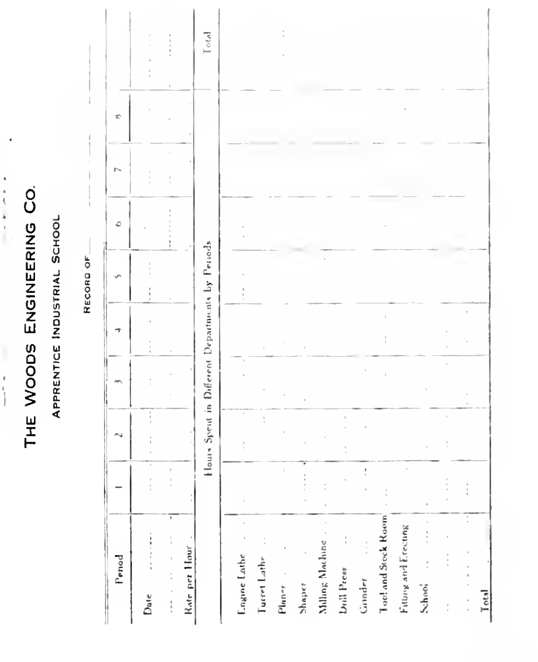


Schedule of Apprentice Industrial School adopted by the Woods Engineering Co., and Form on which the Student's Record is kept

It was felt that by training the apprentices by placing them in charge of an instructor, their efficiency would be increased in a way that would be beneficial to both the company and the boys. Considerable time was spent in investigating all of the schools of this nature that had come to the company's attention and the result of this investigation, coupled with the company's experience, has formed the basis of the industrial school for apprentices that was placed in operation in the shops of the Woods Engineering Co. on September 1.

The schedule which has been adopted by this company is reproduced herewith, and the following outlines the reasons which led to the adoption of the several articles which it contains. Article 1 was made necessary by the school laws of Ohio in regard to the age of boys who take a technical machine shop course. Article 2 was adopted as the result of the experience of other schools that claim to have demonstrated a four-year term to be necessary for the development of an all-around mechanic. The rate of payment outlined in article 3 was based on the rates allowed by other firms. It will be noticed that the apprentice is given an incentive to study out of school in order to shorten the apprenticeship term and receive double pay or 31 cents an hour for any school time that he eliminates in this way. By referring to the articles 4 and 5, it will be seen that the apprentice is given the same rights as the journeyman machinist so that he will not feel that he is being discriminated against. Article 6 was adopted with the view of developing pride in his work by having the apprentice own a part of the tools that he uses.

It was felt that every person should be entitled to some recreation each year, and as a result article 7 was adopted with the intention of making the apprentice feel that taking a week's vacation would not lengthen his apprenticeship term. It is believed that this tends to cheer the boys up and increase their interest in the work. Article 8 gives the employer the right to discharge any boy whose work is unsatisfactory. The provisions made in articles 9 and 10 add about one cent per hour to the wages received during the full term of apprenticeship and give a financial incentive for the apprentice to complete the full course. A brief description of the equipment of the school is given in article 11. The company was willing to adopt the provisions made in article 12 as it was felt that sufficient benefit would be derived from the increased efficiency of boys who went through this course of training.

The school is fitted up with desks, blackboards and the other necessary equipment for handling work of this kind. Six students were enrolled at the start and kept under the supervision of a technical instructor who is thoroughly versed in machine shop practice. It will be noticed that the company has not asked the apprentice to sign an agreement but has placed him strictly on his honor. A boy who is asked to sign any sort of an agreement realizes that he lacks experience in such matters and would probably feel some apprehension as to the outcome, not being able to realize the extent to which he would benefit by so doing. The company has, however, asked the boy's parents or guardian to sign a paper expressing their approval of his enrollment in the school. This was done in order to secure outside influence in making the boy complete his full term of apprenticeship.

* For further information on systems of apprenticeship see "A Modern Apprenticeship System," by A. J. Schneider, published in MACHINERY for June, 1913.

NEW CONNECTING-ROD GEAR FOR ENGINES AND PUMPS

An interesting and ingenious improvement in steam engine connecting-rod gear has been introduced by Mr. H. Williams of the Harvey Engineering Co., Glasgow. Instead of a single connecting-rod and crankpin, two connecting-rods and two cranks are used, in order to obtain a better movement for the reciprocating parts than is possible with a single rod, owing to its angularity. The arrangement of the Williams gear is shown by the accompanying diagram Fig. 1. The crosshead pin carries an oscillating link *A* which is connected by rods *B* and *C* to the two cranks. The latter are tied together by a tie-link *D*. The rods preferably cross at the inner dead center, as shown by the full lines, and they are open or parallel at the outer dead center.

In most of the gears hitherto made, the cranks have been set at an angle of 60 degrees, so that the link *D* is equal in length to the crank radius, and the centers of the connecting-rod pins on the oscillating link *A* are just a little greater than the crankpin centers. The two rods work side by side, somewhat like the eccentric rods of the Stephenson link motion. The centers of the connecting-rod pins on the oscillating link, follow horizontal figure-eight paths with the bottoms of the loops coming close to the center-line of the engine. With this arrangement, the crankpin circle is of larger diameter than the piston stroke. For example, in the engine illustrated in Fig. 2, the crankpin circle is 46 inches in diameter, whereas the piston travel is only 36 inches. This engine is a 200 H. P.

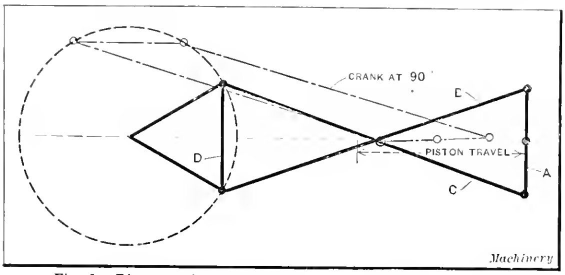


Fig. 1. Diagram of Williams Engine Driving Mechanism which employs Two Cranks and Two Connecting-rods

cross-compound condensing type, equipped with Corliss valves and using saturated steam at 120 pounds boiler pressure.

With this form of drive, the initial piston velocity is about 30 per cent less than with the ordinary type, assuming a constant angular velocity for the crank, but the maximum piston velocity is greater with the Williams gear, than with the ordinary connecting-rod. With the parts proportioned as previously stated, the crank moves through an angle of about 10 degrees before there is any appreciable movement of the piston. The effect of this slow initial movement is that the

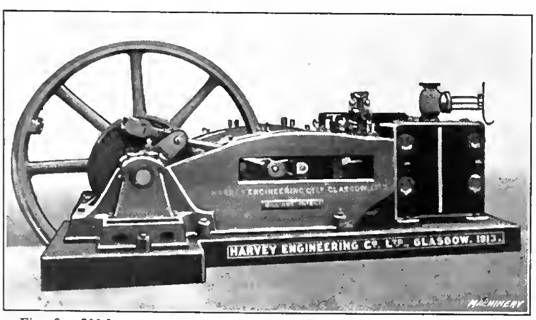


Fig. 2. 200-horsepower Engine equipped with Williams Driving Gear

acceleration of the reciprocating parts is more gradual as well as their retardation at the end of the stroke. As the result of this feature, the engine is said to run very smoothly and the difficulties of balancing the purely reciprocating parts have been gradually reduced. A 25 B. H. P. engine during a trial run, was bolted onto a structure of wooden beams which were ballasted on the ground but not otherwise held. In this position, the engine was run at various speeds and there was a remarkable absence of vibration. The 200 H. P. engine illustrated in Fig. 2, has been driving a weaving factory in Glasgow for several months and the speed of the looms has been increased 10 per cent over what was found possible with electric drive; the number of breakages has also been decreased.

The 25 B. H. P. engine previously referred to, was constructed for making comparative tests, it being arranged to run with either the Williams gear or the ordinary gear. The

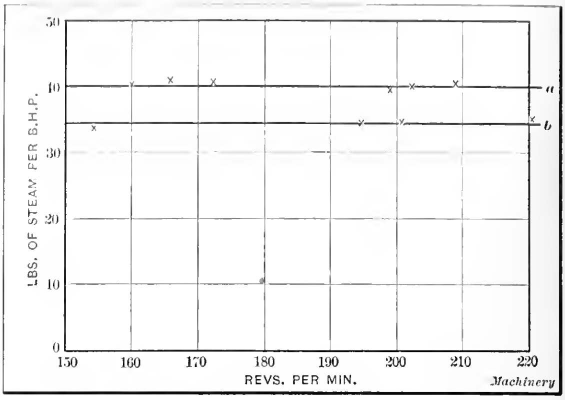


Fig. 3. Diagram showing Steam Consumption when using Single Crank, and when using Williams Two-rod Drive

frame valves and cylinder remained the same for both series of tests, the crankshaft and connecting-rod being the only parts changed. The engine was equipped with an ordinary D-slide valve and used saturated steam at about 75 pounds pressure. The exhaust was at atmospheric pressure. The exhaust steam was condensed and measured and the in-going steam was also measured with a steam meter. The results obtained from these comparative tests are shown in Fig. 3. Line *a* represents the steam consumption per brake horsepower for various numbers of revolutions, when using the ordinary single crank and connecting-rod. Line *b* represents the steam consumption per brake horsepower, when using the Williams gear. In this engine, the saving in steam effected by using the Williams gear was 15 per cent.

This new form of drive has also been applied to pumps with very satisfactory results. The "pause" at the ends of the stroke enables the valves to act without "slip."

* * *

INSPECTING WORK WITH LIMIT GAGES

The use of the fork and crescent types of limit gages manufactured by Wells Bros. Co., Greenfield, Mass., does away with the necessity of employing skilled mechanics to determine the perfection of a shop's product. Any man of ordinary intelligence can use these gages, as it is merely a matter of holding the piece of work loosely between the thumb and index finger, so that the constant force of gravity is alone responsible for carrying it between the contact points. As most mechanics know, the arrangement of these gages is such that the piece to be adjusted must pass between the upper pair of contacts but must be too large to go between the lower pair of contacts. The contacts can be set for different limits of tolerance. Where a practice is made of having the workmen test each piece as it comes from the machine, any error in the dimensions resulting from a change in the adjustment of the tool is immediately discovered, thus preventing a quantity of defective work from piling up.

Wells Bros. Co. and other firms who use these limit gages make a practice of having two sets of gages for each man; these gages are used on alternate days so that the chief inspector has one day in which to examine the gages which are not in use and see that they are accurately set. After completing this inspection, he fills the cavity behind the contact points with sealing wax which is marked with his private seal. This is of a conspicuous color and when the gages are in use in the shop the foreman is able to pass between the machines and see at a glance that each man's gage bears the inspector's stamp. This method of sealing the contact points makes it impossible for the men to tamper with the setting of the gages. The fork and crescent types of limit gages were fully described in the March, 1907 number of MACHINERY.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

UNIVERSAL SCREW MILLING MACHINE

The Universal Screw Cutting Co., 17th St., and Sedgley Ave., Philadelphia, Pa., has been engaged in cutting accurate lead-screws for a number of years, and has made a specialty of cutting screws of unlimited length. Special machines are used for this work, the design of which has been a carefully guarded trade secret. The company has recently decided to build these machines for the market, so that it is now possible for any factory to obtain a machine and cut its own screws by this process. The machine is the result of twenty years study of the subject of universal screw cutting, made by Mr. E. W. Crellin, mechanical engineer of the Universal Screw Cutting Co., and incorporates principles that have never been applied in the design of any other type of machine.

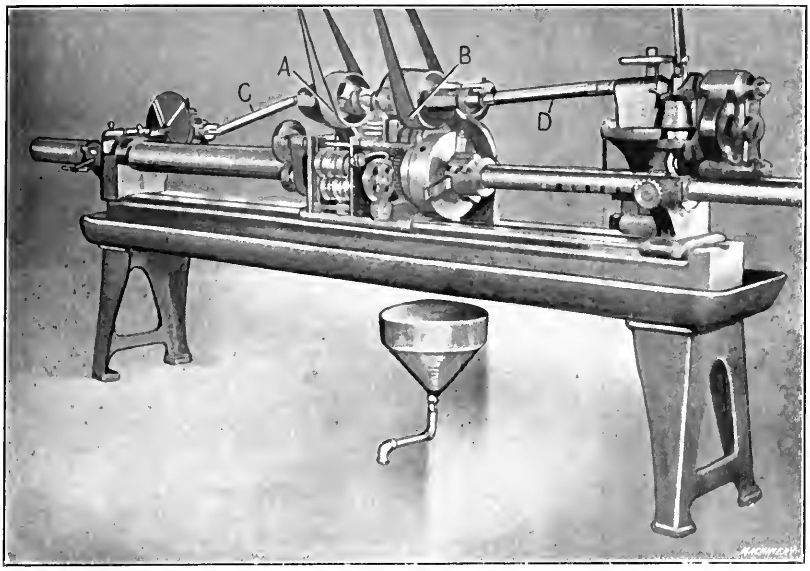


Fig. 1. The Universal Screw Milling Machine

The process is essentially a thread milling operation, but it differs from the established practice in that the work is held by a chuck, which grips it on the outside, and is supported near the point where the milling cutter operates by means of an expansion bushing or steadyrest. As the finished part of the thread passes beyond the head it is evident that the length of the screw which can be milled on this type of machine is unlimited. Another distinctive feature of the design is that the lead-screw is in direct line with the screw that is being milled.

The machine consists of three essential parts: the driving mechanism, the carriage and the cutter head. Referring to Fig. 1, it will be seen that there are two pulleys *A* and *B* located at the center of the machine. These pulleys transmit power to the driving mechanism through universal joints and the rods *C* and *D*.

Figs. 3 and 6 show rear and front views of the driving mechanism. Referring to the front view (Fig. 6), it will be seen that the rod *C*, connected to the driving pulleys *A* and *B*, transmits power to the shaft *D* on which the friction roll *E* is mounted. This friction roll drives the friction disk *F*. In order to provide for varying the speed at which the machine is operated, the screw *G* and crank *H* are provided. By turning the crank, the roll *E* is made to move in or out on the friction disk *F*, thus varying the rate of transmission as desired. In addition to the convenience of this friction drive in varying the rate of transmission, a further advantage is secured on account of the ability of the friction to slip in case the mechanism of the machine is subjected to excessive strain. This avoids the possibility of the machine or work being damaged from this cause.

The rear view of the driving mechanism is illustrated in Fig. 3, where it will be seen that the shaft on which the friction disk *F* is mounted, transmits power through the worm *I* and the worm-wheel *J* which surrounds the lead-screw. A key on the inside of this worm-wheel fits in a spline in the lead-screw, thus causing the latter to rotate. The lead-screw rotates in the split nut *L* and as the position of this nut is fixed at the end of the machine, the rotation evidently results in a longitudinal movement of the lead-screw. The hand-screw *M* shown in Fig. 3 provides for engaging or disengaging the lead-screw nut *L* and taking up any wear which may develop in it.

Fig. 4 shows a detail view of the carriage, the chuck which holds the work and the gear-box. A gear is secured to the end of the lead-screw, and power is transmitted through the gear-box from this gear. By making the necessary changes, the longitudinal movement of the carriage obtained from the lead-screw can be adjusted to obtain the desired pitch for the screw that is being milled. The first and last gears of the train in the gear-box are splined to a shaft which rotates in

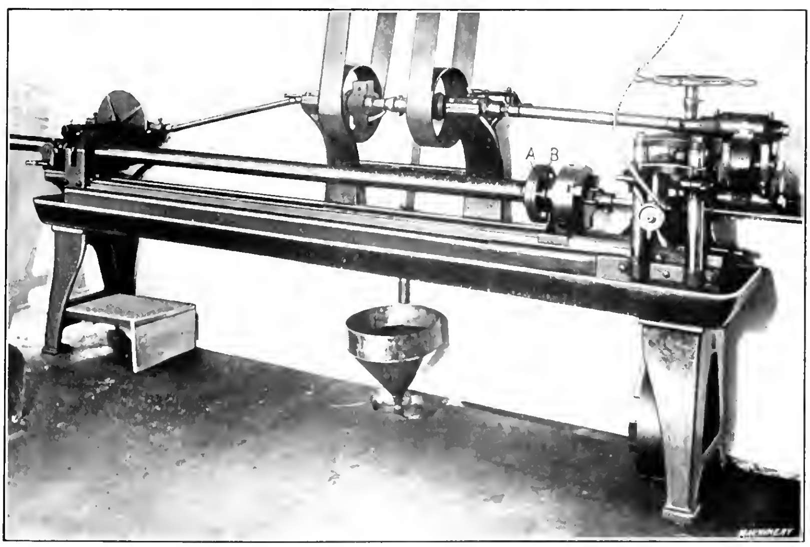


Fig. 2. Duplicating Machine requiring Individual Lead-screws for Different Pitches

flanged bearings that are clamped to the carriage. This is the means by which connection with the carriage is effected, and an idea of the arrangement will be obtained by reference to Fig. 4, in which the last gear of the drive through the gear-box is shown at E. This gear is fastened to a rotating cylinder to which the chuck is attached. The plate G is secured to the end of this cylinder, and it will be seen that this plate is graduated to conform with graduations around the plate H. The purpose of these graduations is for cutting multiple threads; by this means it is possible for the work to be indexed

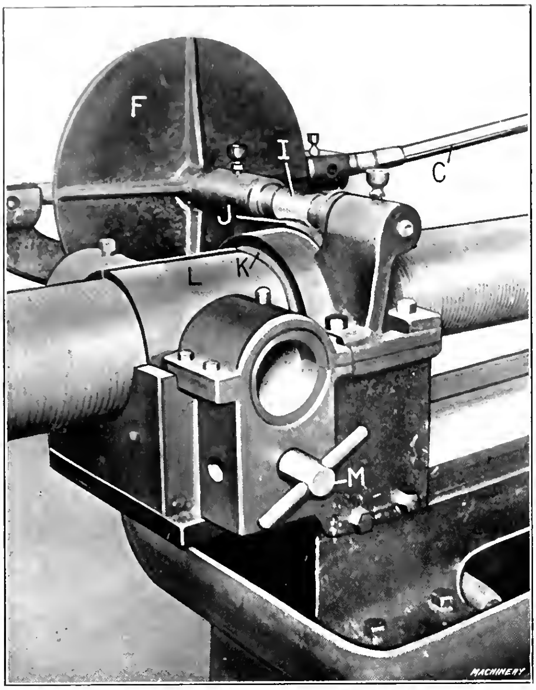


Fig. 3. Rear View of Friction Drive for Lead-screw showing Method of Transmission

through the required part of a revolution to enable it to be set ready for starting subsequent cuts after the first cut has been completed. The plate H is secured to the back of the chuck that holds the work. In order to hold the work positively and prevent it from slipping on the chuck, an auxiliary

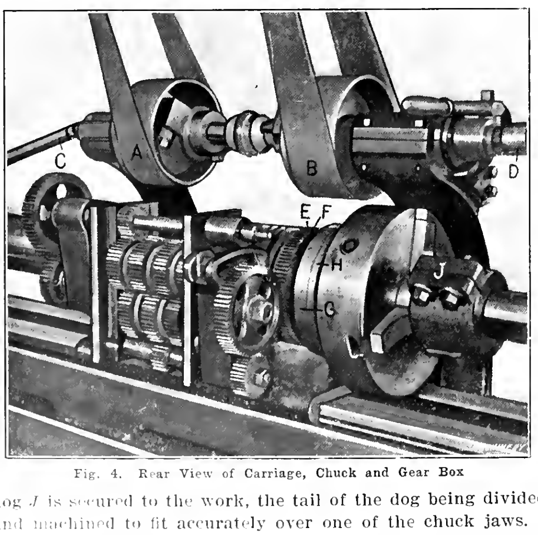


Fig. 4. Rear View of Carriage, Chuck and Gear Box

dog J is secured to the work, the tail of the dog being divided and machined to fit accurately over one of the chuck jaws.

It was stated in a previous paragraph that power is transmitted to the cutter head by means of shaft D, connected to driving pulleys A and B. A detail view of the head is shown in Fig. 5, where it will be seen that shaft D transmits power to a bevel gear H, from which the drive is through the bevel gears I and J to the horizontal shaft K. From this shaft power is transmitted through spur gears to the arbor E upon which the cutter F is mounted. It is evident that the bevel gears H, I and J enable the cutter head to be swiveled about a central pivot 90 degrees to the right or left of the center

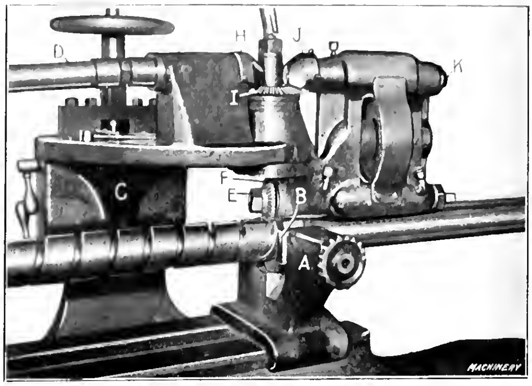


Fig. 5. The Cutter Head, showing Drive and Method of supporting Work

in order to have the cutter F set at any required angle. The work is supported by the bushing B carried in the anvil A, which is secured to the right-hand end of the machine, and the cutter head is further supported by the bracket C which is secured to the bed plate of the machine.

The work is fed to the cutter—in either the right- or left-hand direction—by means of the rotation of the lead-screw in the nut L at the left-hand end of the machine, which was described in connection with Fig. 3. The length of a single cut is limited by the traverse of the carriage along the bed of the machine, but for work of a greater length the chuck can be released, the nut disengaged, and the carriage run back to its original position. The nut is next reengaged and the chuck retightened. After this, the machine is ready to continue milling the thread and this operation can be repeated as

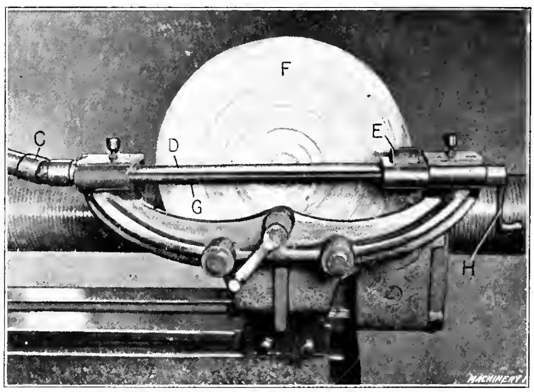


Fig. 6. Front View of Friction Drive for Lead-screw

many times as is necessary to finish the work. While the position of the carriage is being changed, care should be taken to clamp the work securely in the bushing B in order to prevent altering the relative positions of the cutter and the work.

For milling multiple threads it is obvious that the work must be run through the machine the same number of times as there are threads; for instance, a double thread would be run through the machine twice.

It has already been explained that on the machine shown in Fig. 1, a standard lead-screw is used in connection with change gears, which gives the required pitch on the screw that is being milled. A simpler form of screw cutting machine is illustrated in Fig. 2. Referring to this illustration, it will be seen that the change gear box is eliminated and different lead-screws are used for milling threads of the various pitches that are produced on the machine. The same arrangement of index plates for use in the production of multiple threads is

used on both types of machines. In the duplicating machine shown in Fig. 2, the index plate *A* is screwed onto the end of the lead-screw while the plate *B* is secured to the back of the chuck in a manner similar to that described in connection with the gear-box type of machine. It is a relatively simple matter

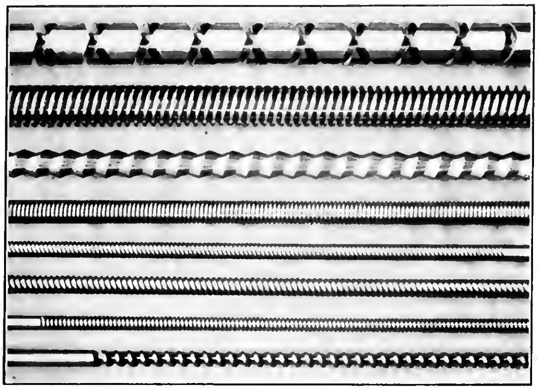


Fig. 7. Examples of Work done on Universal Screw Cutting Machines

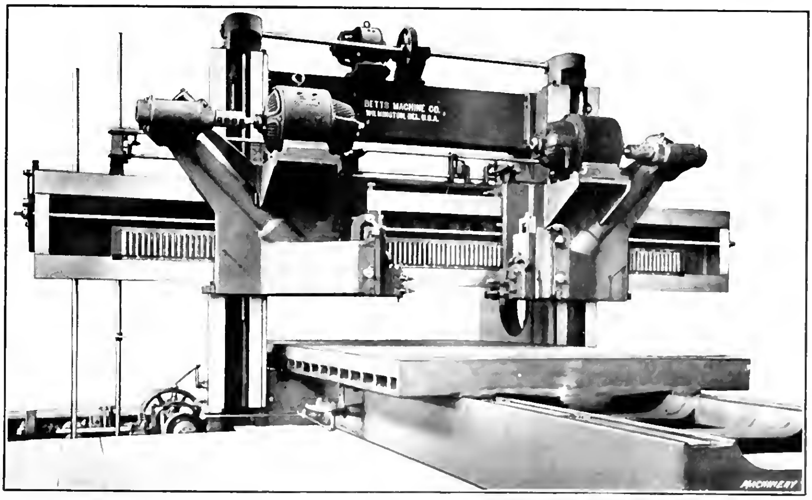
to change the machine for cutting various pitches, it being merely necessary to screw off the index plate and then remove the lead-screw and replace it by one of the desired pitch.

It is obvious that the accuracy of the work is dependent upon the perfection of the lead-screw, and the Universal Screw Cutting Co. has facilities for producing extremely accurate lead-screws for use in the machines. These lead-screws are machined on a larger size of the type of machine described in this article. A very severe test of the accuracy of a thread consists of splitting a section of the lead-screw along its axis and then fitting the threads on the two halves together. Any slight error will make it impossible for the threads to mesh properly, but the process used by the Universal Screw Cutting Co. has been developed to a point where this test can be conducted with satisfactory results.

BETTS CROSS PLANER

A special 120 by 84 inch cross planer which was built for the Commonwealth Steel Co., St. Louis, Mo., is shown in the accompanying illustration. This machine was designed to plane steel frames for passenger cars, but it was felt that at some future date it might be desirable to use it for regular classes of planer work, in addition to the special purpose for which it was built. With this idea in mind the design was worked out in such a way that by substituting a standard cross-rail in place of the special one shown in the illustration and by making a few other minor changes, the machine would be adapted for regular classes of planer work.

Referring to the illustration it will be seen that the two saddles on the cross-rail are equipped with slides set at right angles to the rail, and regular planer heads are mounted on these slides. A 25-horsepower reversing Westinghouse motor is mounted on each of the saddles and transmits power through spiral gears and the rack which is bolted to the cross-rail. The heads work toward each other and are electrically controlled in such a way that one head waits until the other has completed its stroke before reversal takes place.



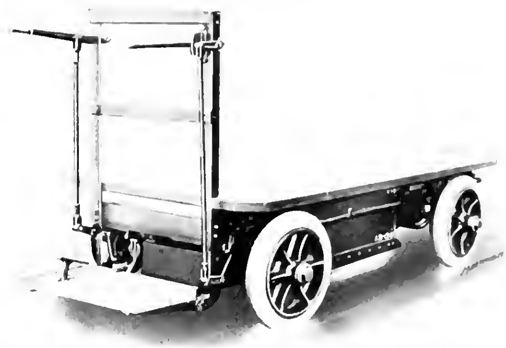
Special Betts Planer built for the Commonwealth Steel Co.

Two table speeds are provided, one of which gives a quick movement of about 20 feet per minute and the other a variable movement for feeding the work to the tool after each stroke. The mechanism for this purpose will be seen at the base of the machine, power being provided by a 7½ horsepower Westinghouse compound-wound motor. The vertical feed for the heads is also obtained from this mechanism, the control being obtained by the tripping dogs which engage a latch on the feed plate. Perfect control is obtained by means of the handle which is shown on the vertical shaft at the left-hand side of the machine, this shaft being connected to the master switch. Pendant switches are also provided.

The planer was built under specifications which required it to be capable of taking two cuts ½ inch deep with a ⅛ inch feed at a speed of 30 feet per minute in steel castings. When the machine was placed in operation, it was found that its actual capacity was considerably in excess of this figure. The Betts Machine Co., Wilmington, Del., is the builder of this special planer.

HUNT INDUSTRIAL TRUCK

A storage battery industrial truck which has been designed by the C. W. Hunt Co., Inc., New York City, is shown in the accompanying illustration. Practically any sort of material



Hunt Storage Battery Industrial Truck

can be handled on this truck, and as it does not run on tracks it can be taken from floor to floor in the elevator or run up into a box car that is being loaded. The capacity is for approximately 4000 pounds, and with this load a speed up to 5 miles an hour can be obtained. The battery has a capacity for a full day's work. Either Edison iron and nickel cells or Exide lead cells can be used. These cells are encased in a steel battery box that is suspended by springs from the cross members of the truck frame. The entire section of the top of the truck over the battery box is removable so that the batteries are readily accessible.

The motors used on these trucks are especially designed for

use in connection with storage batteries, and drive the wheels through cut steel gearing. The gearing is enclosed in an oil- and dust-proof case. Ball and roller bearings are used throughout. It will be seen that the operator's platform is located at the front of the truck. The right-hand lever is used for steering and the left-hand lever controls the motor. The brake is actuated by the foot treadle. When not in operation, the truck is automatically locked.

J. N. LAPOINTE DOUBLE BROACHING MACHINE

The distinctive feature of the broaching machine which forms the subject of this article is that two operating screws and work heads are employed. The sliding heads carried by the operating screws are of the standard form and the design of the machine is such that one head is being returned while the other is engaged on the cutting stroke. This does away with the necessity of waiting for the head to return, so that the operator is kept busy at all times and the output of the machine is materially increased. As it is possible to disengage one of the operating screws, the machine can be changed into the equivalent of a single broaching machine, if desired.

Both operating screws are provided with individual trips so that a very close adjustment of the length of stroke can be obtained. Two forward speeds are available and two operating levers are provided so that the operator can control the machine from either side. A Brown & Sharpe pump and oil reservoir are provided in the base of the machine. The reservoir is readily accessible through an opening at the rear of the machine and the pump is of ample size to deliver a liberal supply of lubricant to the broaching tools. Two flexible tubes are provided at the front end of the machine for the purpose of directing the cutting compound to the desired place. At the rear of the gear case there are two tubes which cover the operating screws; these tubes act as safeguards and also prevent oil from dropping off the screws onto the driving belts.

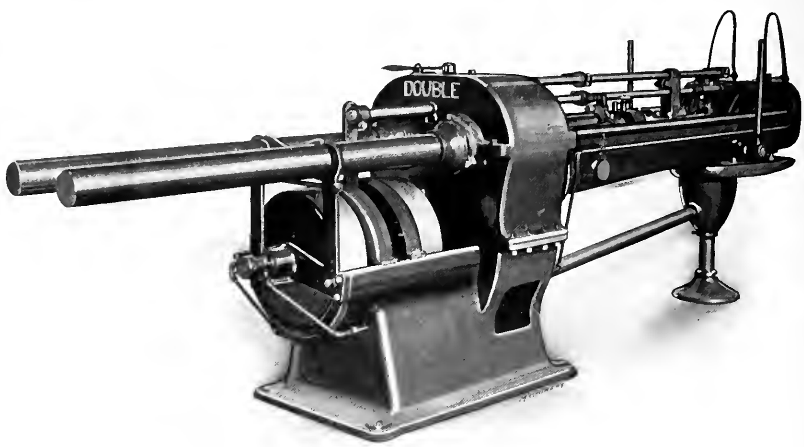


Fig. 2. Rear View of Lapointe Double Broaching Machine

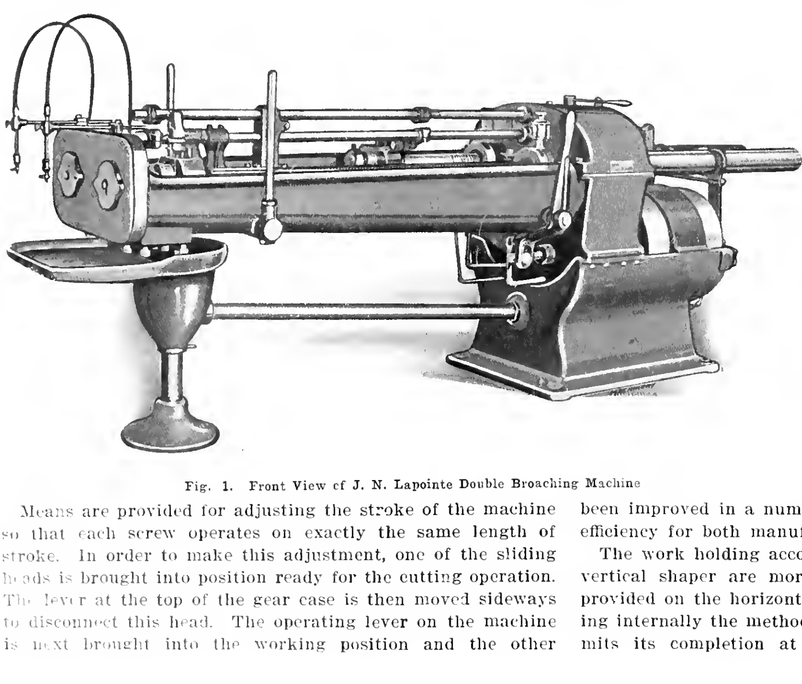


Fig. 1. Front View of J. N. Lapointe Double Broaching Machine

Means are provided for adjusting the stroke of the machine so that each screw operates on exactly the same length of stroke. In order to make this adjustment, one of the sliding heads is brought into position ready for the cutting operation. The lever at the top of the gear case is then moved sideways to disconnect this head. The operating lever on the machine is next brought into the working position and the other sliding head is moved to a position corresponding with the extreme of the stroke that is required. The stops are then set in this position and the stops for the other head are brought exactly in line with them. The lever on top of the gear case is then shifted to bring the first head into operation.

The principal dimensions of the machine are as follows: Travel of sliding heads on low speed, 3 feet per minute; travel of sliding heads on high speed, 6 feet per minute; size of driving screws, 2 3/4 inches diameter, 2 pitch; maximum stroke, 54 inches; floor space occupied, 3 by 16 feet; net weight of machine, 4800 pounds. The machine has a capacity for broaching holes up to 3 inches square. This machine is a recent product of the J. N. Lapointe Co., New London, Conn.

PRATT & WHITNEY VERTICAL SHAPER

The usefulness of the vertical slotting machine is greatly curtailed through its lack of adaptability, and on this account many shops find it difficult to keep their vertical slotters supplied with work. The customary method of supporting the tool on these machines is also a drawback in that the overhang of the tool makes it practically impossible to produce accurate work; and furthermore, the machine cannot be operated with any degree of rapidity. Another disadvantage of the tool support on the vertical slotter is that the tool does not free itself on the return stroke. By dragging over the work, the cutting edge is soon destroyed, and this results in a serious loss of time owing to the frequent intervals at which grinding is necessary. With a view of overcoming these difficulties, the Pratt & Whitney Co., Hartford, Conn., has brought out the 10½-inch vertical shaper illustrated in Fig. 1. This machine is adapted for the classes of work handled on both the vertical slotting machine and the horizontal shaper. It is similar in design to the smaller machine of this type which was briefly described in the January, 1912, number of MACHINERY, but the present machine has been improved in a number of ways which add greatly to its efficiency for both manufacturing and tool-room work.

The work holding accommodations on the Pratt & Whitney vertical shaper are more flexible in application than those provided on the horizontal shaper; for instance, when operating internally the method of holding the work invariably permits its completion at one setting. The same statement

applies to many classes of external work, as in the planing of an irregular shaped die-punch, where the entire periphery may be finished at one setting. The swiveling ram-head that is a distinctive feature of the vertical shaper, also permits two or even four sides of certain work to be planed at one setting, which insures the work being parallel. Furthermore, concave, convex or irregular surfaces which are very difficult to machine on the horizontal shaper, are handled with the greatest ease on the vertical shaper by means of the rotary table. Another decided advantage is that when working to a line, as in the case of die work, the cutting tool always enters the work where the line is scratched; whereas, on the horizontal shaper, it leaves the work on the scratched line, breaking away the chip and making it impossible to follow the line accurately. The feature of angular adjustment for the ram is also an advantage on a large variety of work, especially in the working out of dies, as the desired clearance can be obtained. As another point in favor of the vertical shaper, it might be mentioned that the working strains on the machine when in operation tend to hold all such parts as knees and slides together, which is directly conducive to maintaining the accuracy—while in the horizontal shaper, these strains are exactly opposite and are detrimental to accuracy and stability. The proportions of the Pratt & Whitney vertical shaper are ample to assure stability, and sufficient power is provided to meet every requirement. While the stability and power of the machine are adequate for the severest service on manufacturing work, this vertical shaper is a precision tool in every particular. Attention is also directed to the method pursued in meeting the various operating requirements, all of which are constructed and located with a view of affording the greatest possible convenience in operating the machine.

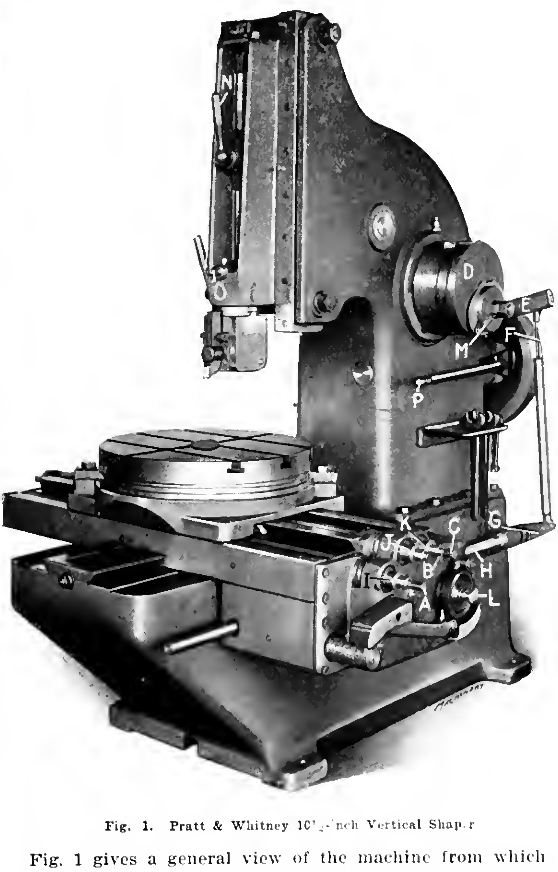


Fig. 1. Pratt & Whitney 10½-inch Vertical Shaper

Fig. 1 gives a general view of the machine from which it will be noted that the rotary table forms a very important part of the construction. It is substantially mounted, liberal dovetail bearings with taper gib adjustment being provided whereby the proper relation between the bearing surfaces may be easily maintained. Both hand and power feeds are provided, the means of controlling which have been worked out very satisfactorily and are worthy of special mention. The entire mechanism is self-contained in a compact unit attached to the saddle at the right-hand side of the machine. The transverse feed is controlled through the shaft A; longitudinal feed through the screw B; and rotary feed through the shaft C. Power is transmitted to the feed mechanism through the cam D which operates oscillating arm E. The desired rate of feed is obtained by adjusting shaft F, the power being transmitted

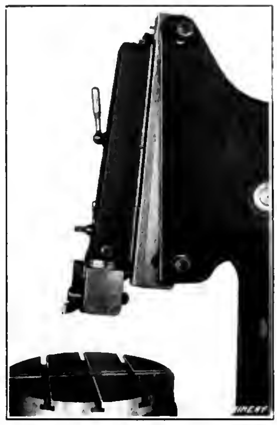


Fig. 2. Angular Adjustment of Ram

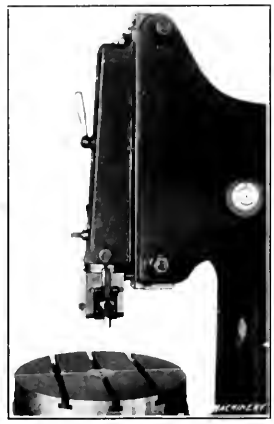


Fig. 3. Ram Head swiveled through 90 Degrees

through crank G and shaft H, to the feed pawl and ratchet clearly shown in the illustration. The various power feeds are engaged through the sliding pinions I, J and K. As shown in the illustration, these pinions are in the outward position, making the power feed inoperative. They are advanced to the inward position for engaging the power feed by hand, and are made of suitable form so that this may be easily accomplished. The power feed is operative in either direction and is controlled through the knob L which operates a clutch, the knob being pushed in or pulled out according to the direction desired. This mechanism gives a very rapid feed action which takes place when the ram is at the extreme upper point of its travel. As the tool is clear of the work at this point, it is not subjected to additional pressure on the return stroke, which results when feeding against the cut. A crank wrench is used for operating the hand feed, the ends of the shaft being squared for this purpose. Micrometer dials are provided, by means of which the various feeds may be very accurately controlled. The periphery of the rotary table is also graduated in degrees. The entire feed mechanism is enclosed, and means have been provided whereby the various feed-screws are absolutely protected against chip interference.

The mechanism for actuating the ram is driven by means of powerful worm gearing, and with this exception it is quite similar in design to the method used on the Pratt & Whitney horizontal shaper. The mechanism is so constructed that it forms a perfect counterweight for the ram; and thus a free, easy running action is obtained. Four speed variations are provided by means of a four-step cone, a very quick return being obtained through the mechanism previously referred to. Any desired length of stroke is readily obtained, the graduated dial M being provided for this purpose. The position of the ram may be changed by releasing binder N and adjusting the screw through shaft O. The ram may be stopped and started entirely independently of the countershaft by means of a friction clutch controlled through lever P. The important feature of angular adjustment to the ram is clearly shown in Fig. 2. This is accomplished by mounting the ram in an independent bearing, the upper part of which is pivoted on a trunnion which enables the bearing, together with the ram, to be swung on an angle. Suitable graduations in degrees are provided for obtaining the required setting. The ram bearing fits in the upright for its entire length and is made considerably longer than the ram, so that the ram is adequately supported even when the maximum length of stroke is used.

Special attention is directed to the method of holding the

tool. As will be noted, a style of toolpost is used which does not project beyond the cutting edge of the tool; consequently it passes directly over the work without interference. In order to accomplish this result the tool is secured from the back, the traditional set-screw which has always been a source of inconvenience on this type of machine having been done away with. The toolpost is carried in a clapper by means of which the same action is obtained as on the horizontal shaper or planer, which permits the tool to clear the work on the return stroke. The clapper is mounted in such a manner as to obtain this result, the force of the cut driving the clapper rigidly against the head. Cases may occur when exceptionally long tools must be used on internal work, where it would be advantageous to bind the clapper solid with the head; and means have been provided whereby this may be easily accomplished.

The ram-head is so designed and mounted in the ram that it is practically as stable as the ram itself, and it may be swiveled to four different positions, one of which is shown in Fig. 3. This feature enables the operator to adjust the tool to the most advantageous position, and as previously mentioned, permits planing two or even four sides of certain classes of work at one setting. In planing the different sides of the work, the rotary table is clamped stationary by means of two binders provided for this purpose. The ram-head is then swiveled to the desired position and either the longitudinal or transverse power feed utilized depending upon the position of the ram-head. This head permits the use of very short tools, especially on external work where practically no overhang is necessary; thus the tool in operation is dependent upon the ram for its stability rather than on the tool itself.

The maximum stroke of the ram is 10½ inches; the diameter of the rotary table, 24 inches; the longitudinal travel, 25 inches; and the transverse travel, 22 inches. The maximum distance from the table to the under side of the ram is 22 inches; and from the table to the under side of the ram bearing, 12½ inches. The net weight of the machine is 5700 pounds.

BARNES 22-INCH SELF-OILED DRILL

The illustrations show a 22-inch upright drill that is a recent product of the Barnes Drill Co., Inc., 814 Chestnut St., Rockford, Ill. This is a heavy-duty machine particularly adapted for severe classes of manufacturing work. One of the distinctive features of the design lies in the provision of a geared pump which supplies oil to all of the bearings and gears of the machine with the exception of the spindle sleeve. A belt-driven pump is also provided on the outside of the machine which supplies lubricant to the work. The machine is all geared with the exception of the short belt used for driving the outside pump, and if desired, a chain drive could be substituted for this belt. Power is provided by a 10-horsepower motor and transmitted through a Morse silent chain drive.

There are eight changes of speed which are obtained by levers within easy reach of the operating position. The spindle may be stopped by placing the shifter lever in a neutral position or by throwing out the clutch gears. With direct drive, the available speeds are 575, 456, 367, and 233 revolutions per minute; and with the back gears in, the available speeds are 144, 114, 92 and 58 revolutions per minute. Ten changes of geared feed are provided which are indicated on an index dial plate. These feed changes are 0.003, 0.005, 0.009, 0.013, 0.017, 0.020, 0.025, 0.041, 0.065 and 0.093 inch per revolution. Heat-treated cut-steel gears are used in the feed box and these gears are flooded with oil. A safety collar protects the machine from being damaged through over-load.

An idea of the capacity of this machine may be obtained from the results of a test which was made with a machine installed at the Foundry and Machine Exhibition in Chicago. A 13/16 Celfor high-speed steel drill was driven at 575 revolutions per minute with a feed of 0.041 inch per revolution. Operating under these conditions, a 2-inch bar of cast iron was drilled through in five seconds, which means that the drill was cutting at a rate of nearly 24 inches per minute. The capacity of the machine is for drills from ½ to 2 inches, and a 2-inch drill can be driven at 144 revolutions per minute

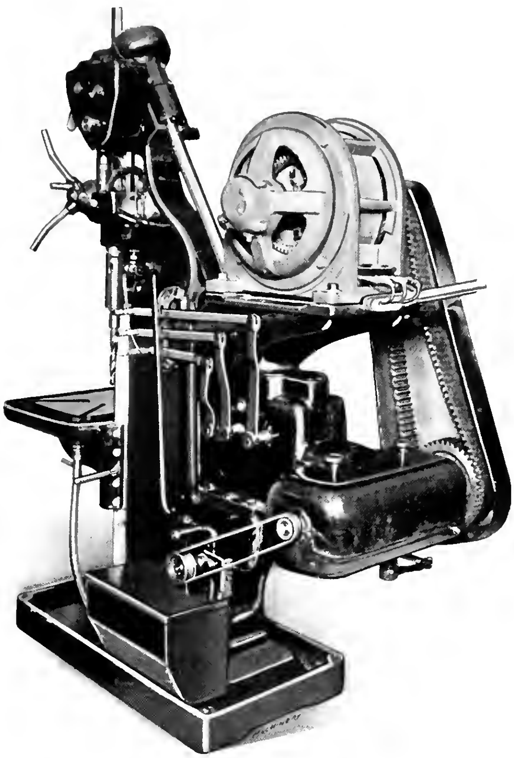


Fig. 1. Barnes 22-inch Drill equipped with Morse Silent Chain Drive

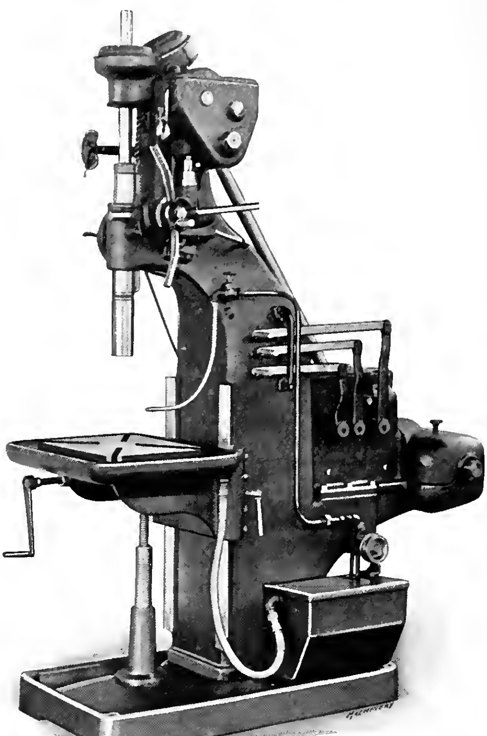


Fig. 2. Front View of Barnes 22-inch Drill

with a feed of 0.025 inch per revolution. The important dimensions of the machine are as follows: Height, 85 inches; distance from center of spindle to face of column, 11 inches; spindle travel, 14 inches; size of table, 14 by 20 inches; vertical travel of table, 23 inches; floor space occupied, 31 by 65 inches; weight of machine without motor, 2620 pounds.

LANGELIER TWO-SPINDLE OPPOSED DRILL

The Langelier Mfg. Co., Providence, R. I., has added to its line a two-spindle machine for drilling watch pendants of the form shown in Fig. 1. Although particularly designed for this class of work, the drill could be used for machining a variety of classes of work where it is necessary to drill, counterbore, or ream holes from opposite sides. An idea of the capacity of the machine may be obtained from the fact that an output of twenty of these German silver pendants per minute was obtained. Holes that do not lie on the same center-line may be produced with this machine by setting one spindle at a greater distance from the frame than the other. When there are several holes to be drilled on each side, the spindles of the machine may be equipped with the multiple heads of this company's manufacture.

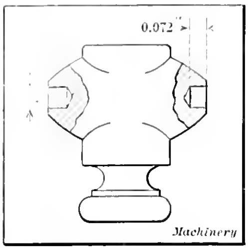


Fig. 1. Watch Pendant drilled by Machine

As it is only necessary for the attendant to insert the pieces to be drilled in the jaws of the jig, a boy or girl of ordinary ability should be able to produce satisfactory results. The jig locates the work in the proper relation to the drills and it is merely necessary to depress the foot treadle, which operates the feed mechanism. The jig is opened and closed automatically by the U-shaped yoke that is fastened to the upper side of a piston operated by compressed air under 30 pounds pressure. A piston valve of special design controls the flow of air to the piston this valve being operated from the treadle rod. The exhaust air from the cylinder which operates the jig jaws is utilized to blow the chips away and keep the jaws clean, so that each piece of work is accurately seated. The faces of the jig jaws are machined so that they fit accurately around the work to be drilled.

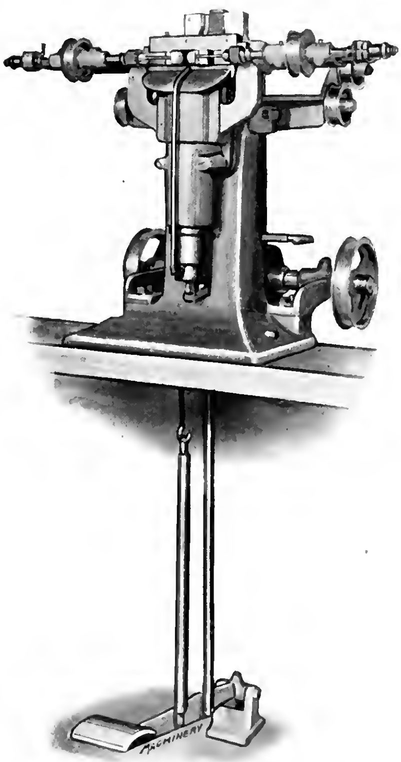


Fig. 2. Langelier Two-spindle Opposed Drill

The spindles are of hardened and ground steel and are arranged for either No. 1 Jacobs or No. 11 Skinner chucks for drills up to 7/32 inch in diameter. An adjustment of 1 inch is provided, and stops are arranged to enable the depth of drilling or counterboring to be accurately regulated. The settings cannot be accidentally changed and require no attention from the operator. After each drilling operation is completed, the spindles are withdrawn by springs located inside the drill frame, and the finished piece drops into a suitable receptacle. Bronze and steel thrust washers and ball thrust bearings are used on each spindle. The spindles are relieved of the tension of the driving belts by means of phosphor-bronze bushings in the drill frame bearings. These bushings extend to almost the middle of the spindle driving pulleys, just enough space for the driving collar being left uncovered by the ends of the bushings. The hub of each driving pulley runs on the projections of these bushings which take the tension of the driving belts, thus relieving the spindle from strain. This construction insures sensitiveness, ease of feed and return, and complete freedom even if the belts are unusually tight.

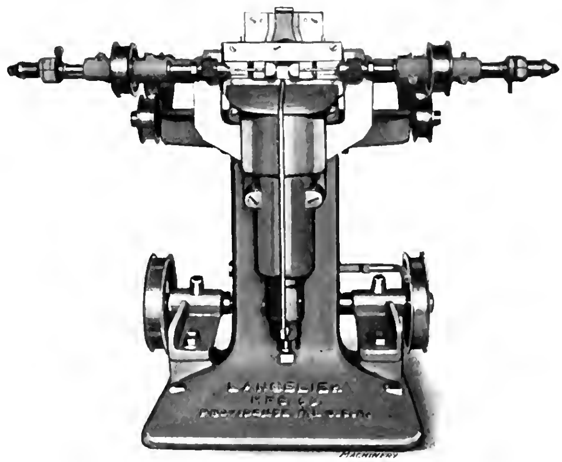


Fig. 3. Nearer View of Langelier Opposed Spindle Drill

The total feed of the spindles is two inches, and the feed is accomplished by causing the cam roll on each drill frame yoke to move in contact with the double inclined plate cam, which will be seen projecting above the center of the machine. Th proper amount of feed is obtained by adjusting stops on the yoke, which is connected to the treadle rod. Each spindle is driven at about 2900 R.P.M. The driving pulleys are located on the base of the machine at the rear; these pulleys are 6 inches diameter by 3/4 inch face and run at 1200 R.P.M. Tight and loose pulleys 5 inches in diameter by 1 1/2 inch face, are also located at the rear of the machine, and are provided with a hand belt shipper. When desired, the machine can be provided with motor drive.

WORCESTER LATHE

The Worcester Lathe Co., 134 Gold St., Worcester, Mass., is now building the 11-inch lathe illustrated in Fig. 1. It will be seen that the head of this lathe is provided with a four-step cone pulley and it is single back geared. The speeds obtained are in geometrical progression and range from 14 to 280 revolutions per minute. The spindle is of 60 carbon steel and runs in cast-iron ring oiling bearings; it is No. 4 Morse taper and has a hole one inch in diameter to adapt the lathe for operation on bar work. The tailstock is of the cut-away pattern and has adjustment to provide for turning tapers. The tailstock is secured to the bed by a single bolt and has an

ample bearing surface on the vee and flat ways on the bed. The carriage bears on the vee at the front of the bed and the flat surface at the rear. It is gibbed under both bearing surfaces. The toolpost is of the ring and wedge type and is suitable for turning tools ½ by 1 inch in size. A compound tool-block is also provided which is graduated in degrees and may be easily set by loosening a single bolt. This block can be quickly removed when it is desirable to use the plain tool-block in its place. The usual form of dial graduated to 0.001 inch is provided on the cross feed screw. The apron is of the worm-driven type and the power cross feed is engaged by means of a pull knob.

The lead-screw is only used when the machine is engaged on thread cutting operations. Three changes of feed are obtainable in the gear box and other combinations of three

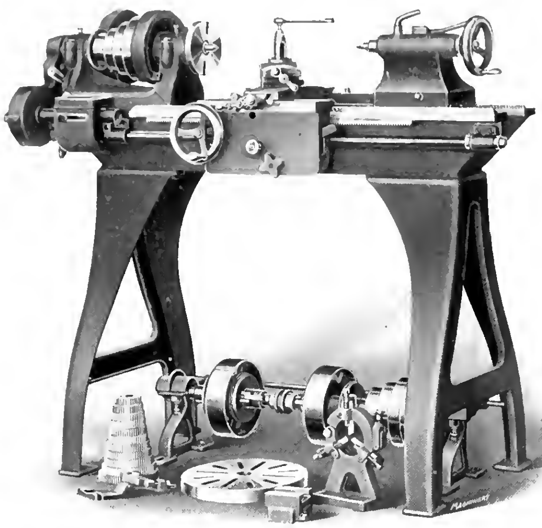


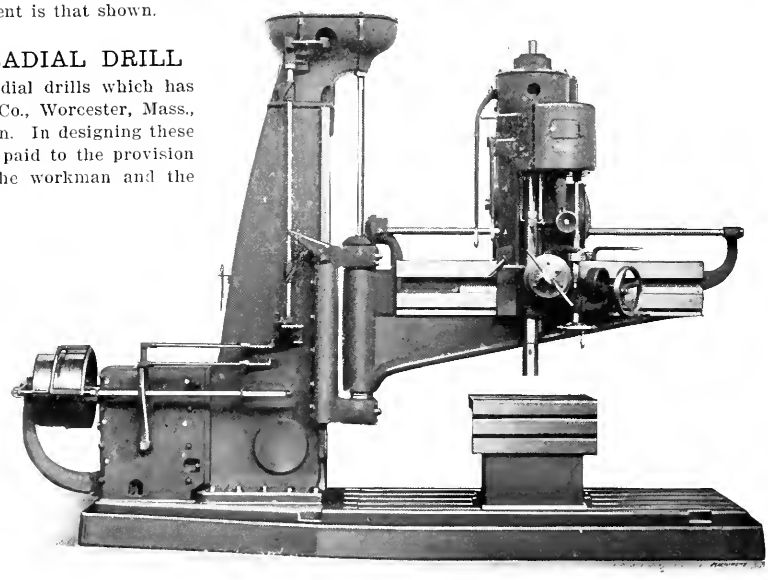
Fig. 1. Worcester Eleven-inch Lathe

changes may be obtained by adjusting the gearing on the machine. The machine can be arranged for cutting metric pitches. The countershaft used is of the flat disk friction type with ring oiled bearings. The bed is rigidly braced by cross tie members. The regular equipment is that shown.

REED-PRENTICE HEAVY RADIAL DRILL

The 6-foot size of a line of heavy radial drills which has been brought out by the Reed-Prentice Co., Worcester, Mass., is shown in the accompanying illustration. In designing these machines, particular attention has been paid to the provision of safety devices which protect both the workman and the machine from injury. All gears are encased in guards which are cast integral with the machine. The counterweight is so constructed that it is impossible for it to drop in the event of the chain breaking. Safety stops are used to prevent the saddle from feeding too far in either direction, thus protecting the gearing from damage. Particular attention has also been paid to the lubricating system in order to insure long life for all wearing parts.

The speed box is located behind the post to which it is bolted. The speed range obtained is adequate for all ordinary working conditions. Four speeds are provided in the speed box—any one of which may obtained while the machine is running, and if desired while the drill is actually under cut. The clutches are so arranged that it is impossible to engage conflicting ratios, as it is necessary for both levers to be in the operating position in order to start the machine.



Reed-Prentice Six-foot Heavy Pattern Radial Drilling Machine

The upper portion of the post is cast so as to provide for encasing the driving gears as well as the saddle raising gears. By means of the vertical rod at the side of the post, the saddle raising gears may be engaged. The arrangement of the gearing is such that the down feed is twice as fast as the up feed. The arm is mounted in a bearing provided with

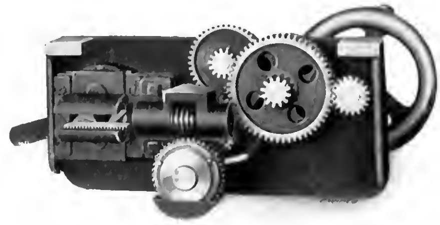


Fig. 2. Apron of the Worcester Lathe

ball thrust collars at the lower end to facilitate swinging it easily. The sliding head is assembled as a complete unit before being placed on the arm, the horizontal arm shaft being located by means of jigs and fixtures which insure perfect alignment of the shaft. Two speed mechanisms are provided in the head which give a slow speed with ample power for heavy work and high speed for light work. This arrangement relieves the strain on the shaft in both cases. These two speeds are multiplied by the four changes in the speed box to give a total of eight speeds without the back gears and sixteen speeds with the back gears.

The tapping attachment is always available for use and is controlled by a lever located at the right of the head directly above the arm. An important feature of these machines is the introduction of helical cut gears which reduce vibration and noise to a minimum. The machines are either built with ball bearings throughout or with bronze bushed bearings. The ball bearing drills can be operated with a power consumption of about 50 per cent of that required for machines with plain bearings. These machines are built in 2½, 3, 4, 5, 6 and 7 foot sizes.

NIAGARA TRIMMING PRESS

The trimming press shown in the accompanying illustration is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. This machine was built for trimming drop-forgings, but a press of this type would also be adaptable for the manufacture of various kinds of hardware, automobile and bicycle parts, and for heavy sheet metal work. Where a trim-

ming press is built with the flywheel and pulley adjoining the main gear, and with an outboard support for the overhanging part of the shaft, a considerable amount of space is occupied. This is objectionable for a press that is to be used for trimming drop-forgings, as it is desirable to have the press located as close to the drop hammer as possible. The independent outboard bearing also makes it difficult to keep the driving shaft in the proper alignment and there is likely to be trouble with the bearings where such a construction is employed. As the bearings are located close to the bed of the press, they are also likely to be subjected to undue wear by particles of dirt and scale finding their way into them. The pulley and flywheel are also in the operator's way and must be carefully guarded to prevent accident.

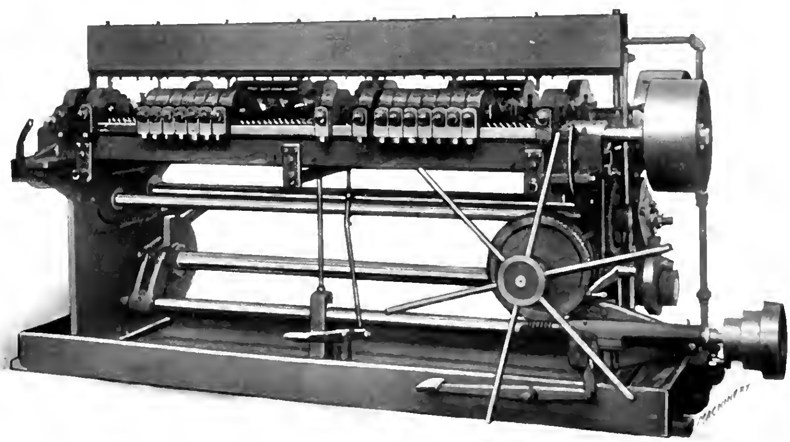
Niagara Press for trimming Drop-forgings

These disadvantages have been eliminated in the new Niagara trimming press. It will be seen that the flywheel, pulley and backshaft are mounted at the top of the machine, where they are out of the operator's way and where the bearings are not exposed to scale and dirt. The necessity for an outboard bearing is also eliminated, thus making the machine self-contained. The press occupies a minimum amount of floor space, is accessible from all sides, and can be located very close to the drop hammer. The motion of the press is controlled by an automatic jaw clutch equipped with a gravity disengaging device. The inner slide is provided with a dovetail recess for use in mounting, trimming and forming dies. The outer slide receives its motion from an eccentric keyed to the main shaft. Both the outer slide and the bed have a recess machined in them which provides for mounting adjustable holders for cutting-off tools. These trimming presses are built in different sizes; they are equipped with either a single or double crankshaft and with straight or gap housings. The smallest sized machine weighs 5000 pounds and the largest, 60,000 pounds.

MOLINE TOOL CO.'S DUPLEX PIPE DRILLING MACHINE

The Moline Tool Co., Moline, Ill., has recently added to its line the duplex pipe drilling machine illustrated herewith. It will be seen that this machine embodies the characteristic features of design that have been worked out by this company. The feed is actuated by a cam and can be quickly changed to adapt the machine for drilling through one wall of the pipe or through both walls, as desired. It will be evident from the illustration that the drill heads are arranged on opposite sides of the pipe. This arrangement enables holes to be drilled very close together. For example, using heads 2 inches in width and feeding each drill through both walls of the pipe, it is possible to drill holes with only 1 inch between centers. When the holes to be drilled are not closer than the width of the heads, a great saving of time can be effected by setting the drills on one side of the pipe opposite those on the other side. With this arrangement, both walls of the pipe can be drilled in the time that would ordinarily be required for drilling one hole, and no time is lost in feeding the drills through the gap.

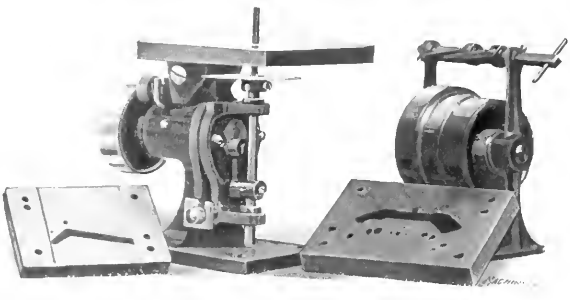
When the pipe is only drilled through one wall by each drill, a smoother product is obtained, as all fins and burrs are on the inside and there is nothing to injure the hands of the man who is to handle the product. The operation of the machine is expedited through the use of an automatic clamping jig which is operated by a cam. Where holes are to be drilled through both walls from each side of the pipe, the drills are not only lubricated from the outside but also by forcing a stream of lubricant through the pipe that is being operated upon. This is unnecessary where only one wall of the pipe is being drilled. The spindles of the machine are hollow and adjusting screws are provided to set the drills to exactly the desired point. Machines of this type can be built in any length up to 10 feet and equipped with any number of heads to suit the requirements of different classes of work. When so desired, hand feed can be substituted in place of the power feed used on the machine shown in the accompanying illustration.



Moline Duplex Pipe Drilling Machine

PATTEN BENCH FILING MACHINE

Mr. E. L. Patten of 4011 Shenendoah Ave., St. Louis, Mo., is now manufacturing the bench filing machine shown in the accompanying illustration. The operating table of this machine can be adjusted to any desired point over an angle of 15 degrees, in either direction from the horizontal, and rigidly locked in the desired position. Similarly, the file carrier can be adjusted up to 15 degrees, in either direction from the vertical, and locked in position. These adjustments of the table and file carrier are obtained by screws and make it possible to obtain any required angle for die work, thus doing away with the necessity of filing by hand. The working parts of the machine are protected by guards which keep the filings from working their way into the bearings. All bearings are made of liberal size and means of adjustment are provided to take up wear in those bearings upon which the pressure is high. These filing machines are made in two styles, known as Nos. 1 and 2. The No. 1 machine is fastened to the bench and driven by a countershaft. The No. 2 machine is equipped with a sub-base and is driven by a direct-connected motor. This makes it a complete unit.



Patten Bench Filing Machine

HORTON DRILLING AND TAPPING CHUCK

The E. Horton & Son Co., Windsor Locks, Conn., is now manufacturing the quick change collet chuck shown in the accompanying illustrations. These chucks are adapted for both drilling and tapping operations. The drill or tap is held in a collet and in order to mount the tool in the chuck ready for use, it is merely necessary to grasp the knurled collar and hold it back against the rotation of the spindle. This causes a pair of retaining dogs to be drawn back into the body of the chuck so that the collet can be slipped into place. The knurled collar is then released and the action of a spring forces the dogs inward, so that they engage a groove in the collet and secure it in the chuck.

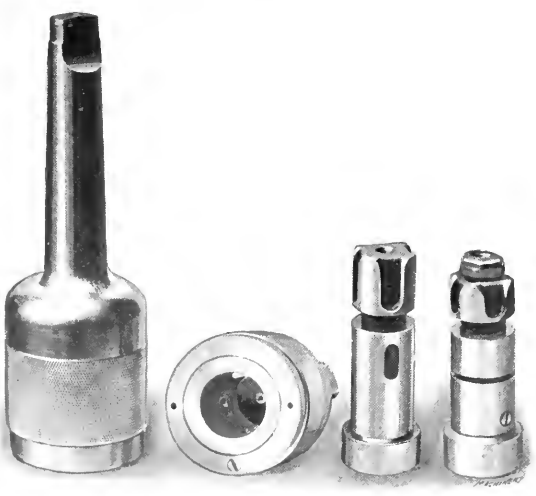


Fig. 1. Horton Chuck and Drilling and Tapping Collets

Fig. 1 shows the chuck and the collets used for drilling and tapping; and Fig. 3 shows a cross-sectional view of the chuck and tapping collet and also a drilling collet. These illustrations, in connection with the following description, will make the principle upon which the chuck operates quite clear. When the knurled collar *A* is held back, the pilots on the retaining dogs *B* move in contact with cam surfaces which cause the dogs to be drawn back into the body of the chuck. The collet is then pushed up into the chuck where it is centered by means of the tool steel plug *D*. The squared ends of the collet are engaged by the studs *E* which afford positive drive. When the knurled collar *A* is released, the retaining dogs *B* are forced inward by the action of spring *C* and engage in the groove machined in the body of the collet.

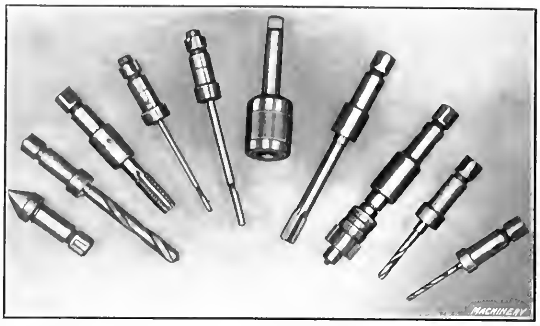


Fig. 2. Examples of use to which Horton Chuck can be put

The collet is made 0.015 inch smaller than the bore of the chuck and the design is such that the collet floats in a way which assures the desired alignment for tapping or reaming. As the collet is positively held in the chuck by the retaining dogs, there is no danger of it dropping out and causing tools to be broken. Another feature of this arrangement is that the chuck can be used for counterboring the under side of a hole or for similar operations. Where there are a number of operations to be performed on a single piece, the necessary tools can be mounted in individual collets and the change of tools can then be made with great rapidity.

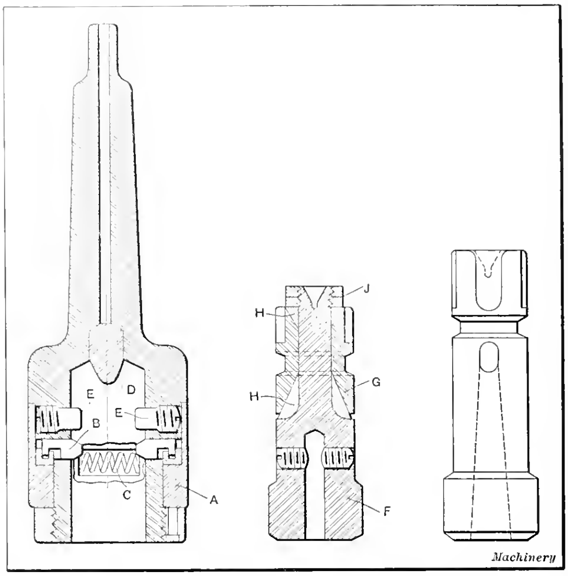


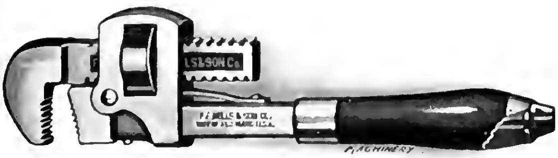
Fig. 3. Cross-sectional View of Chuck and Tapping Collet

Referring to the cross-sectional view shown in Fig. 3, it will be seen that the tapping collet consists of a body *F* and sleeve *G*. Conical fiber frictions *H* are located between the body of the collet and the sleeve, and by adjusting the nuts *J* any desired tension may be obtained. In this way, the frictions will slip in the event of the tap binding, preventing the tool from being broken. The parts of the chuck are held together by means of the adjusting nut at its lower end. It will be seen that this nut is split and fitted with a binding screw which

holds it securely in place. There are no projecting parts on the chuck which can injure the man who is operating it. All studs and other parts subjected to severe strain are of hardened steel in order to provide ample wear. This chuck is the invention of Mr. Oscar F. Bergsten of Worcester, Mass.

F. E. WELLS STILLSON WRENCH

The Stillson pattern pipe wrench illustrated herewith is a recent product of F. E. Wells & Son Co., Greenfield, Mass. This wrench is similar to the familiar style of Stillson wrench, the distinctive feature being that the jaw has been materially

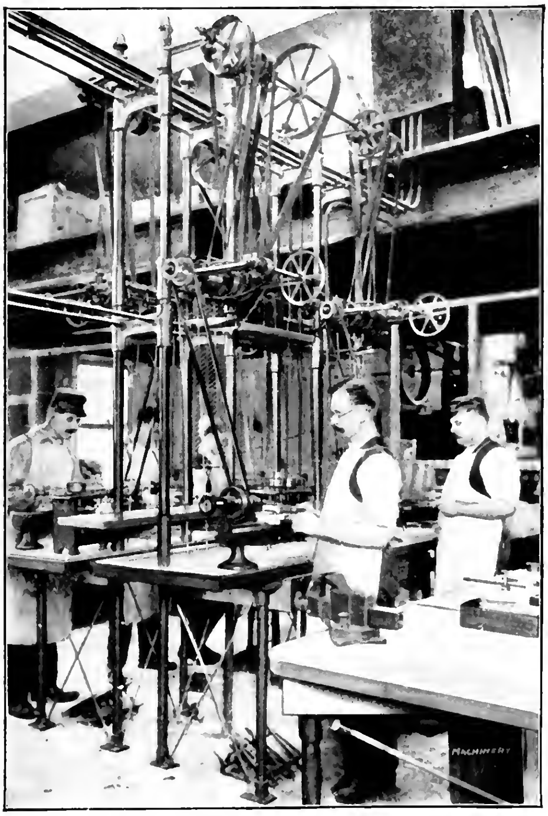


F. E. Wells Stillson Wrench with Heavy Jaw and Double Ferrules on Handle

strengthened at the angle, which is the point where the greatest strain is experienced and where the jaw is most likely to break. It will also be seen that double ferrules are provided on the handle which keep the wood from splitting. These improvements add materially to the durability of the tool.

HARDINGE UNIT SYSTEM OF OVERHEAD WORKS

A unit system of overhead works adapted for use in connection with bench lathes, milling machines and sensitive drill presses, has recently been brought out by Hardinge Bros., Inc., 4201 Ravenswood Ave., Chicago, Ill. This equipment



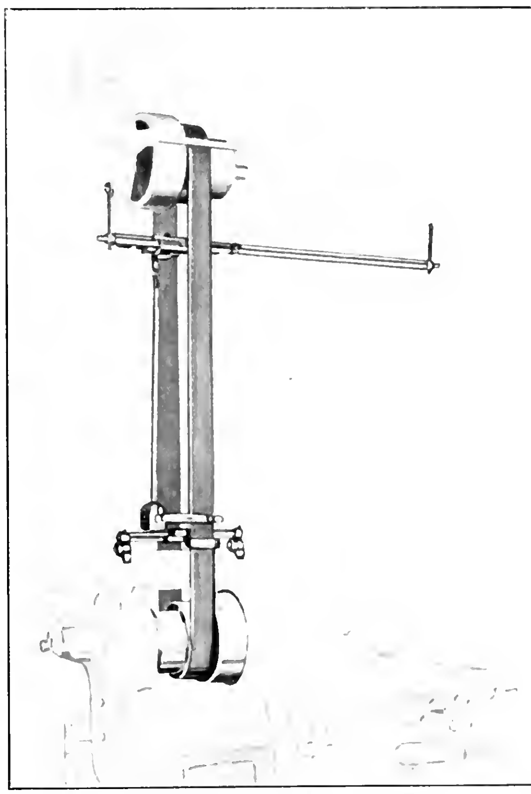
Hardinge System of Unit Overhead Works

differs from the countershaft stand formerly built by this company in that it is not dependent upon the height of the ceiling, the present design constituting a complete unit which occupies a minimum amount of floor space. It will be seen from the illustration that there are four sets of uprights which are made from 1¼-inch iron pipe. Each pair of uprights is held together by means of three yokes which effectually eliminate vibration.

The unit is driven by a one horsepower motor which is mounted on a platform supported by the two middle sets of uprights. This motor has a pulley on each end of its shaft, these pulleys being belted to the main countershafts which drive the machines on the benches at each side of the stand. The countershafts which drive the individual machines on these two benches are driven from the two main countershafts, and adjustment is provided in the individual countershafts for regulating the belt tension. The unit shown in the accompanying illustration has two lathes located on the right-hand bench, while the bench to the left carries one lathe, a drill press and a hand milling machine. Of course the arrangement of units can be modified to meet the requirements of different shops.

LE BLOND MECHANICAL BELT SHIFTER

The R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, is now manufacturing a mechanically operated belt shifter that is particularly adapted for use on milling machines, lathes and other cone-driven machine tools. This device consists of two racks, one of which is mounted on the headstock of the machine and the other on the countershaft. A belt shifter is



LeBlond Mechanical Belt Shifter for Milling Machines, Lathes and other Cone-driven Machine Tools

secured to each rack and in order to shift the belt from one step on the cone pulley to an adjacent step in either direction, it is merely necessary to turn a crank handle through one complete revolution. This crank operates two pinions that are in mesh with the racks, the connection being through bevel gears and a telescopic shaft, the length of which may be adjusted for different heights of ceilings.

The two racks and belt shifters are fixed relatively to each other and one shifter acts one-half revolution of the crank in advance of the other. In this way, one belt shifter throws the belt from one step on the machine cone to the next smaller step by turning the crank through one-half revolution: the other belt shifter then comes into action and the remaining half revolution shifts the belt on the countershaft cone pulley

from one step to the next larger step. If a reduction of speed is desired, the crank is turned in the reverse direction and the steps just referred to will then be reversed. As the crank is always turned through one complete revolution, the operator becomes accustomed to reaching for the handle in the position that it always assumes. The operation of this belt shifting device is such that the belt is automatically locked in position and cannot be shifted except by turning the crank. Stops are also provided in both directions which make it impossible to throw the belt entirely off the cone pulleys. It is stated that belts are longer lived where this shifting device is used because they are held in place and cannot curl up against the edges of the adjacent step of the cone pulley. For this reason, wider belts can also be used on a cone pulley with steps of a given width. It is such a simple matter to shift a belt in this way, that a mechanic will always operate his machine at the proper speed.

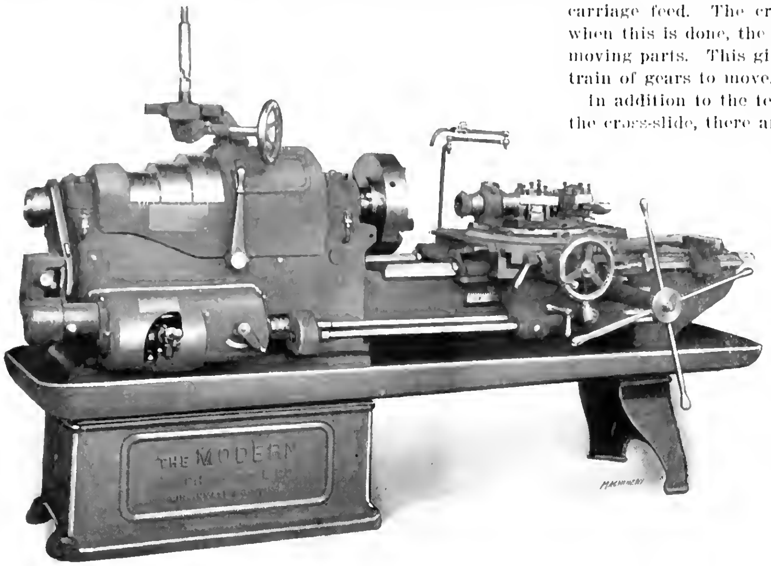


Fig. 1. Modern Flat Turret Lathe equipped with a Cross-slide

"MODERN" FLAT TURRET LATHE

In the July, 1912, number of MACHINERY, the flat turret lathe manufactured by the Modern Machine Tool Co., 4657 to 4659 Spring Grove Ave., Cincinnati, Ohio, was illustrated and described. A new machine has recently been brought out by this company which is built along the same general lines that were followed in the design of the preceding lathe. The important feature of the present machine lies in the provision of a cross-slide upon which the turret is mounted. This cross-slide is provided with ten stops which may be used to locate the turret when moving in either direction, the maximum cross travel being 7 inches. The stops may be used for one tool or in any combination for a series of tools, being engaged by a series of plungers located at the front of the carriage. All of these plungers are operative from any location of the slide. The center position is automatically and positively located by means of a taper locking bolt on the head end of the carriage, which is disengaged when the cross-feed is used. The cross-slide has a bearing surface of 195 square inches on the carriage and is equipped with a long, narrow dovetailed guide to prevent cramping. It has a taper gib which provides for taking up wear and a parallel gib for holding the slide down.

The graduations for obtaining accurate adjustment of the cross-slide are located on the periphery of the handwheel on the cross-feed screw. The cross-slide has independent feed in both directions and the feeds may be engaged while the machine is in operation. The feed is started, stopped or reversed by means of a single lever and is entirely independent of the carriage feed. The cross-feed can be operated by hand and when this is done, the screw and two bevel gears are the only moving parts. This gives an easy action as there is no heavy train of gears to move.

In addition to the ten stops for regulating the movement of the cross-slide, there are twelve independent stops for controlling the longitudinal movement of the carriage. Two of these stops are available for each of the six tools that are carried in the turret. The turret is a circular plate 18 inches in diameter with the lock bolt located close to the edge of the turret. It will be seen from the illustrations that the head and bed of this lathe are cast in one piece to insure the greatest possible rigidity. The bed is supported on a three-point bearing. The head is friction back geared, the gears being located inside the bed under the spindle. The carriage is gibbed to the outer edge of the bed by flat gibs and has a bearing for its entire length on the vees of the bed.

The feed-box provides eight positive geared feeds ranging from 0.005 to 0.085 inch and these feeds are operative in either direction. All gears are made of steel. Referring to the head of the lathe it will be seen that a belt shifter is used which is operated by a handwheel. The design of this shifter is such that one turn of the wheel moves the belt from the center of one step on the pulley to the center of the adjacent step. The principal dimensions of the machine are as follows: Swing over vees, 20 inches; swing over carriage, 16 inches; swing over turret, 6 inches; maximum travel of carriage, 26 inches; maximum travel of cross-slide, 7 inches; diameter of hole in spindle, 2⅜ inches. The speed range provided on this lathe is from 18 to 350 revolutions per minute; the machine occupies a floor space of 4 by 11 feet; and the net weight is 6150 pounds.

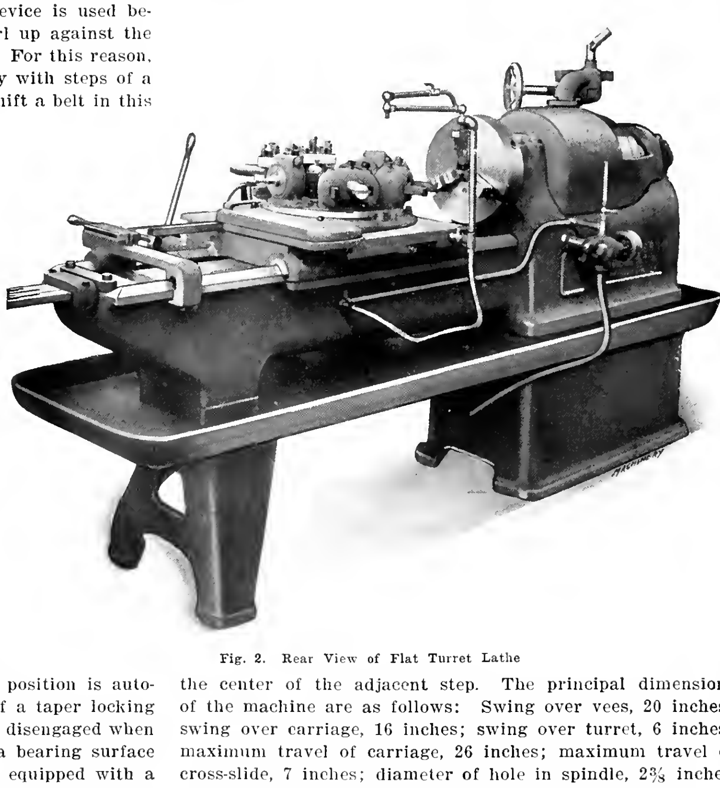


Fig. 2. Rear View of Flat Turret Lathe

HARRINGTON MULTIPLE RADIAL DRILL

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., are now building the multiple radial drill shown in Fig. 1. Five of these machines were recently built for use in drilling boiler plates in locomotive shops, and machines of this type could also be used to advantage on various other classes of work. It will be seen that there are four radial arms mounted on a single cross-rail, and lateral power traverse is provided for these arms by a $7\frac{1}{2}$ horsepower motor which runs at 750 revolutions per minute. This movement is provided in addition to the in and out and radial movements of the arms and spindles. A larger view of one of the drill heads is shown in Fig. 2, from which the design will be more clearly understood.

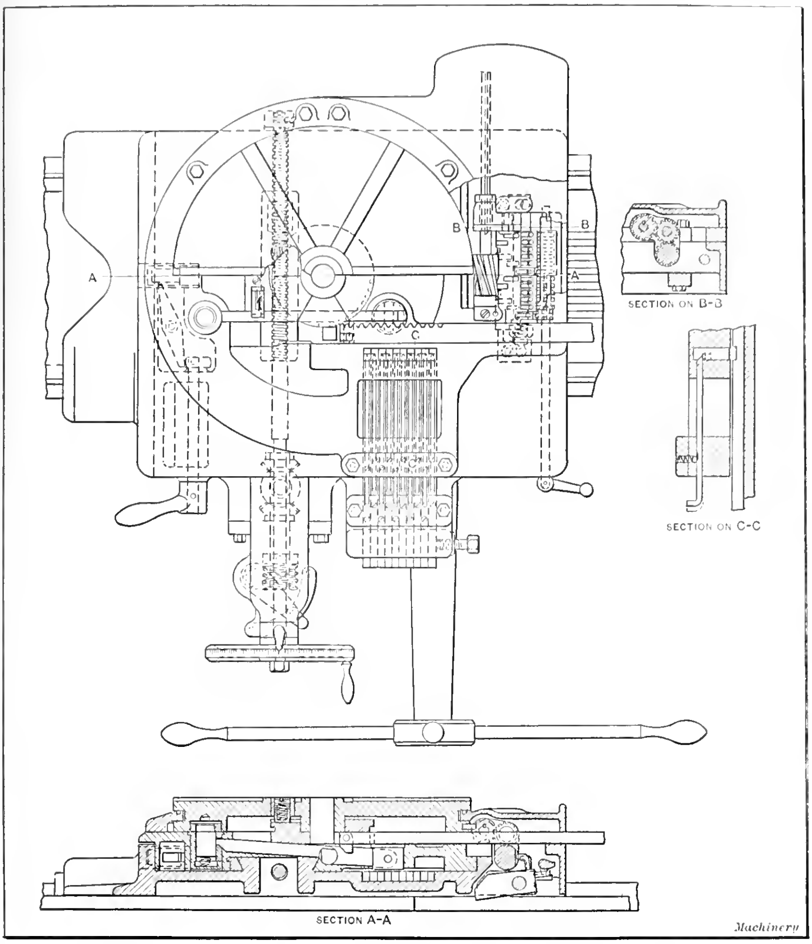


Fig. 3. Longitudinal and Transverse Stop Mechanism of Modern Flat Turret Lathe

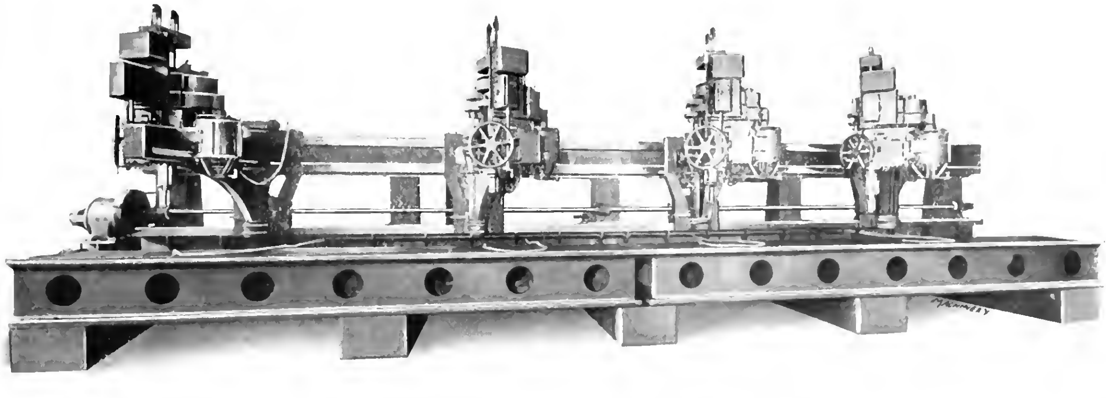


Fig. 1. Harrington Multiple Radial Drill for drilling Boiler Plates

The spindle heads have adjustable steel rollers running on a wide track at the top of the arm, which provides for easy movement of the head by means of the handwheel and worm through which this movement is controlled. The $7\frac{1}{2}$ horsepower variable speed motors which drive the heads are mounted behind the arms, and the controller handles are brought down behind the traverse wheels. The spindles are forged from high-carbon steel and run in large diameter sleeves. Ball bearings are provided to receive the drilling thrust. Three selective feed changes are provided, the feed being driven by gears from the spindle through a safety friction clutch. A positive tooth clutch controlling the feed worm can be operated by hand or by means of an automatic trip. Hand feed is effected by means of a wheel on the worm shaft.

The arms are of heavy box section and are mounted on the saddles by means of roller and ball-thrust trunnion bearings. The binders on the top trunnions are operated by air supplied through hose connections to valves on the spindle heads. The saddles have a long bearing surface on the top rail to prevent tipping and are supported against the lower rail where the drilling thrust is received. The power traverse gearing carried on each saddle permits independent motion in either direction by means of a double clutch located between bevel gears. The motor for driving the traverse operating shaft is located at the left-hand end of the machine at the base. The cross-rails are carried by five box section uprights which are supported by a cast-iron base running parallel with the cross-rail. Five cast-iron sub-bases support both the cross-rail and the table, these bases being located below the floor level. The table is made in two parts which are joined at the center to make one continuous surface. Three T-slots run the full length of the table and a channel is provided which drains the oil back to the tank in the base of the machine. Cutting fluid is supplied by a motor-driven pump which delivers it to each spindle through flexible hose.

The range of the machine can be judged from the follow-

ing dimensions: Shortest distance between spindles with arms straight, 4 feet; greatest distance between spindles with arms straight, 40 feet; vertical traverse of spindles, 15 inches; greatest distance of spindle to table, 28 inches; shortest distance of spindle to table, 13 inches. In and out move-

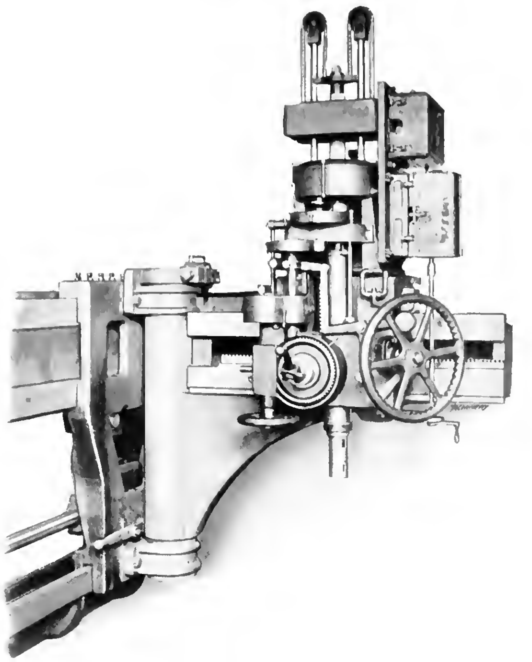


Fig. 2. View of One of the Heads of the Harrington Drill

ment of head on arm, 30 inches; spindle speeds, 75 to 300 R. P. M.; feeds per revolution, 0.005, 0.009 and 0.015 inch per revolution. Size of table, 40 feet by 2 feet 6 inches; floor space occupied by machine, 9 feet 9 inches by 43 feet 4 inches; weight of machine including motors, 85,500 pounds.

FRANKLIN MOORE "IMPERIAL" CHAIN HOIST

A new chain hoist which has just been put on the market by the Franklin Moore Co., Winsted, Conn., incorporates some interesting features in its design and construction, as the accompanying illustrations show. One commendable feature of this hoist is that there are no iron castings interposed between the points where the load is applied and suspended. The "load end of the hoist" comprises three sheet-steel disks which are held together by through bolts and nuts and separated by spacing bushings. The load is carried directly on the casehardened load-shaft passing completely through the three steel plates, and the sprockets on which the chain is held are keyed to it. The load-shaft runs in roller bearings located at each side of the chain sprocket. The roller bearings are held in outer bearings which are both recessed into and riveted to the steel plates. This construction reduces friction to a minimum and at the same time provides a means for keeping the hoist in repair at all times.

The construction of this hoist, referring particularly to the 1-ton size illustrated, and starting at the point where the power is applied at the handwheel by the chain, is as follows: The handwheel shown to the left in Fig. 1, which is an iron casting, is operated by the chain shown, and is fitted to the handwheel shaft, which is provided with a right-hand square thread having a lead of 5/8 inch. This handwheel shaft passes completely through the hoist and is both casehardened and ground. Bearing up against the handwheel is a cast-iron friction gear, these two surfaces being separated by a galvanized iron disk. The opposite side of the friction gear contacts with a leather washer, which is held on a cast-iron friction disk, this being keyed to the handwheel shaft. The large friction gear meshes with a small ratchet gear (the ratio being 4 to 1), which has five internal ratchet teeth in which a casehardened steel pawl drops as soon as the operator releases his pull on the hand-operating chain. This pawl is longer than the diameter of the shaft in which it is fitted (and also the hole in the gear) so that it is impossible for the ratchet gear to slip owing to the pawl not seating properly. It is not spring controlled, but is thrown into lock by the action of the friction gear itself.

The handwheel shaft, as previously mentioned, passes entirely through the three sheet-steel disks, and on its outer end has teeth cut in it to form a pinion. This pinion meshes with two large intermediate gears, one on each side, these, in turn, being keyed onto the extended shoulders of two intermediate pinions. These pinions mesh with the load-gear which is keyed to the load-shaft, the latter also passing through the three sheet-steel plates. The load-shaft which carries the chain sprocket is located in cast-iron bearings on the outer end where no load is taken, and on the inner end is supported by roller bearings, as previously mentioned. The other bearings for both the load and handwheel shafts are made from cast iron and are held in and riveted to the sheet-steel plates so that they can be replaced when worn.

This design of hoist is built in sizes ranging from ½ ton to 20 tons capacity. The sheet-steel plates which form one of the important parts are made from disks varying in thickness from 3/16 to 5/16 inch, depending on the capacity of the hoist. All gears in the power side of the hoist are made of special gear steel, and these are enclosed in a drawn sheet-steel cover, making the entire mechanism dust-proof, increasing the lightness and at the same time making it unbreak-

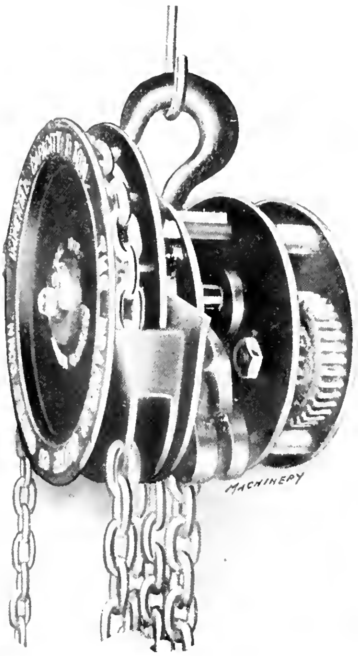


Fig. 1. The Franklin Moore "Imperial" Chain Hoist

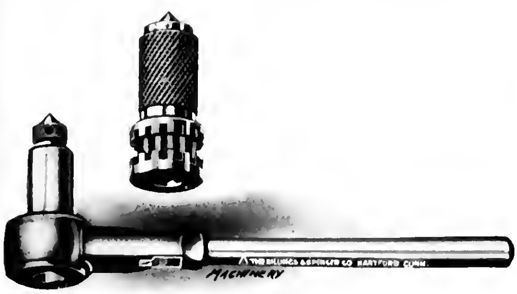
Fig. 2. Hoist under 2000 Pounds Test

able. All gears run in grease, and as they are enclosed in a dust-proof cover need no attention. The chain is guided over the sprocket by rollers providing a free and smooth action.

Another important feature in connection with this hoist is the reversing key which is designed in such a manner that wear on the friction can be easily compensated for. This key has a square hole and fits on the square end of the handwheel shaft. As the frictions wear, the position of this key can be changed by simply removing the nut and turning the key around one-quarter turn.

BILLINGS & SPENCER DOUBLE-ACTING RATCHET

The double-acting ratchet shown in the accompanying illustration is a recent product of the Billings & Spencer Co., Hartford, Conn. This tool is known as the No. 0 size and is intended for light work. The distinctive feature of the design lies in the ability to change the sockets quickly and easily without requiring the use of a wrench or any other tool. This



Billings & Spencer Double Acting Ratchet

ratchet is provided with two removable sockets for handling taper and square shank drills. The taper socket is No. 1 Morse taper and has a capacity for twist drills from 1/16 to 1 9/32 inch. The square socket takes bit-stock, twist drills. The tool is drop-forged and all working parts are hardened.

BROWN HAND-OPERATED CRANE

The Brown Hoisting Machinery Co., Cleveland, Ohio, is now manufacturing the hand-operated traveling crane illustrated in Fig. 1. It will be seen that the cross member of this crane consists of a single I-beam which is supported at both ends by a truck frame of cast steel. The I-beam is of standard size and its lower flange serves as a track for the trolley to run on. The I-beam rests on two planed surfaces at the center of each truck frame, to which it is securely bolted. The truck frame is of light construction; it is so designed that no undue strains are put on any member and the load is equally distributed on the wheels. The simplicity of the construction makes it possible to erect this crane very quickly and it can be used where there is little overhead room.

It will be seen that each truck frame is carried by two wheels and that a bearing is provided on each side of the wheels. These bearings are secured to the frame by means of U-bolts. For cranes of 1/4 to 1 ton capacity, bronze-bushed bearings are used, the bearings being scored to insure efficient lubrication. Larger cranes are equipped with roller bearings of the type shown in Fig. 2, which make the operation of the crane very easy. The provision of a bearing on both sides of the wheel keeps it exactly perpendicular, regardless of any side pressure which may be exerted on the wheel flange; this distributes the wear evenly over the bearings and

Fig. 1. The Brown Hand Operated Crane

insures satisfactory operation. Each crane is equipped with a "squaring shaft" connected to one wheel on each truck. The arrangement of this shaft will be readily understood by referring to Fig. 1 and its use insures a uniform travel of both the truck frames and prevents undue strains on any part of the crane.

Cranes with a capacity of from 1/4 to 1 ton, with spans not exceeding 20 feet, are not provided with a travelling mechanism. Such cranes are propelled by pushing or pulling on the load. Cranes of larger capacity are equipped with a hand

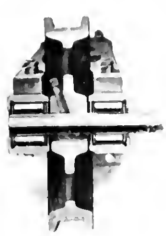


Fig. 2. Roller Bearing

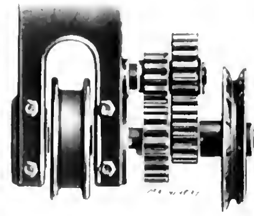


Fig. 3. Traveling Reducing Gears

traveling chain and sprocket wheel which is clearly shown at the left-hand side of Fig. 1. The larger sized cranes are fitted with traveling reducing gears of the type shown in Fig. 3; these gears reduce the amount of pull required on the hand traveling chain to move the crane along the runway. These cranes are equipped with either a plain or geared Brownhoist steel plate trolley and with a Yale & Towne triplex chain block or a Brownhoist electric hoist as desired.

TILTON ENDLESS WOVEN BELTS

The Tilton Mills, Tilton, N. H., are now manufacturing a line of endless woven belts. These belts are suitable for a

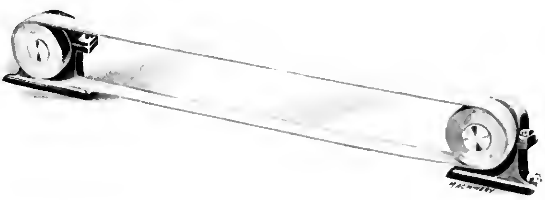


Fig. 1. A Small Size of Tilton Endless Woven Belt

variety of purposes, but the smaller sizes have been found particularly well adapted for driving high-speed machinery,

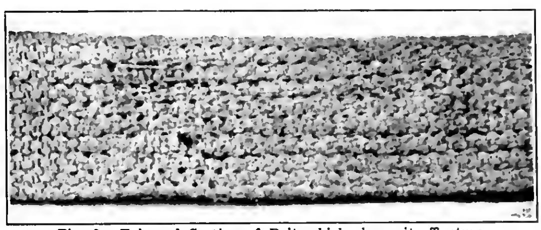


Fig. 2. Enlarged Section of Belt which shows its Texture

owing to the absence of any seams or joints. A case in point is the Rivett internal grinder, upon which the Tilton belts have been used to very good advantage. These machines are driven at angular speeds up to 25,000 revolutions per minute, and operating under such conditions the woven belts give perfectly satisfactory results.

This line of endless woven belts comprises sizes up to 15 feet in circumference by 3 inches width. The belts are made in from 1 to 6 ply and the individual layers of the belt are stitched together. One of the Tilton endless belts is shown in Fig. 1 and an enlarged section of the same belt is illustrated in Fig. 2. A good idea of the texture and way in which the belts are stitched will be gathered from the latter illustration. In conclusion, it may be mentioned that these belts are treated in such a way that they are not in the least affected by moisture or oil.

DAVIS-BOURNONVILLE NO. 2 OXYGRAPH

The Davis-Bournonville Co., 30 Church St., New York City, has added to its line of mechanically guided cutting torches, the No. 2 oxygraph, here shown. This machine is adapted for a variety of cutting operations of the kind usually handled on a vertical slotting machine or horizontal shaper and does the work much faster than a cutting tool. The machine is provided with a substantial bed for holding heavy steel plates or forgings and there is an extension at the rear which supports the pantagraph motion that guides the cutting torches. The double pantagraph frames are made of steel tubing and all joints are provided with ball bearings. A horizontal bar is secured to the pantagraphs at the points opposite their pivots on the vertical supports. The tracing wheel which governs the movement of the torches is attached by a sliding block to any position on this bar according to the pattern or drawing to be followed and the required position of the torches. One or more torches are attached to the bar by similar sliding blocks. The illustrations show the tracing wheel at about the middle of the bar and a torch on each side making duplicate cuts.

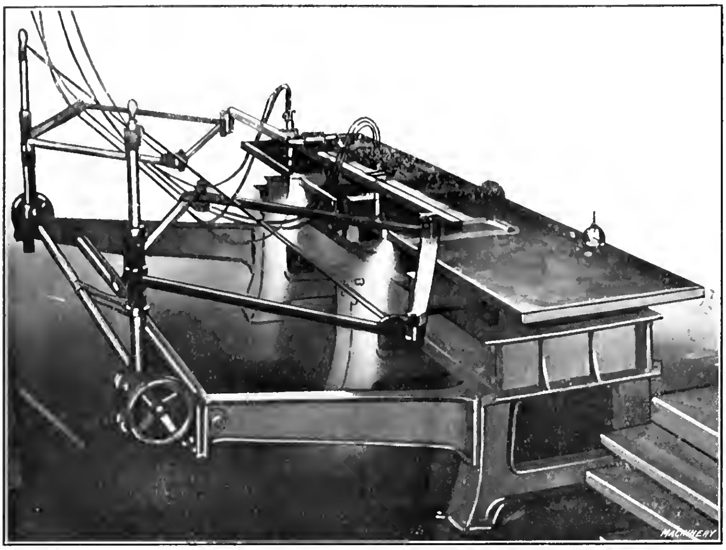


Fig. 1. Davis-Bournonville No. 2 Oxygraph showing Vertical Adjustment for Pantagraph Motion

The tracing wheel is driven by a small electric motor which can be connected to an ordinary lamp socket on either alternating or direct current. This motor is provided with a centrifugal governor for regulating the speed at which the torches move over the work. The drive is taken from the motor by means of a worm on the end of the spindle which meshes with a worm-wheel on a vertical shaft. Another worm at the lower end of this vertical shaft meshes with a worm-wheel on the shaft which carries the tracing wheel. A full size drawing of the cut that is to be made is placed under the tracing wheel; the tracing wheel follows the outline on the drawing and causes the torch or torches to follow a similar path over the work. The most irregular outlines can be easily followed. The speed at which the machine cuts is from 3 to 12 inches per minute, according to the thickness of the work, and in addition to the centrifugal governor on the motor further means of adjustment are provided by three worm-wheels having 95, 50 and 30 teeth, respectively. The motor is supported on a pivot and may be swung around so that the worm is brought into the required position to mesh properly with any one of these wheels.

The torches used are the regular No. 640 two-hose machine cutting torches manufactured by the Davis-Bournonville Co. Vertical adjustment of the torches is obtained by means of a pinion operated by a thumb-screw which meshes with a rack cut in the body of the torch. Referring to Fig. 1, it will be seen that the entire pantagraph motion can also be adjusted vertically by means of a handwheel at each end of the machine. These handwheels operate pinions which mesh with rack teeth cut in the vertical supports, and provide a movement of 12 inches. Any further adjustment that is necessary is then obtained by regulating the height of the torches with the thumb-wheels. The latter adjustment is particularly convenient on certain classes of work where the thickness varies, so that it is necessary to adjust the height of the torch while cutting. During the operation of this machine, witnessed by MACHINERY's representative, a 1-inch plate was cut at the rate of 10 inches per minute. There was a little slag left on the cut surface, but a few taps with a wrench knocked this off and left the surface of the metal perfectly clean.

The torches use oxygen and acetylene on the high pressure positive mixture principle. They have a normal capacity for cutting work up to 6 or 8 inches in thickness. For work over 6 inches thick, oxygen and hydrogen may be advantageously employed. A cut may be made at any point over a surface 42 by 84 inches in size without shifting the torch on the bar. By shifting the torch or by using two torches, the area over which a cut can be made is increased to 42 by 168 inches. Where duplicate work is being done or where two similar cuts are to be made in a single piece the output of the machine is greatly increased by using two torches simultaneously. An example of this kind is shown in the accompanying illustrations where a steel side frame for an electric locomotive is being cut. A convenient feature of this machine in handling heavy work is that the pantagraph motion can be pushed back from the table. This leaves space for the use of a traveling crane.

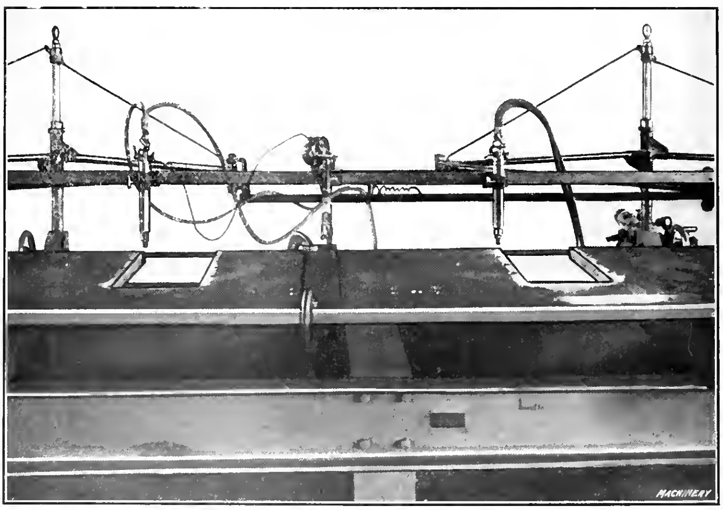


Fig. 2. Front View of No. 2 Oxygraph making a Duplicate Cut

DETRICK & HARVEY DUPLEX FLOOR BORING MACHINE

The Detrick & Harvey Machine Co., Baltimore, Md., has recently brought out a duplex floor boring machine for boring and drilling the frames of heading machinery, and for similar classes of work. Referring to the illustrations, it will be apparent that this machine consists of two horizontal boring machines and a bed plate upon which the work is mounted. One of the boring machines is a standard No. 2 floor boring

machine and the other is a standard No. 0 machine of the same type, the two machines being set at right angles to each other. The runways of each machine are bolted to the bed plate, the size of which may be varied to meet the requirements of individual cases. The illustrations show the bed plate raised from the floor in order to provide for bringing the spindles down close to it. Work can be bored at a single setting; and milling, drilling and tapping operations can be completed on four sides with but one additional chucking.

All of the fast and slow movements of both machines are controlled by levers which are so located that they are conveniently operated from the respective platforms, the arrangement being such that the different movements are non-conflicting. The spindles of the machines are forged from high-carbon steel and are driven from the front or working end. All of the gearing is of steel or bronze and no belts are used.

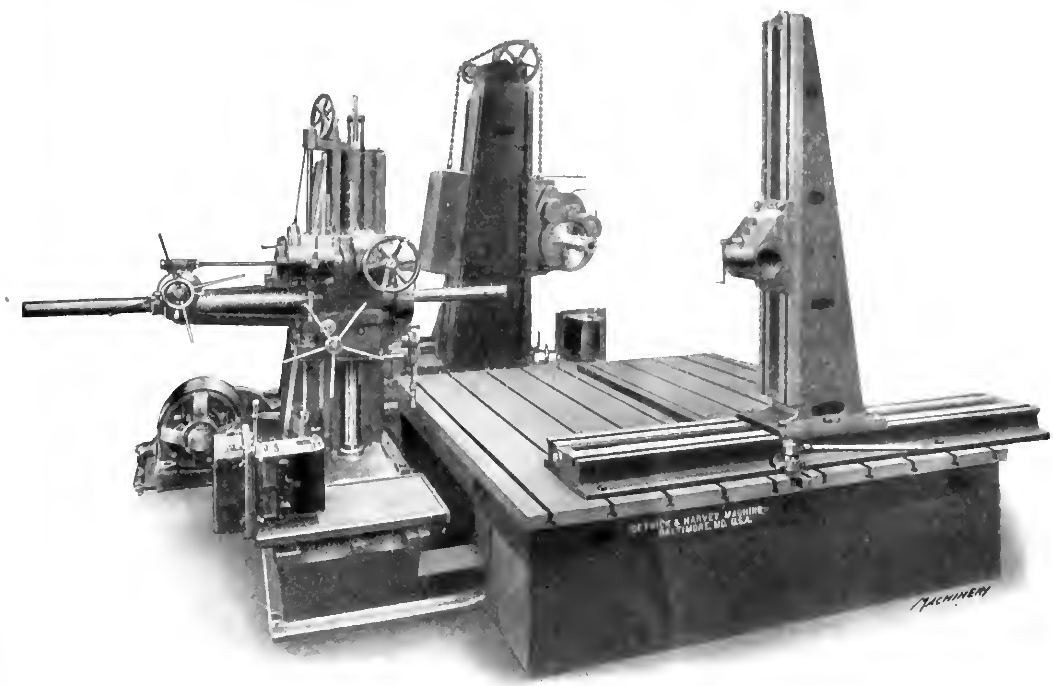


Fig. 1. Front View of Detrick & Harvey Duplex Floor Boring Machine

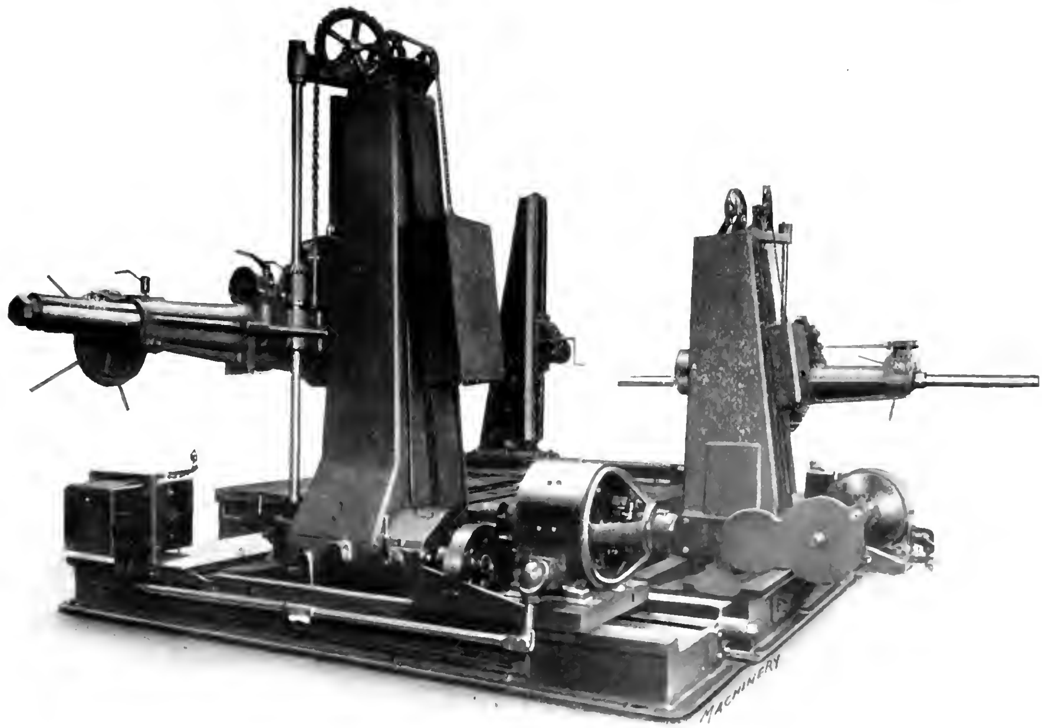


Fig. 2. Rear View showing Arrangement of Motor Drive

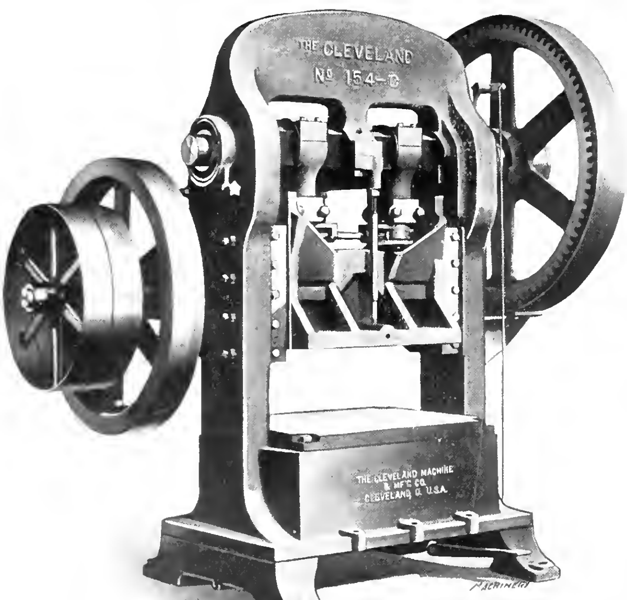
When so desired, the No. 2 machine can be equipped with a large faceplate for attaching facing heads. The total weight of the machine is approximately 37,300 pounds.

The principal dimensions of the No. 2 machine are as follows: Vertical travel of the spindle saddle on the column, 60 inches; continuous feed, 36 inches; spindle diameter, 5 inches. The horizontal travel of the column on the runway and the size of the work bed may be varied to suit different requirements. The machine is equipped with automatic milling feeds, outboard support for the boring bar, and permanent electric wiring for the motor drive. The equipment includes a General Electric ten horsepower variable speed motor for operating on direct current.

The spindle of the No. 0 machine has a travel of 40 inches on the column. The travel of the column on the runway may be varied according to requirements. The spindle is 3½ inches in diameter and has 24 inches continuous feed. The spindle can be brought down to within about 13 inches of the work bed. This machine is also provided with permanent electrical wiring for the 6 horsepower direct-current variable speed motor which forms part of the equipment.

CLEVELAND DOUBLE CRANK PRESS

The double crank-geared power press, illustrated herewith, is one size of a line of presses of this type which have recently been added to the line of the Cleveland Machine & Mfg. Co., Cleveland, Ohio. In designing these machines, particular care was given to the elimination of all weak points. The weak part of the housing, which is around the shaft bearing, has been heavily reinforced; the arch and bed are of extra deep section; and the slide is reinforced to eliminate deflection when using large forming or embossing dies. Knockout rods are attached to the center bearing cap for ejecting formed and drawn parts from the upper die. When so desired, the bed of this press is fitted with a drawing attachment which



Cleveland Double Crank Press

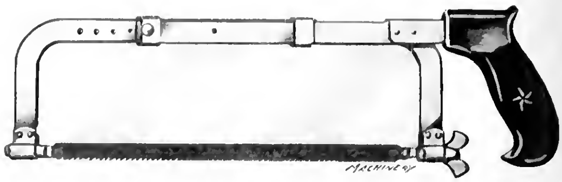
also serves as a knockout device for ejecting work from blanking and forming dies.

These presses are equipped with either a positive clutch or a multiple disk friction clutch, and the clutch may be either automatically or hand operated. The friction clutches are generally used on the larger presses, particularly those that have a long stroke. The gear and pinion are covered with a cast-iron guard. These presses are built in nine sizes and each size is built in several different widths.

MILLERS FALLS HACKSAW FRAME

The tool shown in the accompanying illustration is a recent product of the Millers Falls Co., 28 Warren St., New York City, and is known as their No. 1011 Star hacksaw frame. It will be seen that this saw is provided with a pistol grip, which is very convenient to use, and the frame of the machine is made of a nickel plated steel section 3/16 by 11/16 inch in size. The frame is double at the middle of the back, where the greatest strain comes.

It will also be seen that the blade is tightened by means of a wing nut and stud. This wing-nut is located under the

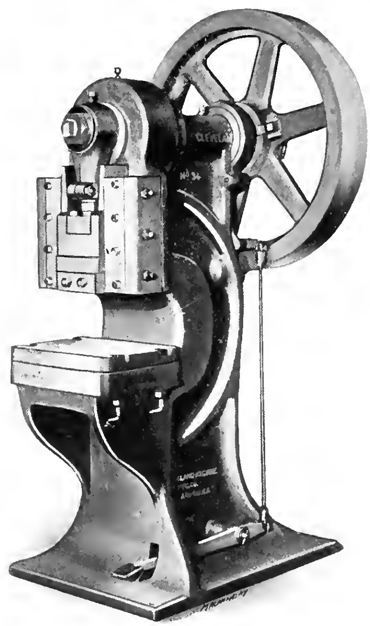


Millers Falls No. 1011 Hacksaw Frame

handle of the saw so that it does not reduce the stroke, as it would do if the nut were located at the opposite end of the frame. The depth of the frame is 3½ inches and it has a capacity for blades from 8 to 12 inches in length. The method by which the adjustment is made will be readily understood from the illustration, where it will be seen that a scale facilitates setting the frame for different lengths of blade.

CLEVELAND POWER PUNCH

The power punching press illustrated in this connection is a recent product of the Cleveland Machine & Mfg. Co., Cleveland, Ohio. The characteristic features of this machine



Cleveland Power Punch

may be briefly outlined as follows: The face of the frame across the gibs is unusually broad to provide for the use of V-gibs; this also makes room for a large area at the base of the slide to support the upper die or punch. The connection is a bronze bushed steel casting and the diameter and length of the pin bearing is larger than where the eccentric adjustment is employed. The adjustment of the slide is also greater than can be conveniently obtained with an eccentric bushing and the design is such that the adjustment will not slip

under the heaviest load. Two clutch points are regularly furnished in the flywheel so that the clutch is engaged every half revolution.

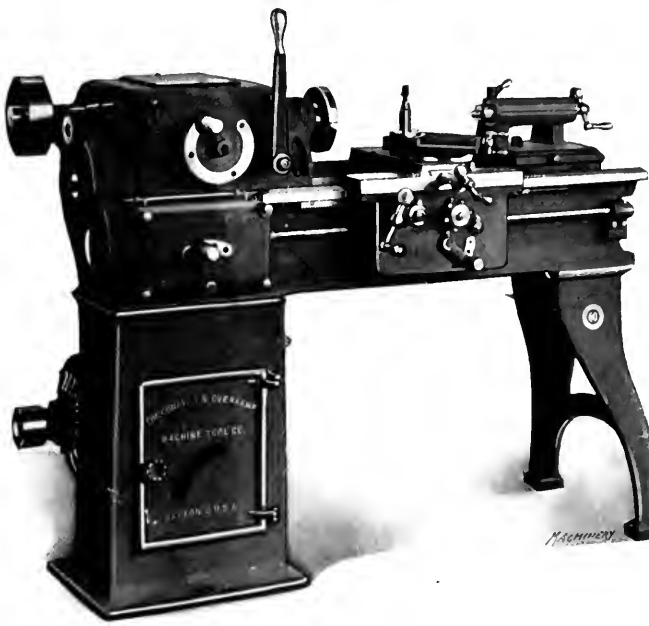
These machines are built in seven sizes, either plain or geared, and are particularly adapted for use in the manufacture of hardware, locks, cutlery, typewriter parts, etc. The principal dimensions are as follows: Bed area, 14 by 20 inches; opening in bed, 9 by 12 inches; distance from bed to slide with the stroke and adjustment up, 9½ inches; stroke of slide, 1½ inch; weight of machine, 5000 pounds.

CONOVER-OVERCAMP HIGH-SPEED LATHE

The Conover & Overkamp Machine Tool Co., Dayton, Ohio, recently built the high-speed geared head lathe shown in the accompanying illustration for use in the Fort Wayne plant of the General Electric Co. It will be seen that the machine is equipped with a single pulley drive and an all-geared head; the machine shown in the illustration is arranged for individual motor drive, although it may be driven from a countershaft with equally good results. There are four geared speed changes. The drive is through a friction clutch located in the headstock, by means of which the lathe may be started, stopped or reversed without paying any attention to the motor.

This machine was designed to operate at 1500 revolutions per minute, which is probably a higher spindle speed than has ever been obtained in an all-geared head lathe. But this is not the limit. During tests to which this lathe was subjected in the Conover & Overkamp shops, the spindle was run at angular speeds up to 3500 revolutions per minute, and at this remarkably high speed, the gears ran without noise. It was also found that the machine could be started, stopped or reversed by means of the friction drive in the head, when running at 3500 revolutions per minute. Lubrication is effected by the splash system, whereby all of the journals in the head and the main spindle bearings are efficiently oiled. Felt wipers are also employed to assist in distributing the oil to the best advantage.

The vertical lever is employed to start, stop or reverse the spindle and the radius plate provides for obtaining either of the four speed changes that may be desired. These changes can be made while the machine is running at its maximum speed. There are also four changes of positive geared feed. The apron is of a standard type. This machine is built for handling small chucking work that may be handled at high speed, as well as for regular turning operations. As previously stated, the particular machine shown in the illustration was built for use in the Fort Wayne plant of the General Electric Co., but the Conover & Overkamp Machine Tool Co. is now building these machines as a regular product.



Conover-Overkamp High-speed Lathe

CORRECTION

An illustrated description of the Nilson four-slide wire forming machine was published in the October issue of MACHINERY. In this article, the statement was made that the cut-off slide of the machine is kept in contact with the lever C by means of a stiff, spiral spring. This statement was made in error. Instead of using a spring, the cut-off slide is kept in contact with the lever C by means of a link fastener at the back of the cut-off slide which connects with the lever.

NEW MACHINERY AND TOOLS NOTES

Machines for Worm Drives: Grant Engineering Co., Detroit, Mich. Two special machines for use in the manufacture of worms and worm-wheels used in automobile transmissions.

Storage Battery Truck: Atlas Car & Mfg. Co., Cleveland, Ohio. A storage battery truck adapted for carrying stock and finished product about in industrial plants. The battery is located in a box at the forward end of the truck.

Three-jaw Air Chuck: Hannifin Mfg. Co., Chicago, Ill. An air operated lathe chuck of the universal type which has independently adjustable jaws. By using a double-acting air cylinder the chuck can be used for both internal and external work. It is made in five sizes ranging from 8 to 18 inches.

Automatic Tube Straightening Machine: Sleeper & Hartley Co., Worcester, Mass. A machine of the swager type for straightening tubing. The work is fed through a rotating die by means of a set of rolls driven by worm-gearing. A second set of rolls grips the work on the opposite side of the die and assists in drawing it through.

Draftsman's Chest: American Drafting Furniture Co., Rochester, N. Y. A chest provided with drawers and compartments of different sizes which are suitable for holding scales, triangles and the different instruments used by draftsmen. The case is covered with leatherette and the fronts of the drawers are of solid mahogany.

Tapping Machine: Peerless Drill Co., Rockford, Ill. A tapping machine of similar design to the 12-inch bench drill which was illustrated in the September issue of MACHINERY. The tapping mechanism is operated by the same lever that controls the feed of the spindle for drilling. The capacity is for holes up to ¾ inch in diameter.

Cold Saw: Newton Machine Tool Works, Inc., Philadelphia, Pa. A cold sawing machine which has a capacity for cutting round stock up to 6½ inches in diameter at one cut. Larger sized bars can be cut by turning them. The machine is adapted for the use of any type of saw blade 22 inches in diameter, although high-speed steel solid or inserted tooth blades are preferable.

Rod-boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A duplex machine designed for boring operations on connecting-rods. It is equipped with two 10 horsepower motors which give direct speeds of 400 to 1200 revolutions per minute. The spindle speeds are 40 to 120 revolutions per minute, and, with the back gears in, from 12 to 36 revolutions per minute.

Vertical Slotting Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. An eccentric-driven slotting machine for heavy forge work which is especially designed for operations on railway frogs and switches. The machine is used for making the angular cuts on the individual parts and for cutting fillets and key slots in the different members. This slotting machine can also be used for taking square cuts on rails.

Hobber and Cutter Grinder: Lees-Bradner Co., Cleveland, Ohio. A machine especially designed for grinding hobs and radially relieved cutters. This grinder has a traversing work slide with a swiveling table mounted on it. The travel of the slide is controlled by a crank handle. Cross adjustment of the wheel is provided at right angles to the movement of the slide.

Cold Saw: Lea Equipment Co., Wyoming and Stenton Aves., Philadelphia, Pa. A cold sawing machine equipped

with sprocket drive. The machine has centralized control and an interesting form of feed mechanism. Machines of this type are built for either belt or motor drive and have a capacity for cutting round stock ranging from 5 to $10\frac{1}{2}$ inches in diameter.

Portable Crane: Canton Foundry & Machine Co., Canton, Ohio. A portable crane adaptable for a variety of purposes in machine shops. The main frame of the crane is of cast iron and stands on a reinforced base. The hook is a drop-forging and the wheels on which the crane runs are mounted in roller bearings. The total height of the crane is 5 feet 8 inches and it is capable of lifting loads up to 3000 pounds through a distance of 4 feet 6 inches.

Hacksaw Machine: W. Robertson Machine & Foundry Co., Buffalo, N. Y. A motor-driven machine designed for cutting steel I-beams, angles and other sections. The machine is equipped with a device for raising the frame on the idle stroke, thereby eliminating the drag on the teeth. A tank is provided underneath the bed, in which the cutting compound is held. The machine is designed to operate at from 90 to 95 strokes per minute.

Machine Vise: Brown Engineering Co., 133-135 N. 3rd St., Reading, Pa. A universal machine vise provided with deep jaws to assure the vertical alignment of the work. The rear jaw swivels so that four different faces can be presented to the work at any angle. Supplementary jaws are arranged to be bolted to the top faces of the vise jaws for holding work of irregular shape. Long pieces of work can also be extended down through the base of the vise through a hole provided for this purpose.

Thread Chasing Attachment: Fitchburg Machine Works, Fitchburg, Mass. A chasing attachment for use on the "Lo-swing" lathe which makes it possible to finish pieces on which threading is to be done at a single setting. The essential parts of the attachment consist of the driving mechanism fastened to the headstock end of either carriage and the chaser which can be mounted at any point on either of the two carriages. The attachment has a capacity for threads up to $1\frac{1}{4}$ inch in length on work from $\frac{5}{8}$ to $3\frac{1}{2}$ inches diameter.

Safety Device: Morgan Construction Co., Worcester, Mass. Two safety devices for use on wire drawing blocks. The first of these devices consists of a safety loop through which the wire passes on its way to the die. A kink or loop—irrespective of whether it has caught the operator or not—catches in this safety loop and stops the machine, thus protecting the operator or machine from injury. Another safety device has been applied which stops the block instantly if the wire breaks, thus preventing the loose end from thrashing around as it would do if the block continued to revolve.

Special Machines for Automobile Work: Grant Engineering Co., Detroit, Mich. These machines were especially designed for machining the spiders for the differential gearing used in automobiles. One machine takes the rough forging, bores the center hole and faces both sides by a single operation. The second machine has two spindles which carry tools for automatically roughing and finishing the arms of the spider. There is also a drilling spindle which drills and centers the end of each arm ready for the grinding operation. The third machine is a duplex grinding machine for finishing the spiders by grinding.

Casehardening Compound: Kasenit Co., 21 State St., New York City. Kasenit is a compound for casehardening malleable iron, cast iron or steel, that has recently been introduced into this country from England. The characteristic properties of this material are the rapidity with which it enables casehardening to be conducted, and the fact that it is non-poisonous. This material is adapted for use in open fires, and it can be used in this way without giving off any injurious fumes. In casehardening with kasenit, a case of ordinary depth can be obtained in a few minutes and a deeper penetration is easily obtained by using this material in the usual method followed for pack-hardening. Under ordinary conditions no special equipment is necessary, as a blacksmith's hearth, a gas jet or a blow pipe work satisfactorily. The work is heated uniformly to a bright red and then dipped or rolled in the kasenit powder, which melts and spreads itself uniformly over the surface. The work is then reheated to a bright red and plunged in clean cold water. This gives the article a uniformly hard surface. If a deeper case is required, the work is reheated a second time before quenching. Three grades of this material are manufactured which are adapted for extra rapid work, for ordinary conditions of casehardening and for pack-hardening.

* * *

An International Exposition will be held in London, in 1914 to celebrate the centenary of peace between the United States and Great Britain, being the anniversary of the signing of the Treaty of Ghent. The executive offices of the Anglo-American Exposition for the United States are in the Woolworth Bldg., New York City.

ERECTING A TOLEDO CRANE

A 50-ton Toledo electric traveling crane was recently installed in the power house of the Omaha Electric Light and Power Co., Omaha, Neb. This crane is equipped with two 25-ton trolleys, and owing to the limited clearance above the rails of the runway, it was necessary to use box section girders of the goose-neck type. When the power plant was originally equipped, a hand-power crane was installed, but the increasing demands made upon this station led to the provision of additional equipment, which was far beyond the capacity of the hand-power crane. For this reason the 50-ton electric traveling crane was ordered from the Toledo Bridge & Crane Co., Toledo, Ohio.

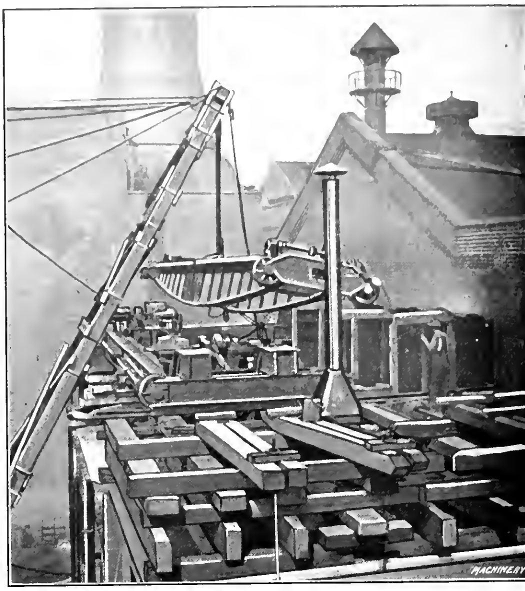


Fig. 1. End View showing New Crane on Temporary Runway

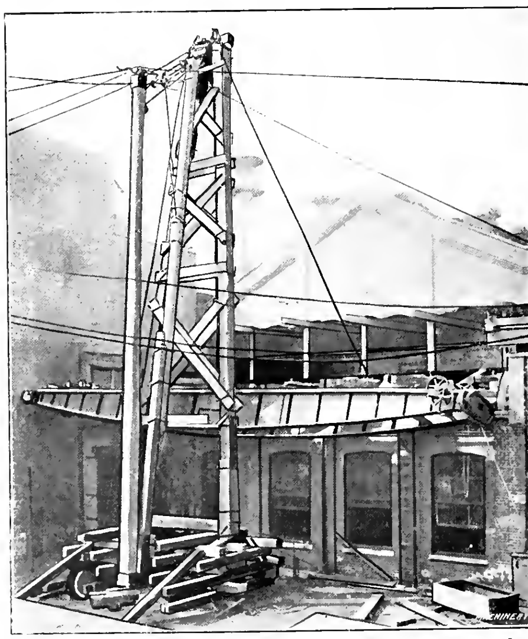


Fig. 2. New Crane inside Building and Old Crane being lowered to the Ground

The removal of the old crane and substitution of the electrically operated crane in its place led to the development of a rather ingenious method. The front end of the building in which the power plant is installed is taken up by the boiler

equipment, and there was no way that the crane could be brought in at the side of the building. This made it necessary to remove a section of the wall at the rear end of the power house in order to remove the old crane and bring in the new one. A temporary extension of the crane runway was built out through this breach and the wall was shored up with posts and jackscrews to support the shoring timbers. The new electric crane was assembled on this temporary runway with the exception of attaching the operator's cage.

After the assembling had been completed, the inside posts supporting the shoring timbers were removed, and the old crane was brought up against the center posts. The inside posts were next replaced, after which the center posts were removed to enable the crane to be passed out. The middle posts were then put back into place and the outer posts removed to allow the crane to move on. The old crane was then lifted out of the way by means of a derrick, after which the new electric crane was moved into the building by reversing the method of procedure followed with the old crane. The operator's cage was then attached, which put the crane into condition for use. The credit for this method of installation is due to Mr. A. C. Anderson, general superintendent of the company.

* * *

SOCIETY OF AUTOMOBILE ENGINEERS

Cycle cars formed the subject of discussion at the meeting of the Metropolitan Section of the Society of Automobile Engineers held in New York City on November 30. The animated discussion concerning the advisability of introducing cycle cars in this country shows that the subject is one that is attracting considerable interest in automobile circles. The argument was advanced that the motorcycle, on one hand, and the cheap automobile, on the other, covered the need for a motor-driven vehicle in a way which left no room for the successful introduction of an intermediate type.

The cycle car was developed in Great Britain to take advantage of the low vehicle tax made possible by coming within certain limits of weight and piston displacement. There has been a great variety in the design of these little cars, but their distinctive features are that they have a narrow tread, light weight and are provided with wheels having wire spokes. The original cycle cars were of very simple construction, but the tendency has been to continually add to their equipment until the most approved designs now have most of the facilities of a modern automobile. Cycle cars are built with either three or four wheels—although modern practice is strongly in favor of four-wheel vehicles.

Experience seems to show that the cycle car is unsuited for rough roads owing to its narrow tread and the inability of a four-wheel vehicle to pick its path as a motorcycle can. This forms one of the strongest arguments against the cycle car, the claim being made that it is unsuited for use on American roads, which are decidedly inferior to those of Great Britain. Furthermore, the claim is advanced that a satisfactory form of cycle car cannot be built for less than $500 and that at such a price it has nothing to commend it as compared with the Ford runabout.

The arguments in favor of the cycle car are that it is much cheaper to operate, it being possible to run a cycle car from 40 to 50 miles on a gallon of gasoline. The cycle car is also cheaper to garage, and as it accelerates more rapidly than an automobile it can move faster through conjested districts where it is necessary to stop at frequent intervals.

Taking the opinion expressed at the meeting the Metropolitan Section as representative, it appears that if there is a field for the cycle car in America, it is limited to cities and suburbs where the presence of good roads is assured. It also appears that a cycle car must have most of the facilities of an automobile in order to give satisfactory service. This means that there is little difference in price between a cycle car and a cheap automobile, the advantage of the cycle car lying in the possibility of reducing the cost of operation. One speaker stated that the appearance of a cycle car should be that of a modern automobile viewed through the wrong end of a telescope.

DETERMINING THE RATE OF PRODUCTION

BY C. W. HINMAN*

A most deceiving arithmetical problem, in shop and factory, is to find correctly how many pieces are actually being finished per hour, when the rate per hour is known for several machining operations on the same piece. As a simple illustration, suppose a piece is being milled at the rate of 125 pieces per hour and is then drilled at the rate of 280 pieces per hour. What is the completed output per hour?

One generally finds that the finished output per hour is really considerably less than what he had supposed, and there lies a mistaken idea whereby some firms actually lose money when figuring on a job.

125 pieces per hour is 1 piece in $\frac{1}{125}$ of an hour, and 280 pieces per hour is 1 piece in $\frac{1}{280}$ of an hour. Adding the fractions and reducing to the lowest terms we have, 1 piece, finished complete, in $\frac{81}{7000}$ of an hour. Then, in one hour, as many pieces can be finished complete as $\frac{81}{7000}$ are contained in 1 or $\frac{7000}{81}$ times = 86.4 pieces. From this we deduce the following formula in which X = one rate per hour and Y = the other rate per hour.

$$\text{Complete finished output per hour} = \frac{XY}{X+Y}$$

Rule.—The *product* of the two rates per hour divided by the *sum* of the two rates per hour, is the complete output per hour. This is a very easy rule to remember. Also, in general, when any number of rates per hour are known, on one piece, use the same rule, treating the operations in pairs, until the final operation is performed.

* Address: 7046 Vernon Ave., Chicago, Ill.

* * *

DECEMBER MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Bldg., New York City, December 2-5. Papers will be presented on boilers and their operation; cement; enameling; fire protection, with special reference to turbo-generators, oils and the novel use of sprinkler systems; gas measurement; gas power engineering; lineshaft bearings; machine tools; management; properties of steam; rope drive; steel railway cars; textiles, covering mill engineering; and vacuum cleaning. The Grashof medal will be presented to George Westinghouse, past president and honorary member. The medal was conferred upon Mr. Westinghouse by the Verein deutscher Ingenieure at Leipzig on the occasion of the joint meeting of the two societies there last June. Excursions to many manufacturing plants and places of interest in and near New York City have been arranged for. The customary reunion will take the form of a German dinner to be held at the Deutscher Liederkranz, Thursday evening, December 4.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Business Managers: Alex. Luchars, Pres't. and Treas.	" " " "
M. J. O'Neill, Sec'y and Gen. Mgr.	" " " "
Publisher, The Industrial Press	" " " "
Owners of one per cent or more of the stock:	
Alexander Luchars	" " " "
Matthew J. O'Neill	" " " "
Fred E. Rogers	" " " "
Louis Pelletier	" " " "
Erik Oberg	" " " "

There are no bondholders, mortgagees, or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 12th day of September, 1913.

HARRY B. HEALEY,
Notary Public No. 78, Kings County.

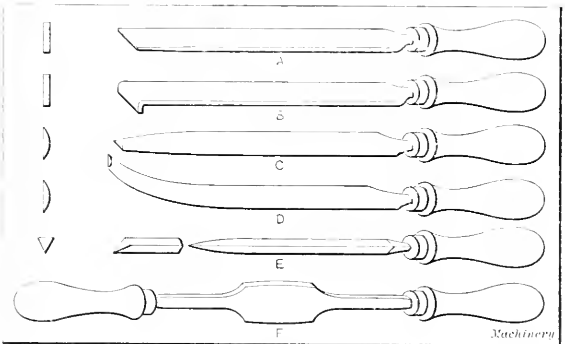
Certificate filed in New York County No. 49.
Register's Office New York County, No. 1171

(SEAL) (My commission expires March 30, 1914.)

SCRAPERS AND HAND SCRAPING

When correcting errors on flat or curved surfaces by hand scraping, it is desirable, of course, to obtain an evenly spotted bearing with as little scraping as possible. When the part to be scraped is first applied to the surface-plate, or to a journal in the case of a bearing, three or four "high" spots may be indicated by the marking material. The time required to reduce these high spots and obtain a bearing that is distributed over the entire surface depends largely upon the way the scraping is started. If the first bearing marks indicate a decided rise in the surface, much time can be saved by scraping larger areas than are covered by the bearing marks; this is especially true of large shaft and engine bearings, etc. An experienced workman will not only remove the heavy marks, but also reduce a larger area; then, when the bearing is tested again, the marks will generally be distributed somewhat. If the heavy marks which usually appear at first are simply removed by light scraping, these "point bearings" are gradually enlarged, but a much longer time will be required to distribute them.

The number of times the bearing must be applied to the journal for testing is important, especially when the box or bearing is large and not easily handled. The time required to distribute the bearing marks evenly depends largely upon one's judgment in "reading" these marks. In the early stages of the scraping operation, the marks should be used partly as a guide for showing the high areas, and instead of merely scraping the marked spot the surface surrounding it should also be reduced, unless it is evident that the unevenness is local. The idea should be to obtain first a few large but generally distributed marks; then an evenly and finely spotted surface can be produced quite easily.



Different Forms of Scrapers commonly used

The proper distribution of the bearing marks on the finished surface depends somewhat on the class of work. For flat surfaces which must be very accurate, all the marks should be approximately the same size and evenly distributed. In locomotive work, the bearing marks on driving-wheel boxes should indicate a heavier bearing in the "crown," or top of the box, than on the sides. Split bearing boxes such as are used for engine connecting-rods, should also be scraped in this way. If the heaviest bearing were left at the sides, a slight heating of the journal would be more likely to greatly increase the friction and cause excessive heating.

In the accompanying illustration, the different forms of scrapers commonly used are shown. The flat scraper *A* is almost invariably used for plane surfaces. For ordinary purposes, the scraper blade is about 3/16 inch thick, 1 to 1¼ inch wide and is drawn out at the point to a thickness of about 1/16 inch. The cutting end is made as hard as possible and is rounded slightly, in grinding, so that the outer corners will not score the surface being scraped. The grinding should be done, preferably, on a wet grindstone, the edge being finished with an oilstone. The hook scraper *B* is also used on flat surfaces. It is preferred by some workmen for obtaining a fine, smooth surface and can be used, occasionally, in narrow spaces where there would not be room enough for a straight, flat scraper. Straight and curved scrapers of the "half-round" type are shown at *C* and *D*. These are used for scraping bearings, etc., the sides forming the cutting edges. The curved type *D* is more convenient to use on large half-bearings, as it is held at an angle and the scraping is done by the curved edge. The "three-cornered" or "three-square" scraper shown at *E* is also used to some extent on curved surfaces. When the end is beveled, as shown in the detail view to the left, this form of scraper is convenient for producing sharp corners or for "relieving" them slightly.

The two-handled scraper shown at *F* is an excellent form for scraping bearing boxes and all curved surfaces which are so located that this type can be used. This style of scraper does not seem to be in general use, although it is much superior to the forms shown at *C* and *D*, especially for large work. The straight or curved half-round type works very well on soft bearing metals such as babbitt metal, but on brass or bronze it cuts slowly and, as soon as the edge is slightly dulled, considerable downward pressure is necessary. The type *F* requires very much less effort on the part of the workman, and it will cut rapidly. As there are two handles instead of a single handle at one end, the blade can be pressed against the work with little exertion. This form of scraper is largely used in railroad shops, for the heavy scraping required on driving-wheel boxes and in fitting the large connecting-rod brasses now in use. The sides are sometimes ground slightly concave to give the cutting edges "rake," by holding them against the face of the grinding wheel.

The marking material commonly used in connection with scraping operations is composed of a mixture of red lead or Venetian red and oil. The Venetian red is finer than the red lead, and is preferable for accurate work. It is important to keep the marking material in a covered box in order to exclude all grit or chips.

The scrapers used in the U. S. Navy for fitting bearings, etc., are made in sets of four. The Navy specifications are as follows:

One half-round, 10 inches long, 1 inch wide, with two cutting edges. One "mill" 8 inches long, 0.8 inch wide and 0.135 inch thick, with two ends and four side cutting edges. One "three-square," 8 inches long, ⅝ inch width of triangular side, with three cutting edges. One "three-square," 6 inches long, ½ inch width of triangular side, with three cutting edges. These scrapers are made from uncut file blanks, the terms "half-round," "mill," etc., corresponding to the shapes used for files.

F. D. J.

* * *

CONVENTION OF THE NATIONAL FOUNDERS' ASSOCIATION

The seventeenth annual convention of the National Founders' Association was held in the Hotel Astor, New York City, November 19-20. The former president, O. P. Briggs voluntarily retired and was succeeded by W. H. Barr of the Lumen Bearing Co. Otto H. Falk was elected vice-president, and J. M. Taylor, secretary. During the convention a number of interesting papers were presented, dealing more particularly with labor troubles, the prevention of accidents and workmen's compensation. A list of the different papers follows: "Union Lawlessness," by George F. Monaghan, general attorney for the National Founders' Association; "Erie Strike," by Thomas E. Durban, Erie City Iron Works; "Birmingham Strike," by W. D. Tynes, Hardie-Tynes Manufacturing Co.; "Anxiety Caused by Practical Business Problems—Publicity a Possible Solution," by Henry M. Leland, Cadillac Motor Car Co.; report of the committee on safety and sanitation; "A Review of the Work for the Past Year and What the Committee Proposes for the Coming Year," by M. W. Alexander, chairman; "Workmen's Compensation—How the Different State Laws have operated," by Staunton B. Peck, Link-Belt Co.; C. H. Gifford, American Blower Co., and H. P. MacDonald, Snead & Co. Iron Works.

* * *

Many a man will expound to his wife the doctrine that good things never come cheap, and then he will hunt all over the country for the lowest-priced tool he can find for his shop.

COATING STEEL AND IRON WITH GLASS

A paper on the art of enameling or coating steel and iron with glass will be presented by Raymond F. Nailler, of Elyria, at the December meeting of the American Society of Mechanical Engineers. Mr. Nailler briefly traces the history of the art of enameling from early times. Enamels are used for artistic or decorative purposes and for sanitary reasons. The most familiar class of enamel work is cooking utensils, these being of the so-called agate or granite ware class. The second class is enamel signs and a third class is large tanks, kettles, evaporators, pipes, etc., used in the preparation of food stuffs. The first step in enameling metals is the preparation of the enamel. This must be done very carefully as purity of the raw material of the enamel is absolutely necessary. Three general methods are employed in applying the enamel to metallic surfaces. The first, applicable to small pieces only, is known as dipping, the piece being dipped into the enamel and the excess shaken off leaving a thin coating. The second method, known as slushing, consists of pouring the prepared enamel over the surface and allowing it to drain. The third method and principal one used on large pieces consists of spraying the finely ground enamel onto the metal surface by means of a compressed air atomizer. The pieces are fired in furnaces of various designs. The temperature required varies with the nature of the enamel and in cases of high silicon acid-proof enamels reaches as high as 2500 degrees F. The chemistry of enameling is somewhat complex and not altogether fully understood. Production of first-class white enamel either for cast iron or sheet metal depends at present, on the use of tin oxide. Efforts have been made to substitute less expensive substances but with indifferent success. In the preparation of foods in factories there is a constantly increasing demand for larger pieces of enameled steel apparatus in the form of pans, kettles, tanks, pipes, etc. Enamels for these purposes should be acid-proof.

* * *

THE PRICE OF MONOPOLY

Some figures published by the *English Mechanic and World of Science*, relating to coal prices in England, provide food for the thoughtful mind. These figures give an idea of the price that the community and its industries must pay to monopoly, and show that the increased cost of living is not entirely due to increased wages, as has been claimed by many. When the miners' dispute in Great Britain was settled about a year and a half ago, the Mining Association decided to advance the price of coal sixty cents a ton. This was done in the face of the fact publicly declared by Sir Arthur Markham, who held a large interest in mining properties, that the granting of all the miners' demands did not increase the cost of mining more than eight cents a ton. It may be interesting to note in this connection that the British papers recently told of one mining company in South Wales paying a sixty per cent dividend, as was also done by another company in Durham, England. Of course, there is no need of going to England to meet with this condition, except for the fact that it is, as rule, more difficult to obtain accurate facts about the doings of large monopoly interests in this country than abroad. Exact figures, such as here quoted, are not easily obtained, although both manufacturers and individual consumers of any product under monopoly control, are well aware of the same conditions. It is a well-known fact that in this country also, an increase in the wages of the coal miners of a few cents a ton has caused a permanent increase of twenty-five or fifty cents a ton to the consumer. We do not believe that conditions of this kind are in the interest of the manufacturers of this country any more than they are in the interest of the smaller consumers of monopolized products; nor are such conditions necessary.

* * *

It has been found by experiments that the difference in power that can be transmitted by the same belt in damp and dry weather may vary as much as 50 per cent especially if the drive is a vertical one; that is, if in general, the pulleys are placed in an unfavorable position.

CUTTING METAL UNDER WATER

A German engineer, Herr A. Heckt, has designed a burner, according to the *Scientific American*, which makes it possible to use the hydrogen-oxygen flame for cutting metals under water. The burner consists of a bell-shaped head which is screwed onto an ordinary burner and which allows the flame to continue to burn below the water in a supply of compressed air. This process has been so improved of late that the cutting of metals under water is claimed to be effected almost as quickly as above the surface. At tests recently made with the new apparatus at the harbor of Kiel, before prominent engineers and representatives of the German government, a diver went down into the sea to a depth of about 16 feet, and, after boring a hole into an iron bar $2\frac{1}{2}$ inches square, cut off the bar in about thirty seconds. An iron sheet $\frac{3}{4}$ inch thick was drilled through and cut for a distance of one foot in ninety seconds.

* * *

PERSONALS

M. G. Doll has been made general sales manager of the Bury Compressor Co., Erie, Pa.

Robert J. Anderson, vice-president of James Anderson & Sons, makers of "Conus" oil cups, Sidney, Ohio, sailed on the *Amerika*, November 22 for a business trip to Sweden.

G. F. Collister, for three years assistant to the general superintendent of the Cleveland Twist Drill Co., Cleveland, Ohio, has taken charge of the tool steel department of the Betz-Pierce Co., of Cleveland.

Heinrich J. Freyn, formerly consulting engineer of the gas engine department of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., recently joined the H. Koppers Co., of Chicago in the capacity of third vice-president.

W. M. Corse, works manager of the Lumen Bearing Co., Buffalo, N. Y., has resigned to become general manager of the Empire Smelting Co., Depew, N. Y., on January 1, 1914. H. P. Farrock, sales manager, will assume Mr. Corse's duties as superintendent, combining the two offices.

R. G. Williams, who read a paper "Safety Devices used in connection with Grinding Wheels" before the New Haven meeting of the A. S. M. E., November 21, has been promoted from the position of assistant research engineer of the Norton Co., to the position of safety engineer.

James H. Herron has tendered his resignation as general manager of the National Machine Tool Builders' Association to take effect January 1, 1914. Charles E. Hildreth, well known to the members of the association for his able secretarial work in past years, has been appointed to the position.

Charles E. Thwing, formerly sales manager of the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., and prior to that connection treasurer of the Draper Machine Tool Co., of Worcester, has started in business for himself as a manufacturer of engine lathes under the name of the Worcester Lathe Co. For the present, the lathes will be made by the Whitcomb-Blaisdell Machine Tool Co.

S. H. Reck, secretary and treasurer of the Rockford Drilling Machine Co., Rockford, Ill., manufacturer of upright drills, gang drills and lathes, has sold his interest in the business to William Nelson, president, who now becomes sole owner. Mr. Reck expects to make his home in Cincinnati, Ohio, where he will engage in business, the nature of which has not yet been determined.

K. R. Odman of Stockholm, Sweden, is at present in the United States as special representative of *Svenska Teknologföreningen* (Society of Swedish engineers) to arrange for a delegation of the society to take part in the International Engineering Congress to be held in San Francisco, 1915. In addition, Mr. Odman is endeavoring to arrange for a convention between the Swedish engineers who will visit this country in 1915, and the great body of engineers of Swedish birth who permanently live in this country.

* * *

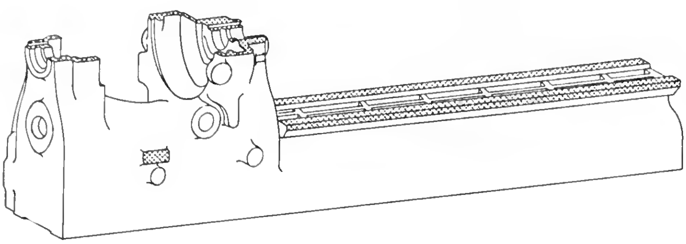
OBITUARIES

E. C. Dove, a well-known manufacturing machinist lately connected with the Lima Locomotive Corporation, Lima, Ohio, in an official capacity, died in Lima after a week's illness.

John D. Jones, died suddenly while at work November 15, aged seventy-four years. He established the old Anderson Mfg. Co., now known as the National Machinery Co., of Tiffin, some years ago.

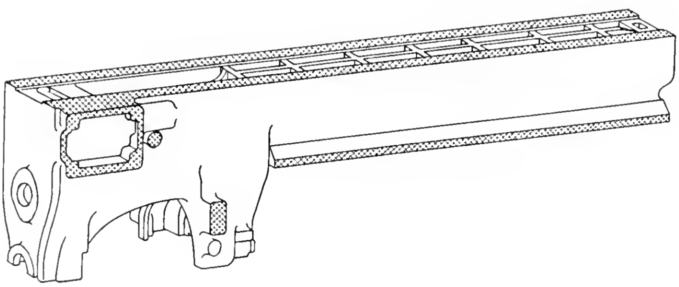
Ashmead Gray Rodgers, for twelve years superintendent of the Carborundum Co.'s plant at Niagara Falls, N. Y., died October 23 as the result of injuries sustained through an

We Saved Four and One-Half Hours On Each of These Castings



This demonstrates the superiority of the milling machine for this class of work.

Are there not jobs in your shop on which an equal saving could be made?



These castings are Screw Machine Beds. Twelve different settings are required in milling them, but the facility of making the settings and the advantages of gang milling and fast operation enable a substantial saving in time to be made. A bed is first inverted and clamped in a fixture. The bottom is milled, the bed turned over and clamped directly to the table of the machine, when the top is finished. The remaining surfaces at the sides are finished with a face mill. A gang of cutters is used for milling the ways of the bed, so that once these cutters are accurately set the ways milled are exact duplicates in width and distance between. Work similar to these castings is common to nearly all manufacturing shops, as, for example, machine beds or tables, bases or frames of engines, pumps and compressors, crank cases or similar parts. No doubt if you look around your shop, you will find at least a few examples of this class of work.

Send us blue prints of any such work and let us aid you in securing maximum production.

READ PAGE 69

automobile accident October 5. Mr. Rodgers had many friends and acquaintances throughout the mechanical and chemical world who will sincerely feel the loss of a man of his pleasing personality, democratic ways and general capabilities in his chosen line of work. Mr. Rodgers was born in Albany, N. Y., in 1872. Prior to his connection with the Carborundum Co., as superintendent, he was superintendent of the Eddy Electric Co., Hartford, Conn. He was a member of the American Chemical Society, Engineers' Society of New York, Chemists' Club, Niagara Club, University Club, Country Club of Niagara Falls and several other scientific and social organizations.

Everete F. Morse of the Morse Chain Co., Ithaca, N. Y., died at his home in Ithaca, November 11, aged fifty-six years. When Mr. Morse was only sixteen years old he patented an improvement on the horse-drawn hay-rake and made good use of the earnings of his first invention to supplement other efforts to give him an education. He attended Cornell University in 1875 and after being out for several years, graduated with the class of 1884 as a mechanical engineer. After spending some time at Algona, Iowa, where he was manager of a flax mill, he returned to New York State and settled at Trumansburg. Here in 1893 he patented the Morse rocker-joint bicycle chain and in conjunction with his brother, Frank L. Morse, founded the Morse Chain Co., and began the manufacture of bicycle chain. The novel mechanical principle embodied in this chain and its high efficiency attracted immediate attention and eventually secured for the company a profitable business which lasted until the phenomenal slump in the bicycle trade about 1897. Meantime, his brother, F. L. Morse, who has been the active manager of the Morse Chain Co. for the past thirteen years, developed the present type of silent chain for power purposes, and in 1906 built the new plant where the business has grown from small beginnings to its present proportions. At the time of his death, E. F. Morse was a director and secretary of the Morse Chain Co., but for some years past he had devoted himself very largely to his heat gage interests and to various public duties in which he was most active and efficient. The Morse thermo gage invented by Mr. Morse and patented about 1900 is an ingenious device for the measurement of high temperatures, especially of steel and other metals. This invention won him much distinction at home and abroad, having been adopted by the United States and the German bureaus of standardization. In recognition of the high mechanical merit of the rocker-joint chain and thermo gage, Mr. Morse was awarded medals by the Franklin Institute of Philadelphia.

COMING EVENTS

December 2-5—Annual meeting of the American Society of Mechanical Engineers. Headquarters, Engineers Bldg., 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their sub-divisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty-one museums of safety in Europe, and all these will contribute to the American Exposition.

December 29-31—Seventh Annual Convention of the American Society of Agricultural Engineers, Chicago, Ill. Great Northern Hotel, headquarters. I. W. Dickerson, secretary, Urbana, Ill.

May 1-October 31 (1914)—Anglo-American Exposition, London, England to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

Worcester Boys Trade School, Worcester, Mass., has begun the publication of a small weekly named "Occasional Suggestions." The object of this little publication is to present the principles underlying the methods of the school. The first number contains very readable essays in mathematics by E. P. Neal and C. B. Price.

International Correspondence Schools, Scranton, Pa. Catalogue of the International Library of Technology, listing reference libraries of the following subjects: advertising, architecture, automobiles, business, chemistry, civil engineering, commercial law, concrete engineering, designing and illustrating, electrical engineering, electrotherapeutics, locomotive engineering, mechanical engineering, mechanical drawing, mining and metallurgy, navigation, poultry, refrigeration, salesmanship, sanitary engineering, shop practice, structural engineering, telegraph and telephone engineering, textiles. The catalogue gives tables of contents of each volume of 113 volumes covering the leading trades, professions and industrial sciences and containing about 55,000 pages. The volumes are six by nine inches, averaging 525 pages and 243 illustrations each. The books on any subject can be highly recommended to those in need of the information they contain.

National Association of Purchasing Agents was organized at the Hotel McAlpin, New York City, October 16. H. T. Leeming of Thomas A. Edison, Inc., was elected temporary chairman and Elwood B. Hendricks, the organizer, temporary secretary and treasurer. Mr. Hendricks is the son of S. E. Hendricks, president of the Hendricks-Sullivan Corporation, publishers of Hendricks' Commercial Register. The temporary headquarters of the association is at the Hotel McAlpin. The association will be devoted entirely to the interests of purchasing agents and buyers and will have sub-associations in all sections of the country. Some of the objects are: (1) The formation of the purchasing agents and buyers into a national body; (2) Mutual acquaintanceship and the resulting privilege of exchanging ideas and opinions; (3) The standardization of purchasing routine and methods; (4) The investigation and certification of new appliances and materials; (5) The improving of existing methods for the diffusion of market information; (6) The gathering and dissemination of data relating to the subject of buying; (7) The standardization of specifications. All communications should be addressed to E. B. Hendricks, P. O. box 1106, New York City.

NEW BOOKS AND PAMPHLETS

Pyrometer Testing and Heat Measurements. 19 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 7.

Permissible Explosives. By Clarence Hall. 11 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 52.

Portable Electric Mine Lamps. By H. H. Clark. 13 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 47.

Commercial and Agricultural Organizations of the United States. 125 pages, 6 by 9 inches. Published as Senate Document 1109 of the 62d Congress, Third Session, Washington, D. C.

Heavy Oil as Fuel for Internal-Combustion Engines. By Irving C. Allen. 36 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 37.

Safety in Tunneling. By David W. Brunton and John A. Davis. 19 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C., as Miners' Circular 13 of the Bureau of Mines.

Manufacture of Lime. By Warren E. Emley. 130 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 16.

First-Aid Instructions for Miners. By M. W. Glasgow, W. A. Raudenbush and C. O. Roberts. 66 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines as Miners' Circular 8.

The Analysis of Black Powder and Dynamite. By Walter O. Snelling and C. G. Storm. 80 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 51.

Proposed Regulations for the Drilling of Gas and Oil Wells. By O. P. Hood and A. G. Heggem. 28 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 53.

Apparatus for Gas-Analysis Laboratories at Coal Mines. By George A. Burrell and Frank M. Seibert. 24 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 14.

The Commercial Trend of the Producer-Gas Power Plant in the United States. By R. H. Fernald. 93 pages, 6 by 9 inches. One folding plate. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 55.

The Prevention of Waste of Oil and Gas from Flowing Wells in California. By Ralph Arnold and V. R. Garfias. 15 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 42.

Directory of Clay Products Manufacturers in the United States Comprising Manufacturers of Common Brick, Pressed Brick, Face Brick, Fire and Silica Brick, Paving Brick, Tiles, Pottery. 142 pages, 6 by 9 inches. Published by L. L. Longdon, Oxford, Ohio. Price, $2.50.

Proceedings of the Twenty-first Annual Convention of the Traveling Engineers' Association. Edited by W. O. Thompson. 371 pages, 5¾ by 8½ inches. Published by the Association. W. O. Thompson, secretary, Buffalo, N. Y.

The proceedings of the convention held at Chicago August 12-15, 1913, include papers and discussions of technical interest to the railway men connected with the operating and motive power departments.

Standard Regulations for Manufactured Gas and Gas Service. 170 pages, 6 by 9 inches. Published by Department of Commerce as Circular No. 32 of the Bureau of Standards, Washington, D. C.

This circular supersedes Circular No. 32 first edition entitled "State and Municipal Regulations for the Quality, Distribution and Testing of Illuminating Gas." The importance of established standards for illuminating gas to municipalities and all gas consumers is obvious.

Cranes and Hoists. By Hermann Wilda. Translated from the German and adapted to British practice by Charles Salter. 168 pages, 4½ by 6¼ inches. 399 illustrations. Published by Scott, Greenwood & Son, Ludgate, E. C., England and D. Van Nostrand Co., New York City. Price $1.25 instead of $1 as quoted in the review appearing in the November number.

Harper's Wireless Book. By A. Hyatt Verrill. 185 pages, 5¼ by 8 inches. Illustrated. Published by Harper & Bros., New York City. Price $1.

This book for amateur wireless electricians tells how to use wireless electricity in telegraphing and telephoning and the transmission of power. It explains electromagnetic waves and tells how to build and use wireless apparatus, telegraphs, telephones, etc. An appendix contains tables and standards useful to the worker.

Harper's Beginning Electricity. By Don. Cameron Shafer. 275 pages, 5¼ by 8 inches. Illustrated. Published by Harper & Bros., New York City. Price $1.

The book, as the title indicates, is intended for amateurs, boys and others who wish to make simple experiments in electricity and to learn more about electrical phenomena. It treats of static electricity, galvanic electricity, batteries, magnetism, permanent and electro-magnets, induction coils, the telegraph, telephones, generators, motors, electric light, and the history of electricity. An electrical dictionary is included, defining many of the common electrical terms.

Shop Sketching. By Joseph W. Woolley and Roy B. Meredith. 102 pages, 6 by 9 inches. 122 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $1.

This book is made up of the instruction papers used in the extension division of the University of Wisconsin and is presented as a course of instruction for apprentices and mechanics who need more knowledge of drawing. It contains seven chapters as follows: Principles of Mechanical Drawing; Screws and Screw Fastenings; Sections; Assembly and Detail Drawings; Gearing; Isometric Drawing; Freehand Drawing. The book is in no sense a treatise on mechanical drawing, but is intended to make shop men familiar with the principles of mechanical delineation and able to read working drawings.

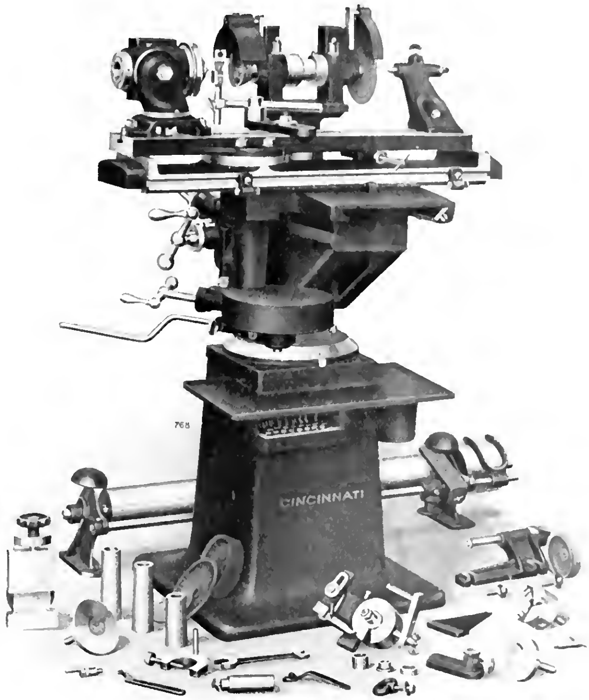
Jigs and Fixtures. By Fred H. Colvin and Lucian L. Haas. 168 pages, 6 by 9 inches. 391 illustrations. Published by the McGraw-Hill Book Co. Inc., New York City. Price $2.

The development of interchangeable manufacturing of guns, sewing machines, typewriters, engines, automobiles and hundreds of other products depends on jigs and fixtures as the most important accessories of manufacturing equipment. The variety of jigs required to suit the multitude of shapes to be machined, the accuracy with which they have to be constructed and the designing of them to be efficient and convenient in use, test the best skill of tool designers and toolmakers. The contents of the book comprise: Tool-room systems; various kinds of jigs; jig locating means; standard bushings; details of jigs; clamps and clamping methods; milling fixtures; pneumatic fixtures; advantages of lap jigs; designs and materials for gages; external and internal thread gages; manufacturing gages; and machine vise jaws and mandrels. The work is one that should be appreciated and found useful by tool designers, toolmakers and machinists generally.

Formulas in Gearing. 225 pages, 6 by 9 inches. Published by the Brown & Sharpe Mfg. Co., Providence, R. I. Price, $1.50.

This well-known work on gearing was first published in 1900. It has passed through five editions

The New Cincinnati No. 1½ Cutter Grinder



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Takes work 10" diameter 17" long. Has 16" table travel—9½" cross and 7¼" vertical.

Will grind High Power face mills up to 12" in diameter and Standard face mills up to 16" diameter; formed cutters up to 5½" diameter, using a 4" diameter grinding wheel.

It is in every way as handy as our well-known No. 1 Grinder, but is much heavier and more rigid, as the illustration shows.

The following features produce quick and accurate results:

1. A vertical movement which can be adjusted and clamped without disturbing any other settings.
2. A swiveling or angular adjustment of the knee and table through a complete circle about the column which is entirely independent of all other settings.
3. A slow screw feed for cylindrical, internal and some classes of surface grinding.
4. A quick lever feed for all sharpening operations.
5. A conveniently located feed lever which the operator can set to that position handiest for the work being ground.
6. A large swiveling headstock which receives the shanks of end mills, face mills, etc., holding them for the sharpening operations just as they are held in the milling-machine spindle.
7. As graduated dial on the headstock spindle from which the clearance angle for cutters may be read direct. No clearance tables or diagrams are needed.
8. A Gear Cutter Sharpening Attachment which grinds the teeth equally, straight and radially and also *feeds the cutter to the grinding wheel radially.*
9. A single, universal tooth rest, the blade of which forms a solid support for all cutter sharpening.
10. A dial reading in degrees and also a dial reading in inches per foot for angular and taper work.

Ask for descriptive matter showing how these things have been accomplished.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

into the sixth enlarged edition. Forty-two pages have been added, the additional matter including a table of prime factors from 10,000 to 100,000 and a new table giving the chordal thickness of gear teeth and the distance from the chord to the top of the tooth. The tables for bevel gears giving the diameter increment, the apex distance to the pitch line, angles of edge and angles of face have been extended. Additions have also been made to the tables giving the number of cutters for use in cutting bevel gears. The subject is dealt with essentially from the draftsman's standpoint and covers the principles of spur gearing, spur gearing formulas, bevel gearing, worms and worm-wheels, spiral gearing, internal gearing, bevel gear cutters, indexing, gearing of lathes for screw cutting, tooth parts, solution of triangles, trigonometrical tables, angles for gashing worm-wheels, and the subjects before mentioned.

The Resistance of Guns. By Leone Compaye and Pietro Malavat. 262 pages, 7 by 10 inches. Illustrated. Edited by Carlo Pasta, Piazza Castello, 22 Turin, Italy.

Captain Hector Bravetta of the Italian Royal Navy, well known to students of naval matters on account of the many articles contributed to technical reviews in Italy and abroad, has translated and united in one volume three important memoirs on the resistance of guns which engineers Leone Coupaye and Pietro Malaval of the French Naval Artillery had published in French. Mr. Coupaye points out that it is absolutely impossible to build guns having purely elastic deformations greater than the elastic limit of the metal of which the internal tube is made, and that the limit is about nine-tenths of the elastic limit. This is true whatever system of manufacture be adopted, and applies to both built-up and wire-wound guns. The elastic limit of a gun is very limited. If the metal forming the internal tube, for instance, possesses an elastic limit of 40 kilograms, a gun of normal thickness will become permanently deformed under a pressure of 3600 kilograms per square centimeter. The work is published in Italian.

Scientific American Reference Book of 1914. By Albert A. Hopkins and A. Russell Bond. 597 pages, 5½ by 7½ inches. 1000 illustrations. Published by Munn & Co. Inc., New York City.

This comprehensive reference book is indispensable to the business man as it will answer all sorts of questions that may come up in the course of affairs. The work is divided into two sections, Part I containing statistical information and Part II scientific information. Under statistical information are statistics on population and social relations; farms, foods and forests; mines and quarries; manufacture; commerce; mercantile marine; railroads; the Panama Canal; telegraphs and cables; wireless telegraphy; telephone statistics of the world; post office affairs; patents, trade-marks and copyrights; armies of the world; navies of the world; aviation. In Part II on scientific information are chapters on chemistry; astronomy and time; meteorology; machine elements and mechanical movements; geometrical constructions; weights and measures. The division of the matter into parts and chapters and the index make for easy reference to any matter treated.

Working Drawings of Machinery. By Walter H. James and Malcolm C. Mackenzie. 143 pages, 6 by 9 inches. 220 illustrations, 21 folding plates. Published by John Wiley & Sons, Inc., New York City. Price $2 net.

The authors are, respectively, assistant professor of mechanical engineering and instructor in mechanical engineering of the Massachusetts Institute of Technology, and the book was written to meet the needs of the second and third year students studying drawing in the Institute. The aim has been to give correct conception of the character and purpose of a working drawing and to suggest the relation between a pictorial drawing of an object and its orthographic projection. The plan was also to illustrate good, modern drafting-room practice. The contents comprise discussion of general principles, conventional representations, dimensioning and describing, sketching, scale detail drawing, general drawing, design drawings, diagrammatic drawings, mechanical pictorial drawings, etc. The book should be found generally useful to draftsmen. The appendix contains a number of tables of machine details, such as bolt heads and nuts, cap screws, machine screws, standard threads, Acme threads, washers, cotter pins, taper pins, tapers, keys, etc.

NEW CATALOGUES AND CIRCULARS

James Anderson & Sons, Sidney, Ohio. Circular of the "Comus" oil cups for all purposes.

Standard Tool Co., Cleveland, Ohio. Catalogue No. 21 of drill chucks and circular of the "Shield" brand high speed drills.

American Can Co., 104 So. Michigan Ave., Chicago, Ill. Catalogue of sheet metal presses, wire working machinery and die shop equipment.

Richard W. Jefferis Co., Camden, N. J. Folder of Jefferis pressed steel lockers, wardrobes and shelving for offices, shops and factories.

Fosdick Machine Tool Co., Cincinnati, Ohio. Circular illustrating and describing new style No. 0 horizontal boring, drilling and milling machine.

W. W. Blakely, 100 Leicester Court, Detroit, Mich. Circular of the "Common Sense" adjustable boring tool for use on lathes, boring machines and drilling machines.

Billings & Spencer Co., Hartford, Conn. Circular describing the Billings & Spencer No. 0 double-acting ratchet which is provided with two removable sockets for taper and square shank drills.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue E of Brown hoists, grab buckets, slag buckets, contractor's grab buckets, shovel buckets and various kinds of tubs.

Millers Falls Co., Millers Falls, Mass. Circulars of automatic boring tool No. 15, "Star" hacksaw frame No. 11½ and "Star" hacksaw frame No. 1011 having pistol grip.

Walden Mfg. Co., Worcester, Mass. Circular of "Walden Worcester" wrenches comprising ratchet wrenches, combination sets for automobiles, offset wrenches, tee-handle wrenches, etc.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Booklet on ball bearings for axle lighting generators, showing details of railway car equipment for generating electricity used for lighting cars.

Index Visible, Inc., Times Bldg., New York City. Circular of a visible card index system, the cards being mounted on vertical aluminum strips so that the key word of each card is visible.

G. L. Simonds & Co., 115 S. La Salle St., Chicago, Ill. Booklet entitled "Economical Steam Production" showing the use of the "Vulcan" soot cleaner and data on economies effected.

Crescent Tool Co., Jamestown, N. Y. Circular of "Crescent" universal pliers which hold securely taper, half round, triangular, and other shapes as well as rectangular, parallel and round pieces.

F. E. Wells & Son Co., Greenfield, Mass. Card illustrating the Wells improved Stillson pattern pipe wrench in which the wooden handle is provided with double ferrules to prevent breaking.

H. W. Johns-Manville Co., 41st St., & Madison Ave., New York City. Specifications of J M asbestos roofing and waterproofing material for shops, factories, mills, office buildings and other structures.

Morrison Boiler Co., Sharon, Pa. Circular of the Morrison water tube boiler illustrated with views of a 200 H. P. boiler recently erected for the National Pulp & Turpentine Co., Green Cove Springs, Florida.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34 D on Chicago pneumatic Corliss compressors, steam driven, containing description of construction and mechanical details with illustrations.

Gilbert & Barker Mfg. Co., Springfield, Mass. Pamphlet on the Gilbert & Barker process for burning fuel oil under low pressure, with illustrations of apparatus and installations in large manufacturing plants.

Fox Machine Co., Grand Rapids, Mich. Sectional catalogues on hand and power feed milling machines Nos. 2, 3 and 3½; universal trimmers; bench, floor and column types, and mitering machines; tube and pipe cutting machines Nos. 1, 3, 5 and 6; adjustable dado heads.

E. L. Patten, St. Louis, Mo. Postcard illustrating and describing the "Universal" bench filing machine having adjustable work table and adjustable file carrier enabling the user to file all angles in either direction up to 5 degrees.

Flexible Steel Lacing Co., 544 W. Jackson Blvd., Chicago, Ill. Circular of "Alligator" steel lacing for machinery belting, consisting of steel hooks that can be applied with a hammer only. The hooks form a flexible joint when joined with a sectional rocker hinge pin.

Firth-Sterling Steel Co., E. S. Jackman & Co., agents, 710-714 Lake St., Chicago, Ill. Catalogue of Firth-Sterling steels, including treatise on tool steel, the selection of steel, and heat-treatment of all grades. The catalogue contains valuable information for all steel users.

Graham Mfg. Co., 94 Point St., Providence, R. I. Pamphlet entitled "The Virtues of a Vise" illustrating uses of the Graham drill vise for drilling machines, milling machines, shapers or planers. The jig vise may be used as a substitute for expensive jigs on many kinds of work.

Kasenit Co., 21 State St., New York City. Circular of "Kasenit" open fire casehardening compound which is said to be the most rapid compound for open fire hardening. It is non-poisonous, non-explosive and non-inflammable, and may be used for casehardening and carbonizing wrought iron, mild steel and tool steel.

C. H. Driver & Kerr Co., 1300 Sixteenth St., Racine, Wis. Circular of the Driver & Kerr drill racks for use in machine shops. These racks are ingeniously devised so as to prevent the drilling machine man from putting his drills into the wrong holes. Hence, the rack is a time saver, as every drill must be in its proper place.

Cincinnati Milling Machine Co., Cincinnati, Ohio. Circular of "Cincinnati" semi-automatic milling machines with intermittent feed and power quick return, 28-inch size. The circular illustrates the machine including details of construction. This is essentially a manufacturing machine, applicable to the work found in armories, sewing machine factories, etc.

Cowan Truck Co., Holyoke, Mass. Catalogue on the Cowan transveyor illustrated with views showing use in printing plants, automobile factories, electric welding shops, screw machine departments, electric manufacturing works, paper mills, etc. The catalogue gives conclusive evidence of the value of the truck or transveyor in reducing cost of handling materials in industrial plants of all kinds.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Pamphlet on the LeBlond belt shifting attachment for lathes, milling machines and other machine tools. This mechanically operated attachment shifts the drive belt of cone-driven machines quickly and in either direction. It not only eliminates the danger incident to changing belts, but converts an ordinary cone-driven headstock into a quick speed change mechanism.

Hannifin Mfg. Co., Chicago, Ill. Catalogue of "Aero" devices comprising air-operated chucks, countershafts, mandrels, clamping fixtures, vises, gate valve seating chucks and other air-operated tools and machinery. The use of compressed air for quick machine tool operation, especially in brass working lathes has assumed large proportions in the last few years. The catalogue is of considerable interest to all mechanics.

J. S. Bretz Co., 250 West 54th St., New York City. Booklet on F. & S. annular ball bearings (made in Germany) of the single annular type fitted with ribbon ball separator and the W. H. narrow width ball separators. The company is the sole importer of these bearings, and the booklet lists each bearing, giving the outside diameter, bore, width, ball diameter, number of balls, load in pounds, etc. The dimensions are given in millimeters and a table of inch equivalents is included.

Wells Bros. Co., Greenfield, Mass. Catalogue of gages, comprising standard cylindrical or ring and plug gages, plug and templet thread gages, screw pitch gages, pipe thread gages in sets, fork cylindrical limit gages, fork thread limit gages, "Crescent" thread limit gages, screw thread micrometers. The catalogue contains interesting and useful matter on standards of length, the use of measuring tools, how to hold screw thread micrometers and data on screw threads. It should be in the hands of every progressive mechanic.

American Swiss File & Tool Co., 24 John St., New York City. Catalogue and revised price-list of American Swiss files. A price revision was made necessary by the new tariff law, under which hand cut files and files of precision are dutiable at 25 per cent ad valorem. The company has revised its prices to meet the competition as far as possible, but states that the new prices cannot be lowered without lowering the standard of quality. Excepting a few shapes and cuts below 6 inches in length, all files will be found as low in price as any of approximately equal quality made abroad. The catalogue is of interest to all toolmakers and other users of fine files.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Bulletin No. 3, "Rail Reports on Open Hearth Steel" containing a summary of the results of chemical and physical tests on seven standard and seven titanium-treated open hearth A rails. The work being done by the company in making comparative tests of standard and titanium-treated steel rails and publishing results of same is attracting wide attention from metallurgists and users of rails. The bulletin is profusely illustrated, showing large sulphur prints and sections of A rails and micro-photographs taken from the top of head, center of head, web, center of flange, bottom of flange and end of flange.

TRADE NOTES

Worcester Lathe Co., 134 Gold St., Worcester, Mass., is the designation under which C. E. Thwing is marketing a new eleven-inch lathe built for him by the Whitcomb-Blaisdell Machine Tool Co.

W. H. Leland & Co., Worcester, Mass., manufacturers of sensitive drilling machines, have changed the firm name to "Leland-Gifford Co.," the members of the firm remaining the same as before.

N. C. Walpole, Southern representative of the Niles-Bement-Pond Co. and the Pratt & Whitney Co., has opened a sales office and a machinery display room at 2015 First Ave., Birmingham, Ala.

J. Faessler Mfg. Co., Moberly, Mo., manufacturer of boiler tools, has removed its general sales office to rooms 1934-6 Railway Exchange Bldg., St. Louis, Mo. Charles F. Palmer remains in charge.

DeForrest Electric Welding Co., Cleveland, Ohio, has been incorporated to do an electric welding business. The following are interested: H. J. Lamb, M. M. McLaughlin, C. F. Miser, H. B. Altman and Edward Cherney.

Hoefer Mfg. Co., Freeport, Ill., has appointed the J. R. Stone Tool & Supply Co., Detroit, Mich., which has opened a Chicago branch office at 820 Ashland Block, as agent for the Hoefer auxiliary heads in Chicago territory.

James Maher Chain Tongs & Wrench Mfg. Co., of East Liverpool, Ohio has been incorporated with a capital of $25,000. James Maher, Michael Maher, Thomas Terry, H. E. Pfaff, L. L. Campbell and George Wurzell are interested.

Galion Iron Works & Mfg. Co., Galion, Ohio, has been incorporated with a capital of $10,000 to manufacture machinery and tools. W. Pelton, B. T. Meyer, C. C. Gilmore, C. D. Wise, D. G. Strother, O. P. Beck and D. C. Boyd are incorporators.

Rockford Drilling Machine Co., Rockford, Ill. S. H. Beck, secretary and treasurer has sold his interest to William Nelson, president who now becomes the sole owner of the business of manufacturing upright drills, gang drills and lathes.

Kelly Reamer Co., Cleveland, Ohio, has increased its capital stock from $25,000 to $50,000 common stock. The increase of capital stock was made to enable the company to increase its facilities and to care for the rapidly growing business in Kelly reamers, etc.

Baxter-Frick Gear Cutting & Mfg. Co., Cleveland, Ohio, has been incorporated with a capital of $25,000 to manufacture and sell gears. The following parties are interested: Archie K. Baxter, William H. Frick, Vincent A. Taylor, Oswald M. Hoch and Mrs. Grace Dartos.

MACHINERY

JANUARY, 1914

Fig. 1. Section of Film illustrating Lathe Operation

THE MOVING PICTURE IN THE MACHINE TOOL BUSINESS*

BY CHESTER L. LUCAS†

The moving picture as an entertainer is rapidly making room for the moving picture as an instructor. This has been much in evidence recently in the scientific films which have been shown to illustrate plant life, biology, laws of physics and similar subjects. Another phase of moving picture activities was manifested in motion study for "scientific management" and a still later one in the moving picture as an aid to the machine tool builder in handling factory problems and selling campaigns. Several examples of the use of moving pictures in aiding the salesman will be cited in this article and suggestions offered whereby the application of the moving picture may be made of greater value in the machine tool industry.

Primarily, the service which the moving picture can render to the machine builder is instruction in the factory or the selling field. Suppose, for instance, a manufacturer of an intricate machine had trouble in getting his machines properly set up and started after they had been taken down at the factory for shipment to distant points. Although drawings and printed instructions were sent with each machine, there was often difficulty in setting up and starting. This manufacturer could have a moving picture film made to show just how the machine should be assembled and operated. It could show the sequence in which the members should be put together, graphically illustrate the important parts to be most carefully assembled, and in fact show the building up of the machine from the time it left the crate to the completed stage ready for operation. No amount of verbal or written instruction could make this process as clear as a picture could, and, moreover, the entire process of assembling the machine, unless extraordinarily long, could be carried through in a thousand feet of film, requiring about twenty minutes to show. The question will be raised as to how the man who is to set up the machine is to see the film in a case like this. If the machine is going to a point not far distant, the machine manufacturer can arrange to have the men who are to set it up come to his factory and see the film on a screen and listen at the same time to instructions. It would often be the case, however, that the film would be most valuable when the machine is going so far away that verbal instruction in the factory is impracticable. In such cases the erectors can have the film shown in the nearest moving picture theater in the morning hours and study it at leisure. It seems a safe prediction, however, to say that not many years will elapse before a small moving picture machine will be as essential a part of a manufacturing plant's equipment as the camera is at the present time. Many colleges and schools are now using moving picture machines for instruction purposes.

Depicting mechanical movements is an interesting field for the moving picture. It is practicable to slow down or speed up any movement when making a moving picture film. Suppose, for instance, the operation of a very slowly moving piece of mechanism is to be shown. In this case the moving picture camera is set up and the operating crank is turned very slowly so as to take as few pictures as possible and still show continuous movement. This is the method employed in making botanical pictures showing the growth of a plant—a process normally requiring several weeks being reproduced in a few minutes. To get this effect, the photographs are taken at the rate of one every eight hours instead of sixteen every second as for ordinary moving pictures.

The value of this possibility to the mechanical public is illustrated in an automatic machine that was made in Brooklyn, N. Y. This machine made one revolution every thirty-one

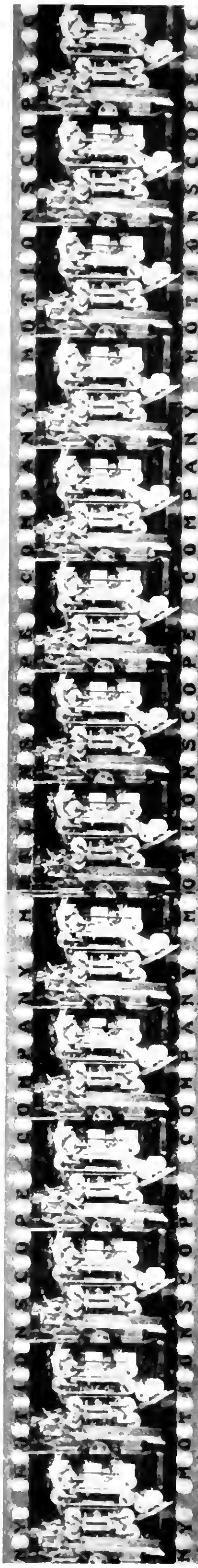

Fig. 2. Section of Film showing Operation of Automatic Machine

* For additional information on the moving picture machine and its relation to the machine shop see "The Moving Picture as an Aid to Mechanical Instruction," MACHINERY, May, 1912, engineering edition, and articles there referred to.

† Associate Editor of MACHINERY.

minutes, and as it was desired to show its operation, a moving picture was made, taking the pictures so slowly that the full revolution of the machine could be thrown on the screen in a few minutes. Conversely, a mechanism operating at high speed may be taken by accelerating the picture-taking camera speed if it is desired to show it operating at a slower speed. Then when the film is projected at the normal rate of sixteen pictures per second, the speed can be made apparently slow. Thus the movement of any kind of mechanism can be graphically illustrated to students or apprentices, who perhaps could not grasp the operation if it were running at full speed. Especially is this true of spring-actuated mechanism, such as that employed in some adding machines in which analysis of the movements of the parts is difficult. The National Cash Register Co. uses moving pictures to instruct repair men as well as salesmen in the manipulation of the different parts of the mechanism.

In the comparatively slowly operated pictures the water takes on the appearance of molasses, and its motion seems sluggish in comparison with the rotation of the ball. The experiment has been carried still further by shooting the column of water with a rifle bullet. When this is shown on the screen, the effect of the bullet is to shatter the column from top to bottom, after which it is seen to pull itself together and finally return to the former position.

Another case where the moving picture will undoubtedly prove of value as an instructor is in showing the operation of automatic machinery that has been built and shipped perhaps years before. A concern building automatic machinery might have produced a machine such as that illustrated by the film from which the print in Fig. 2 was made, the mechanism of which was especially complex. Suppose, after the machine had been built for several years, it was destroyed by fire. If a film showing the operation of this machine was at

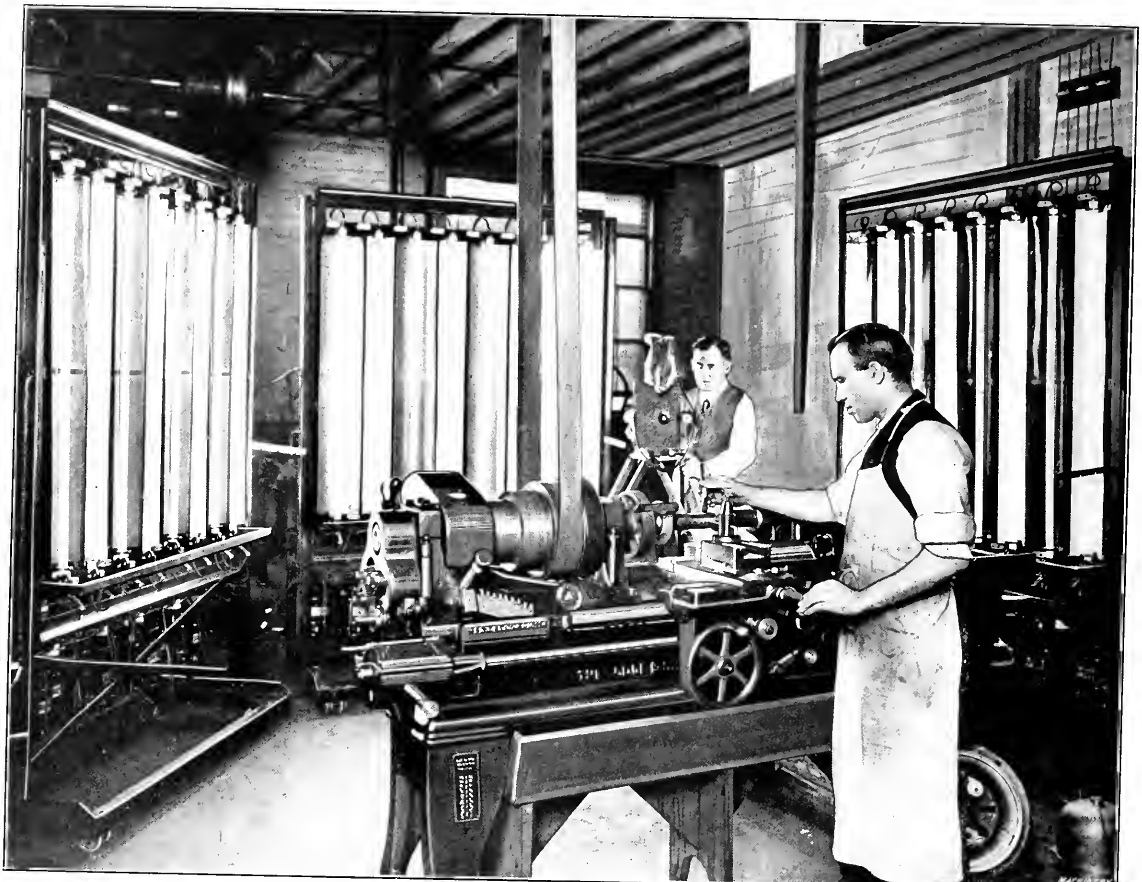

Fig. 3. Making a Moving Picture Film in a Machine Shop

Films for instruction purposes along mechanical lines can be used at much less expense than that of keeping and operating the mechanism itself. Thomas A. Edison proposes to demonstrate the elementary laws of physics to school children who would have great difficulty in understanding them from textbook descriptions, by making moving pictures of pumps having glass working parts. If the operating parts of any mechanism are inaccessible to observe or study, they are the parts that should be most clearly shown. Moving pictures of such sections make the operation of the machine clearly understood.

An instance of the aid of the moving picture to the scientist and teacher in the study of gyroscopic motion may well be cited. Why does a hollow rubber ball balance itself so perfectly at the top of a jet of water? By making moving pictures at high speed and projecting them upon the screen, the ball is shown to acquire a gyroscopic motion at the top of the column of water, tending to keep it from going off at the side.

hand, it should facilitate the building of a duplicate machine by a new set of men, for even though drawings are accessible, there is often doubt about operating points that a moving picture would clear up.

Recent Developments in High-speed Pictures

Pathe Freres are undoubtedly among the leaders in producing scientific films, and it is through their courtesy that much of this information and some of the views were obtained. They have recently developed a high frequency spark apparatus used for taking pictures of rapidly moving objects. These pictures, of course, must be taken in a dark room; the film operates continuously, that is, without the intermittent motion of the ordinary moving picture camera. The spark operates at the rate of 1200 flashes per second and this number of exposures is made on the film. By this method, they have been able to record the path of a bullet shot at a clay pipe. By projecting the film at a normal speed, the bullet could be followed slowly across the screen until it entered the clay

pipe bowl. It seemed to remain within the bowl for a few seconds and then slowly, very slowly, the bowl dropped to pieces and the sections fell to the floor. Of course this film looked unnatural, but it showed the possibility of analyzing the action of rapidly moving objects.

Of course, there is hardly any need of mentioning the value of the moving picture as an aid in instructing apprentices and unskilled workmen in their duties. One does not have to draw on the imagination to a great extent to see the advantage of the moving pictures in instructing the apprentice as to the sequence of operations to follow in performing a given operation in the approved manner.

The Moving Picture as an Aid to the Salesman

Just as the highest type of technical advertising involves showing machine tools actually at work, so the great advantage of the moving picture lies in its ability to show to the prospective customer just what the advantages of the machine in operation are. A large steel company was particularly interested in securing foreign business. It wished to show foreign prospects the equipment of the plant, the large lathes, planers and the magnitude with which the business was conducted. It was impossible to bring these men to the works, so the company decided to take the works to the men. Accordingly, moving picture films were made, showing panoramic views through the plant and detail views of some of the large machine operations. These films were sent to the company's foreign agents, who, through the aid of a projecting machine, showed them to the prospective customers. The views made such an impression that large orders from these foreign countries were soon received.

The educational film showing, for instance, the making of a typewriter or the building of an automobile is becoming quite common, and its value as an advertising attraction has been well demonstrated. Several large manufacturing companies are already exhibiting films at conventions and exhibitions showing the manufacture of their product.

Small portable projecting machines are coming to the front more rapidly than ever. One of the latest of these weighs but little more than a typewriter, and the turning of the crank also operates a magneto, thus generating electric light for illuminating the pictures. The machine is self-contained and, with its case, comprises a portable outfit which a salesman can easily take into the office of a prospective customer. Then, by drawing the shades, the moving pictures can be projected upon the blank wall to show the superintendent or manager just how the machine works. Of course, films would be selected to exploit some impressive job, showing the machine working at its full capacity, preferably on the class of work done by the prospect. The salesman can demonstrate exactly how the different movements are secured. The explanation of an automatic feed throw-off, or the action of a cam movement, could be readily made in a demonstration of this sort.

Many times a salesman would like to take a prospective customer to a plant to show one of his firm's machines in action. This is sometimes difficult to accomplish; days when the machine would be working at its best are comparatively few. Even should a time be arranged for showing the prospect the machine at work, the surrounding conditions might detract from the effectiveness of the demonstration, and if the shop were far away from the prospective customer's location, he might be unwilling to go there. With a good film of his machine to show, however, a salesman could take his prospect, or several of them, to the nearest moving picture theater, and for a small sum the proprietor would be glad to run the film for him during the morning hours. There is scarcely a town of 500 inhabitants or more but what has its moving picture theater, and there is hardly one of the managers who would not gladly run special films during hours when the theater would otherwise be idle. Similarly, the morning hours of a theater could be utilized for instructing the apprentices of nearby factories.

The Motionscope Co., of Indianapolis, Ind., makes a port-

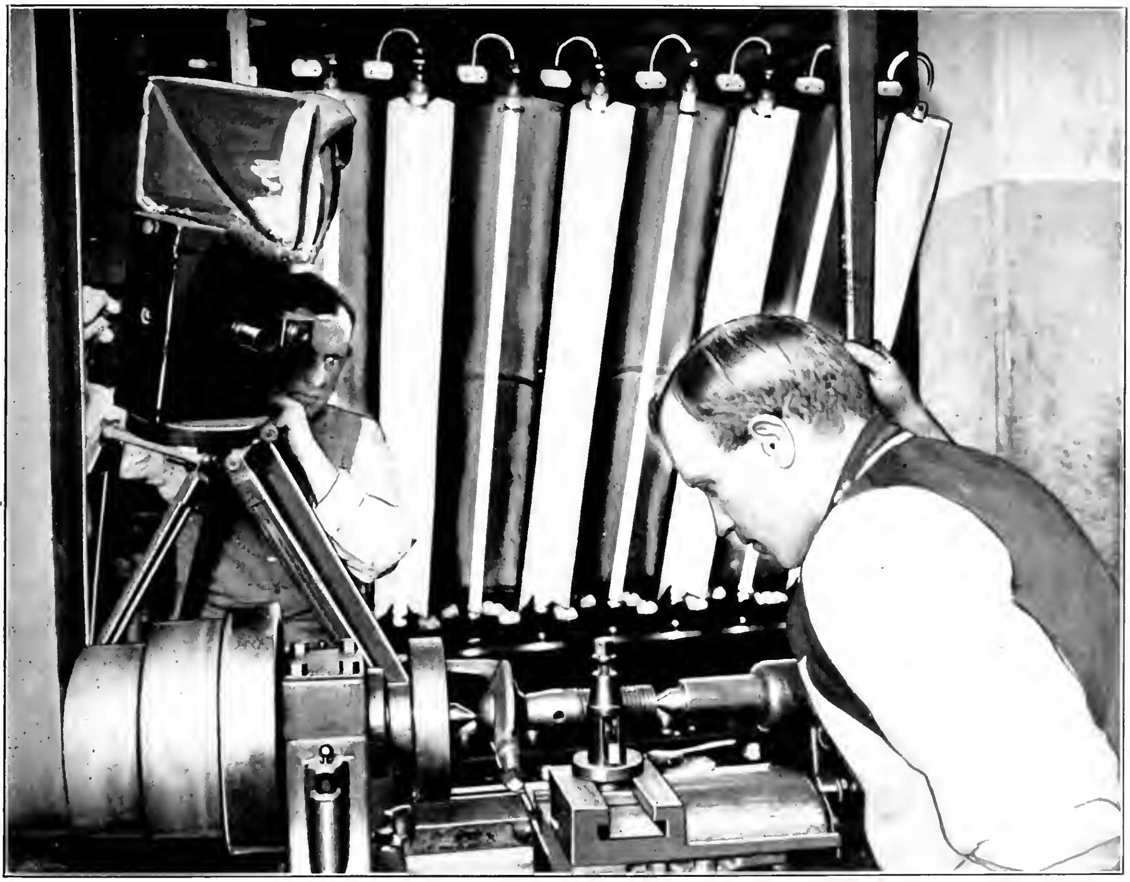

Fig. 4. The Way the Camera and Lamps are arranged to make a Detail Film

able outfit by means of which a salesman can show his prospect the film in his own factory or even in the salesman's room at the hotel. This machine is illustrated in Fig. 5, and is adjustable for any electric light current whether alternating or direct, 110 or 220 volts. Less than five minutes is required to put it in operation and it will show a picture as large as six feet wide. This machine may also be used for showing slides or stereoptican views. Equipped with a 24-inch screen, the outfit is contained in a case measuring 24 by 14 by 9 inches, and weighs approximately 35 pounds. Fig. 6 shows the way in which the machine is used in an office. The operation of any machine tool can be demonstrated with such an outfit. The salesman can stop at any point and dwell upon particular features that the view shows and he is not at the disadvantage of putting forth his argument in the midst of a noisy shop where much of his selling powers would be wasted. The film, of course, would show the machine working at its best, for moving pictures are not made on the "off days" of the machine.

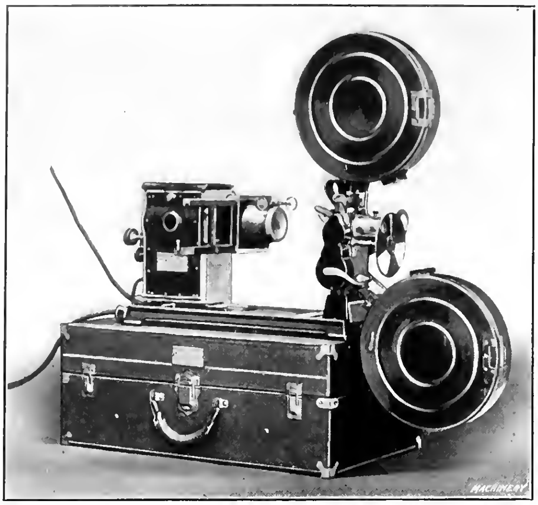

Fig. 5. Salesman's Portable Projecting Machine

In instances where it would be impracticable to send a salesman because of the distance, a film could be sent by registered mail to a prospective customer a thousand miles away. Arrangements could be made with a local moving picture house to show the film, this perhaps making the closing argument in a chain of selling correspondence.

The cost of making a mechanical moving picture film of one thousand feet or more in length is about one dollar per foot. This includes the services of the men who go to the plant, arrange the lighting and apparatus and make the film. When this film is once made, however, copies can be made at the cost of fifteen cents a foot. Should a sales manager decide to equip six of his salesmen with projecting machines and films to show a machine tool, it could be done at the rate of about thirty cents per foot, figuring the cost of the first film at one dollar per foot and the additional five at fifteen cents per foot.

Making a Mechanical Moving Picture Film

The requirements for making a moving picture film of a machine tool operation are comparatively simple. The film manufacturer understands how to get proper exhibition effects of any class of mechanism, and the lighting requirements are easily taken care of. It is seldom that a machine tool operation can be photographed without the aid of artificial light. Cooper-Hewitt electric lights are used to a large extent by the moving picture film men, and by using enough of these lights in conjunction with arc lamps it is possible to take views.

In order to show the exact method in which a mechanical moving picture of a machine tool operation is made, the views in Figs. 3 and 4 are reproduced. This shows the method of procedure in making a picture to demonstrate the operation of cutting a thread upon a jack screw. The lathe used was not equipped with a thread-cutting attachment as it was desired to have the operation explained on the ordinary type of lathe.

The lathe is shown set up for a thread-cutting operation, and as the object of the part of the film being made in Fig. 3 is to secure a general effect, showing the position of the operator and the manipulation of the lathe, the moving picture camera is situated at the back of the lathe. Cooper-Hewitt lamps are used, there being in this case three banks, each of which has eight tubes having 800 candlepower each; thus in each bank there is 6400 candlepower or a total of 19,200 candlepower in all. The positions of the banks of light upon the standards may be changed at will by raising, lowering or tilting. All being in readiness, the machine tool is operated in a natural manner, and the camera man turns his film at the rate of sixty turns per minute, making exposures at the rate of sixteen per second. Those exposures, of course, show the operator and machine in ever-changing positions, each of which represents conditions at intervals of 1/16 second; thus the fifteen views shown in the strip of film in Fig. 1 represent the 15/16 second time required for the lathe man to drop his hand from the shipper rod down to the cross-feed screw on the carriage.

To make the thread-cutting film complete, a section would necessarily show the selection of the change gears and method of setting up the work. The setting in of the cross-slide after the successive cuts could also be graphically shown. In fact, a film for teaching such an operation should show enlarged views of all of the important phases of the work. In making such detail sections of a moving picture, the camera is set up as illustrated in Fig. 4. In this view, but one bank of lights is required, raising and inclining it so the rays will fall directly upon the work. The camera has also been raised and is pointed down upon the top of the screw thread and tool so as to show the actual cutting operation, the form of chip turned off, and the comparative speed of the work. The object of this feature of the film is to show the reversing operation necessary at the end of the thread. The thread tool is nearing the end of the cut and the operator, with his hand upon the shipper, is about to reverse the traverse of the carriage. This section of the film would be particularly valuable in instructing the novice in properly withdrawing the tool and reversing the lathe at the end of a thread cut.

Fig. 6. Demonstrating a Machine Tool in a Prospect's Office

Credit is due Pathe Freres, Jersey City, N. J., and the Harold Ives Co., 1 Madison Square, New York City, makers of industrial films, for assistance in preparing this article.

* * *

October 13 was celebrated in New York City by flights from Staten Island around Manhattan Island. The celebration commemorated the first flight with a motor-driven aeroplane by Wilbur Wright at Kittyhawk, N. C., October 13, 1903.

MACHINING CONVEX AND CONCAVE SURFACES

DESIGN OF CONVEX AND CONCAVE TURNING ATTACHMENTS FOR USE IN THE LATHE AND VERTICAL BORING MILL

BY ALBERT A DOWD*

The machining of convex and concave surfaces is a problem which frequently confronts the manufacturer, and its solution may be required under a great variety of conditions. Even the size of the work to be machined is a controlling factor, as it determines to a certain extent, the type of machine to be used. For example, the small steel cup washer shown in the upper part of Fig. 1 would naturally be machined on an engine lathe or turret lathe of the horizontal type, while the huge ball pipe joint in the lower part of the illustration would preferably be handled on some type of vertical boring machine. A manufacturing proposition may be necessary where one thousand or more pieces are to be handled, or it may be that only one piece is required. The work may be concave, or convex, in a plane perpendicular to the center of rotation, or it may be parallel with it and either internal or external. As the conditions governing the handling of work of this nature are so varied, and as the pieces themselves are of such widely different forms, it is very evident that we must consider several types of machines to which the forming devices may be attached. The construction of these devices must be adapted to the class of machine on which they are to be used, and this naturally influences the design of the attachments. The reader's attention is called to a few important points along these lines.

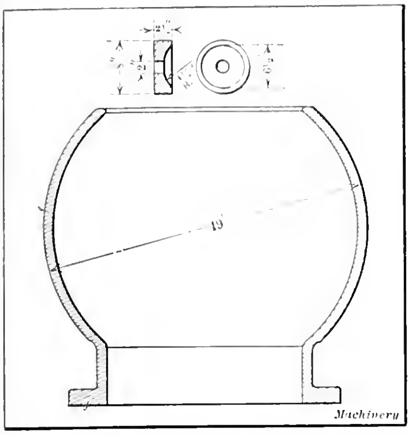

Fig. 1. Cup Washer and Ball Pipe Joint—Examples of Concave and Convex Turning

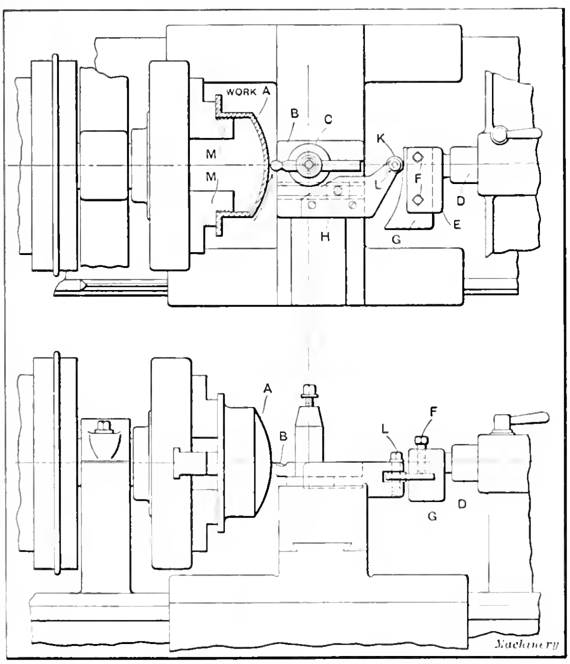

Fig. 2. Simple Attachment for Convex Turning in Engine Lathe

Important Points in Design

1. Whenever possible the attachment should be so designed that the form will be generated radially, so that the same portion of the tool will do the cutting at all times.

2. Try to use stock sizes of steel for the cutting tools so that replacements can be made easily.

3. See that the tool does not overhang too much, and that it is well supported and rigidly held. Care should also be taken that moving portions of the tool-holder or slide are of generous proportions and possess means of adjustment for wear.

4. Generate the curve by means of the machine alone, whenever possible, so that errors in the contour may not be occasioned by the failure of the operator to keep a certain roll or stud in contact with the forming plate.

5. When the attachment is of the type requiring the use of a roll and forming plate, it is essential to so arrange the plate that it will act as a guard against the tool being forced away from the work. That is, the action of the roll against the plate should be in the direction tending to carry the tool into the work, so that the thrust of the cut will always assist in keeping a positive contact between the roll and the plate. Counterweights or springs should also be used to obviate any tendency to draw in.

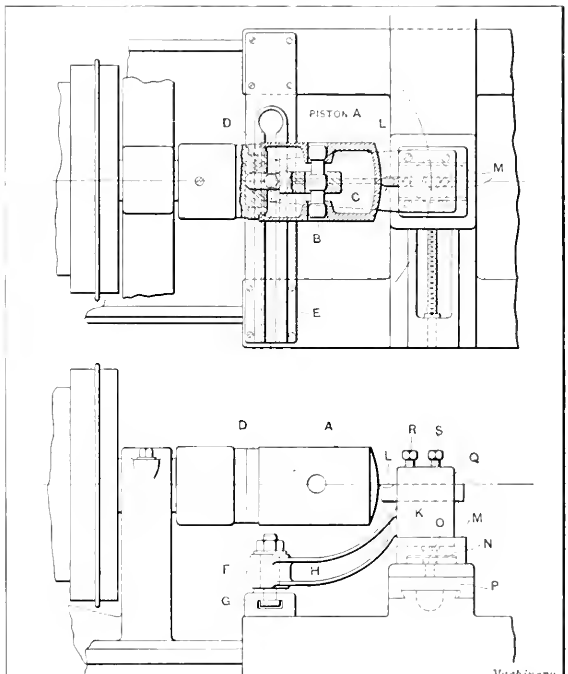

Fig. 3. Piston Crowning Attachment for the Lathe

6. Economy in operating expense and the first cost of the attachment should also be considered, while the difference in workmen's rating is also a factor which should not be overlooked.

Radius Turning on the Engine Lathe

When concave or convex turning or boring is required or only one or two pieces, or, in cases where it is not practicable to combine the radial work with other operations, the engine lathe may be adapted to a great variety of conditions. In manufacturing, it may occasionally be used to advantage, especially in cases when the length of time required to do work is sufficient to permit one man to run two machines.

Fig. 2 shows the simplest kind of a forming attachment for convex work, which is adapted to the engine lathe. The work .t is held by the inside in the chuck jaws *M*. The bracket *H*

* Address: 84 Washington Terrace, Bridgeport, Conn.

is screwed to the top of the cross-slide and carries at its outer end, the tool steel hardened and ground roller K, held in place by the screw L. The tailstock spindle D receives the holder E in which the plate G is inserted and secured by the two screws F. This plate is formed to the proper radius and is of tool steel unhardened. The cutting tool B is held in place in the regular toolpost C. The form of the cutting end of this tool is important as it must be formed to a perfect radius, in order that the cutting action may be uniform. In operating this attachment, the cross feed-screw is thrown into engagement, and the operator is required to force the roll K against the forming plate by means of the handwheel controlling the longitudinal feed of the carriage. An attachment of this sort requires the entire attention of the operator and, therefore, variations are liable to occur in the contour of the work, due to imperfect contact between the roll and plate; hence it is a very poor attachment to use if there are many pieces to be machined.

Piston Crowning Attachment for the Lathe

The arrangement shown in Fig. 3 was used for manufacturing in large quantities, and four lathes were equipped in this manner and required the services of two men to operate them. The piston A was located on a special draw-back chuck, on the steel locating ring D, and was drawn back firmly by the rod C acting on the pin B through the wrist-pin holes. A cast-iron bracket E is bolted onto the carriage of the lathe and is slotted at G. A cast-steel bracket H terminates at its upper end in the tool-block K which is dovetailed at M as shown in the plan view. The stud F is tee-shaped at its lower end to fit the slot in the bracket E. A steel block is screwed to the top of the cross-slide P, and is shouldered at N to fit the upper block in which the dovetailed tool-block K slides. The screw O simply holds the units together. A steel plate Q contains the two screws R and S which securely hold the tool L. In operating this device, the cross feed-screw is simply thrown into engagement and its forward action causes the tool to swing radially at the desired distance from the center F, thus developing a spherical surface. This device was comparatively inexpensive and the results obtained by its use were very satisfactory.

Concave Turning with a Compound Rest

A very simple device which may be used when one or two pieces only are required is shown in Fig. 4, but the radius which can be generated by this method is limited by the size of the compound rest. The work A is held by the outside in chuck jaws, and the tool C generates a radius equal to the distance from the end of the tool to the center of the swivel. The socket G is placed in the tailstock spindle and the overhanging end contains the round head pin H. The bar D is cup-shaped at E and F and bears against the end of the compound rest screw at E, while the other end engages the button at F. In using this arrangement, the holding-down gibs or straps of the compound rest swivel, are set up to produce considerable friction, and the tailstock spindle is fed forward by hand, thus causing the compound rest to swing on its own center, thereby generating the desired radius. It is obvious that the carriage gibs must be tightened to prevent any longitudinal movement.

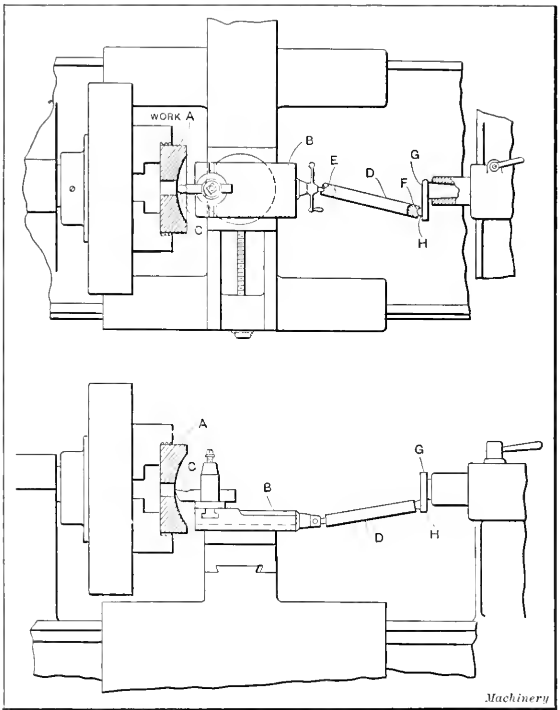

Fig. 4. Concave Turning with Compound Rest

Radius-bar for Concave Turning

A very simple arrangement for the engine lathe is shown in Fig. 5. The work A is held by the outside in chuck jaws and the round nose tool B is used to generate the concave surface. The tool is held in the ordinary manner in the toolpost C on the cross-slide of the lathe. A slotted holder K is tapered on its rear end to fit the tailstock spindle L and is slotted to receive the flat steel radius-bar G which is held in position by means of the shoulder screw H. The stud F enters the tool slot of the cross-slide and serves as a pivot for the forward end of the radius-bar. This bar is made of the correct length to generate the desired radius. As in a previous instance, the cutting end of the tool B must be ground to a perfect radius. The arrangement shown here is a very simple one and may be used for various pieces of work by the substitution of a bar of the proper radius.

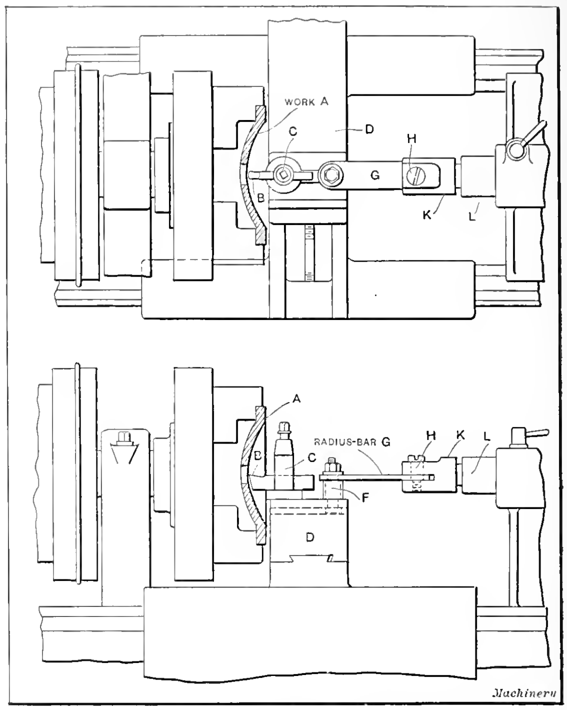

Fig. 5. Radius-bar Type of Concave Turning Attachment

Pulley Crowning Attachment for the Engine Lathe

Fig. 6 illustrates an arrangement that was applied to an old-style Pratt & Whitney lathe which had, at one time, been equipped with a taper attachment. The arrangement shown was specially designed for crowning pulleys which previously had been "chucked," faced and rough-turned straight on the periphery. A keyway had also been cut through the hub. A special arbor D was held on centers in a lathe, the dog E acting as a driver in the special faceplate F. The pulleys were put on the arbor until the face of the hub came up against the shoulder H, the spacer J being interposed between the two hubs. The cast-iron driving plate K was then put on,

followed by the washer M. The nut L was then used to tighten the pieces in position. The driving bar G was used in order to prevent vibration which would otherwise be troublesome due to the thin flange of the pulleys. The two round-nosed tools B were mounted on the tool-slide C and held in the ordinary manner. A steel plate Y was bolted to the end of the slide and overhung sufficiently to permit the bar X to pass through it. This bar passed completely through the carriage and was a sliding fit in it. The stud Q passed through the bar and formed a bearing for the roller R. The cast-iron bracket N was fastened to the rear of the carriage and was tapped at its outer end to receive the screw O, which was used for adjusting the compression of the spring P. This spring was of square section 1/4 inch in size and served to keep the roll in contact with the cam-plate S. Two brackets V and the plate U were a part of the taper attachment with which the lathe was originally equipped. The dovetail plate T served as an adjustable support for the cam-plate S and it was held in its proper location by the screws W. The upper view in the illustration is partially broken away to show the roll R in position

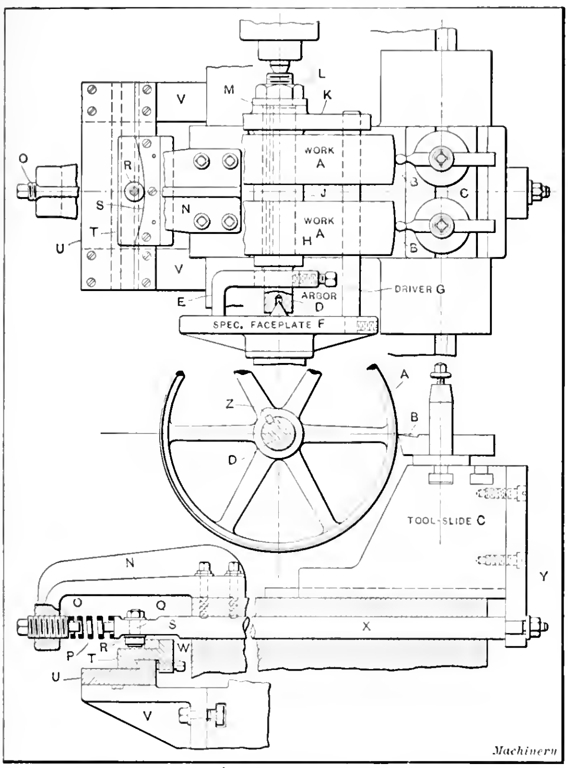

Fig. 6. Pulley Crowning Attachment for Engine Lathe

against the cam-plate. The operation of this attachment is obvious and it is only necessary to state that its action was very satisfactory.

Convex Turning Attachment using a Radius-bar

Fig. 7 shows a rather peculiar attachment for turning the convex surface on the cast-iron head-piece shown at A. The device is applied to the engine lathe, and its construction is such, that by the substitution of various lengths of radius-rods, it may be used for an infinite number of radii. The cutting tool B is held in the toolpost C in the ordinary manner and the longitudinal feed-screw is left free so that the carriage R may be perfectly independent. The bracket F is secured to the inner ways of the lathe so that it is absolutely prevented from moving. This bracket is dovetailed along its upper face and the slide G is mounted upon it. A tool-steel stud E is screwed into the side of the cross-slide and enters the bushing H which is contained in the bracket slide G. This bushing is eccentric and is split along one side thus permitting a slight adjustment to compensate for wear. The binding screw J holds it rigidly after setting. The tie-rod L connects the carriage R with a special bracket Q at the rear end of the lathe, this bracket taking the place of the regular tailstock, and being gibbed to the ways in such a manner that it is free to slide longitudinally. The tie-rod is held in place by the

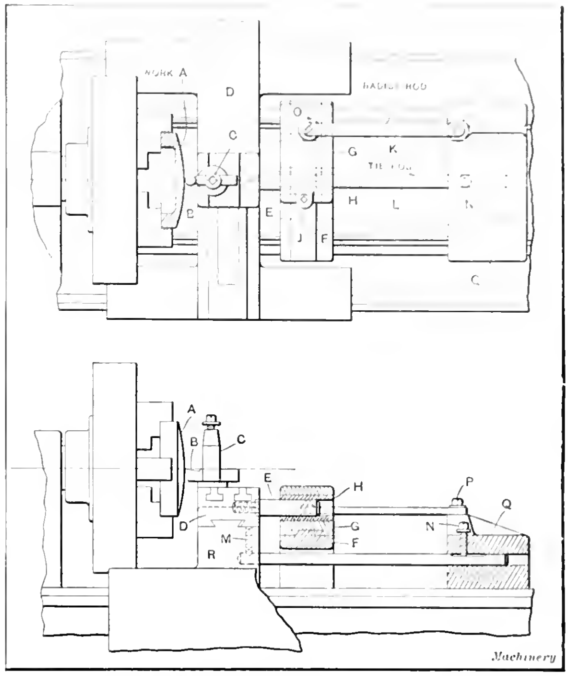

Fig. 7. Convex Turning Attachment of Radius-bar Type

screws N and M. The radius-rod K is made from a piece of flat steel and swings on the two screws O and P, located in the bracket slide and the tailstock substitute respectively. In the operation of this mechanism, the cross feed-screw is thrown

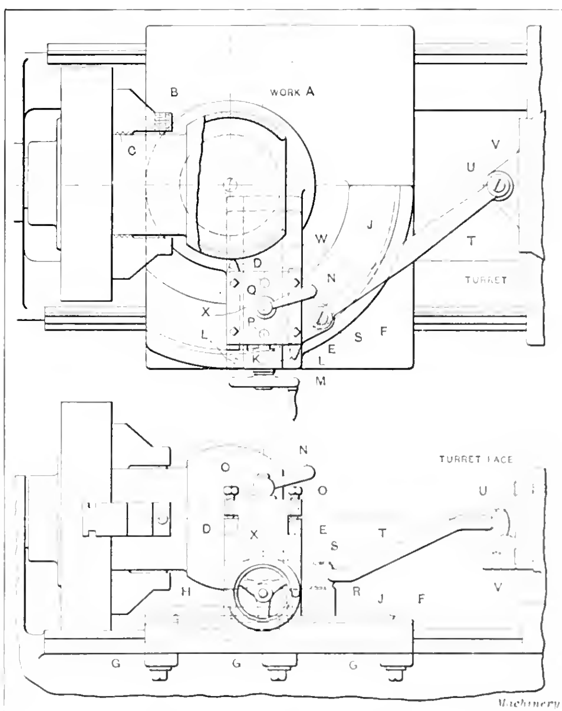

Fig. 8. Spherical Turning Device for Horizontal Turret Lathe

into mesh and the slide D moves forward carrying with it the bracket slide G to which the radius-rod is attached. As the bracket F cannot move longitudinally, it is evident that the tail-

stock substitute Q will be forced backward by the radius-rod and will carry with it the entire carriage and cross-slide, thereby generating the desired radius.

Ball Turning Device for the Horizontal Turret Lathe

We now come to a somewhat more pretentious device designed for the horizontal turret lathe for the purpose of generating the spherical portion of the steel pipe joint shown at A in Fig. 8. This work is held in chuck jaws at C, the supplementary screws B being used in the outer ends of the jaws to assist in supporting the work. The regular turret lathe cross-slide and carriage are removed and the special slide F is substituted. It is gibbed firmly to the ways in the desired position by the gibs G. Directly under the center line of the spindle, a large circular recess is bored to receive the swivel H, and circular rim J is dovetailed so that the outer end of the swivel may be gibbed at K to insure rigidity. The two screws L hold the gib. The slide W is dovetailed and has an adjustment for diameters, controlled by the handwheel M. The roughing and finishing tools D and E are held in the indexing toolpost X, the tools being secured by the screws O. The index location is insured by means of the pin P entering a hole directly underneath it in the slide, and the other index position is determined by the hole Q. The binder N locks it rigidly. At the right of the swivel the lug R is built out to receive the pivot screw S, on which the forward end of the radius-arm T is fastened. A bracket V is bolted to the face of the turret and carries the screw U which supports the other end of the radius-arm.

In the operation of this device, the turret longitudinal feed is used while the roughing tool D removes the scale from the casting. The toolpost is then indexed and the finishing tool E completes the work. This attachment gave very good results

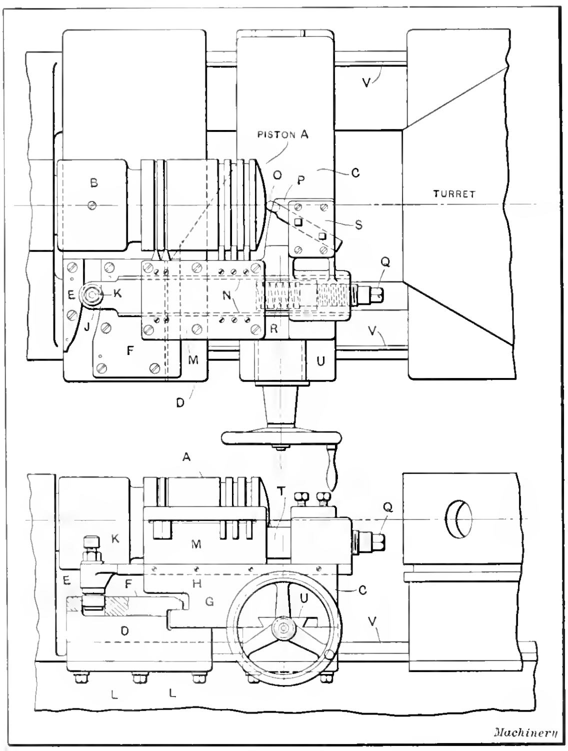

Fig. 9. Turret Lathe Piston Crowning Attachment

and was satisfactory in every respect. There are several points in the construction of this device to which attention should be directed. One of the points is the turret toolpost by means of which the tools always remain set, so that the diameters are easily held to size. Another point is the dovetail gibbing of the outer portion of the swivel. This method does away with all possibility of chatter, providing the gib is kept tight. Another advantage is the adjustment for various diameters by means of the slide W which is mounted on the swivel.

Turret Lathe Attachment for Crowning a Piston Head

The attachment in Fig. 9 is part of an equipment of tools for finishing the piston A, the work being held by the inside on a special chuck B, which is screwed onto the end of the spindle. There are turning tools fastened to the turret which are in action simultaneously with the attachment shown. These are not shown in the illustration, as they have nothing to do with the radius attachment. A special steel cross-slide C is mounted on the carriage in place of the regular slide, and

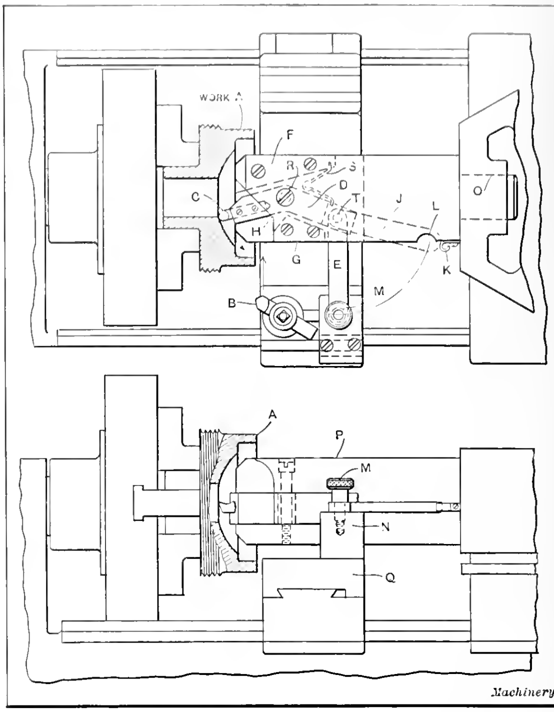

Fig. 10. Turret Lathe Attachment for turning Concave Seat

the overhanging portion G carries a tool-block M in which the grooving tools for the piston are mounted. A special bracket D is firmly gibbed to the ways and secured by the screws L. The tool-steel forming plates E and F are screwed to this bracket and doweled in position. The plate F also acts as a strap for the overhanging portion of the cross-slide at H. A hardened and ground tool-steel roller J is pivoted on the stud K, and controls the form of the crown by its contact with the plate F. The other plate E only acts as a guard. The radius forming slide is dovetailed at N and passes through under the tool-block. It carries a tool O mounted in the tool-holder S. A supporting pad P is provided on the cross-slide directly under the tool-holder and serves to prevent vibration. A heavy coil spring R is used to insure proper contact of the roll with the cam-plate. The necessary adjustment is obtained by means of the screw Q. A brass tube T protects the spring from chips and dirt which might otherwise impair its action.

This attachment was built for a large manufacturing plant in the East, and proved very satisfactory. It is designed so that all the tools can work at the same time. In building the attachment, it was found necessary to fit the dovetail slides and other moving portions, after the tool-blocks were put in place, and the tools clamped in position. This was unavoidable because of the clamping strains, as these caused a certain amount of distortion, making it necessary to do the fitting after the tool-blocks were in position.

Radius Boring Attachment for a Horizontal Turret Lathe

The device for generating the internal radial seat in the brass casting A, shown in Fig. 10, is somewhat out of the ordinary, and in addition to this, it is comparatively inexpensive. Furthermore, it is practically a self-contained unit, and requires no special fitting or attachments to the machine.

The steel bar P is held in the turret by the shank O and is

secured in place by the turret binder. The bar is slotted completely through to receive the swivel arm D which is a machinery steel forging ground on two sides to fit the slot. The forward end of this swivel arm carries the tool C which is set at the proper distance from the screw R to produce the desired radius. At the end of the bar, a mill cut is made at H in order to permit access to the screws which hold the tool in position. The steel filler blocks F and G are put in to give additional rigidity to the end of the bar. The flat spring S is simply used to prevent back-lash in the swivel arm. The operating link E enters a slot in the end of the swivel arm and is held by the pin T. A special steel block N is fastened to the cross-slide and the knurled screw-pin M couples the end

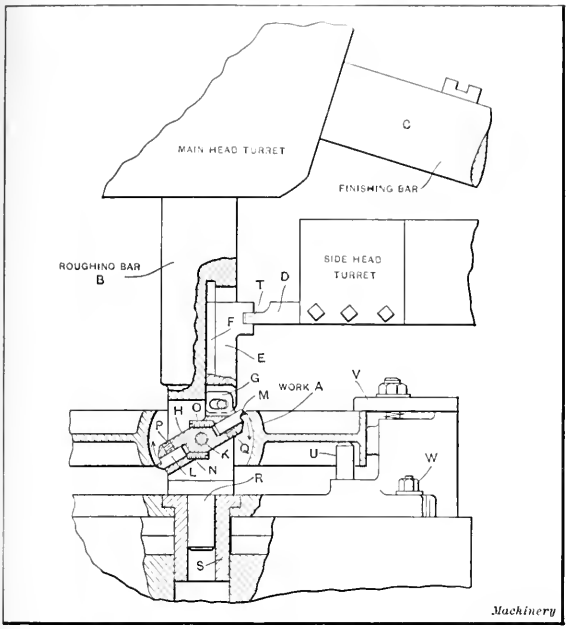

Fig. 11. Radius Boring-bar for Vertical Turret Lathe

of the link to the slide. The tool B is used in connection with the attachment for facing the end of the work.

In operation, the cross-slide feed-screw is engaged and the radius nicely generated by the radial action of the arm. As

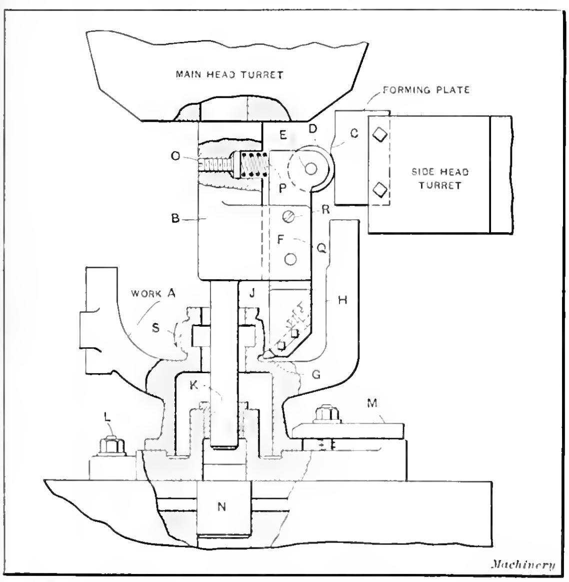

Fig. 12. Attachment for Convex Turning in Vertical Turret Lathe

soon as this operation has been completed, the knurled screw M is rapidly removed and the link E, swung over into the slot J where it is held by the flat spring K. The cut L allows the fingers to grasp the link when the radial attachment is again put into use. This attachment has many good points, the only serious draw-back being that there is a slight tendency to chatter when the cut is excessive.

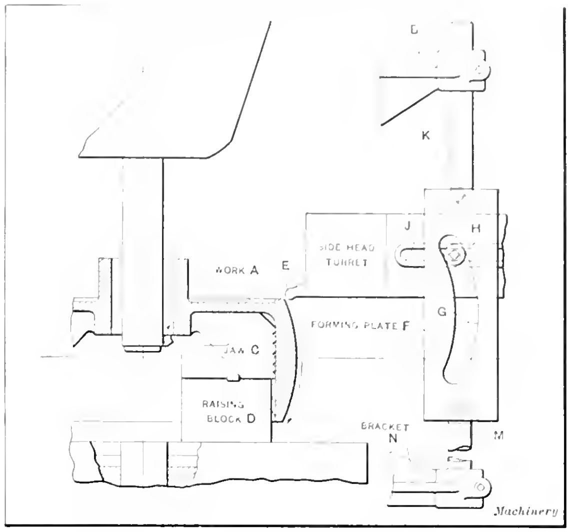

Fig. 13. Device for crowning Pulleys in Vertical Turret Lathe

Radius Boring-bar for the Vertical Turret Lathe

The device shown in Fig. 11 was designed for use on the vertical turret lathe, and was used in connection with other tools in the main and side heads for the purpose of boring the radial portions of the automobile crank-case cover bracket shown at A in the illustration. The work is held on a locating fixture upon three pins U and is clamped by means of the straps V. Only a part of the work is shown, as the piece is a

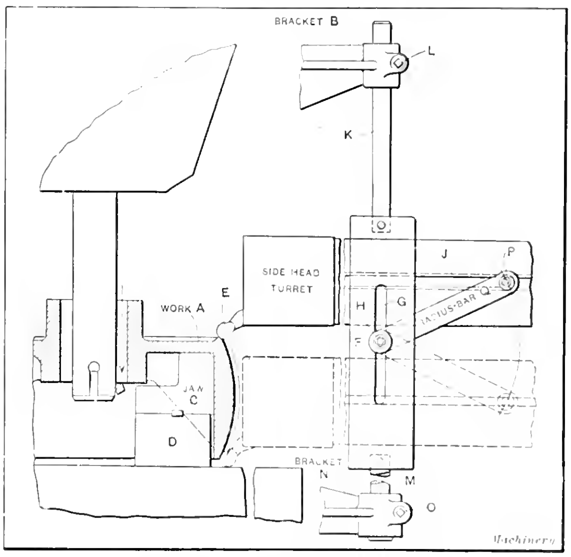

Fig. 14. Another Pulley Crowning Attachment

somewhat crooked one and the other portions have nothing to do with the radial boring. The fixture is held to the table by three tee-bolts W and it is centered by the steel bushing S, which also acts as a guide for the stem of the boring-bar R. This bar is slotted out at its lower end to receive the swivel block H, which carries the tools L and M for rough-boring the radius. The block swings on the pin K, when forced to do so by the downward action of the operating arm E. The two cutting tools are backed up and adjusted by means of the screws N and O, and they are held firmly in position by the set-screws P and Q. The bar B is slotted out to receive the tongue F on the operating arm, and the lower end of this arm contains a pin which works in a slot at G in the upper

portion of the swivel tool-block. The steel piece *D* is held in the side head turret and engages a groove in the upper part of the operating arm.

The finishing bar *C* is of the same general construction as the roughing bar except that only one tool is used for finishing, instead of the two shown in the roughing bar. It is well to note that the use of two tools in roughing practically reduces the roughing time one-half, it being only necessary to cut half way with each tool, as one comes up from the bottom while the other is coming down, so that the two cuts meet at the center. In operation, the down feed of the side-head turret is started, thus providing the necessary power for operating the device. This scheme gave very satisfactory results as far as accuracy is concerned, but as the mechanism was confined in a small space, the size of the tools could not be made large enough to properly conduct away the heat generated in boring.

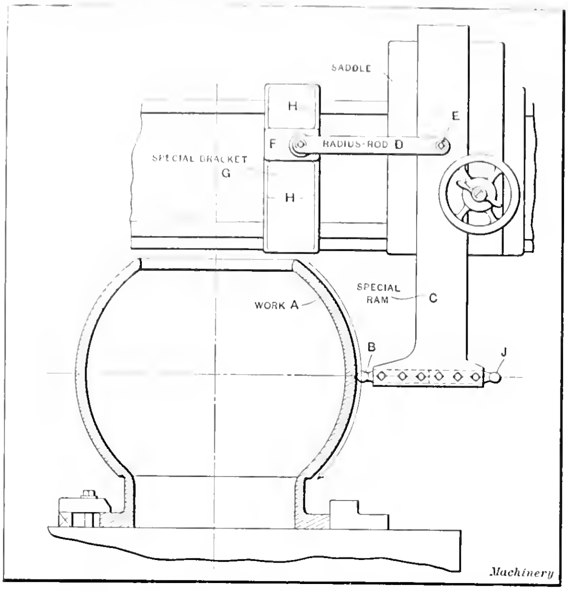

Fig. 15. Spherical Turning Attachment for Vertical Boring Mill

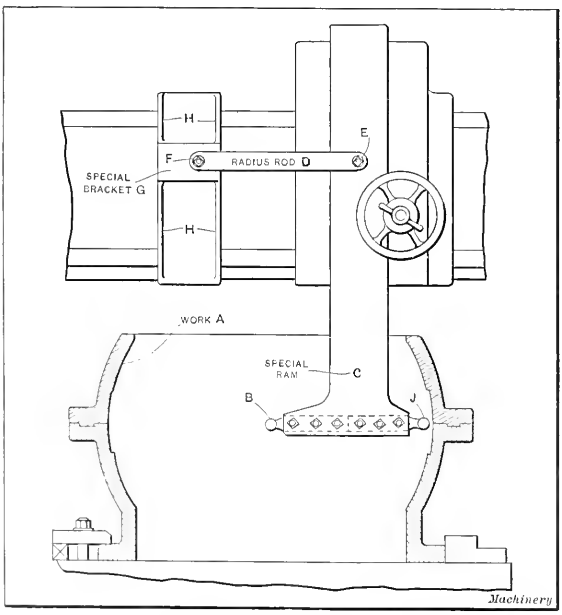

Fig. 16. Attachment shown in Fig. 15, used for Internal Work

Convex Turning Device for a Difficult Piece of Work

Fig. 12 shows a device for convex turning. The jack-shaft tube bracket *A* has been previously machined at its lower end and is located for this setting by the finished surfaces. A special fixture is bolted to the table of the vertical turret lathe, by the three tee-bolts *L*, and it is firmly secured by the straps *M*. The stud *N* serves to center the fixture on the table, while the bushing *K* acts as a guide for the end of the bar. The radial surface *S* is to be machined at this setting, and it will be noted that it is somewhat confined. The generating bar *B* is a 0.40 carbon steel forging, and the piloted end is carbonized, hardened and ground to a running fit in the bushing *K*. The projecting portion *Q* of the bar is of rectangular section and is slotted to receive the swinging arm *J*, which is pivoted on the pin *F*. This pin is equi-distant from the end of the cutting tool *G* and the center of the pin *E*. A hardened and ground tool-steel roller *D* revolves upon the latter, and is kept in contact with the forming plate *C* by means of the spring *P*, which is very stiff. Adjustment is provided through the screw *O*.

In operating this device, the turret down feed is used and the side-head turret is locked in the proper relation to the cutting tool, to produce the radius at the correct height on the casting. For the finishing cut, the roughing tool *G* is removed and a finishing tool substituted. A special screw *H*, having a large head against which the ends of the tools bear, makes this comparatively easy. The work can be turned closer to size if two roughing tools and a finisher are used, leaving only about 0.010 inch for the final cut. A defect in this fixture is that the thrust of the cut has a tendency to force the roll away from the cam-plate, and the action of the spring is sometimes insufficient to entirely overcome this. Had it been possible to design this attachment in such a way that the thrust of the cut would simply hold the roll more firmly against the forming plate, its action would have been more positive. The results obtained were sufficiently close, however, to conform to the required limits of accuracy, and it may therefore be stated that its work was satisfactory.

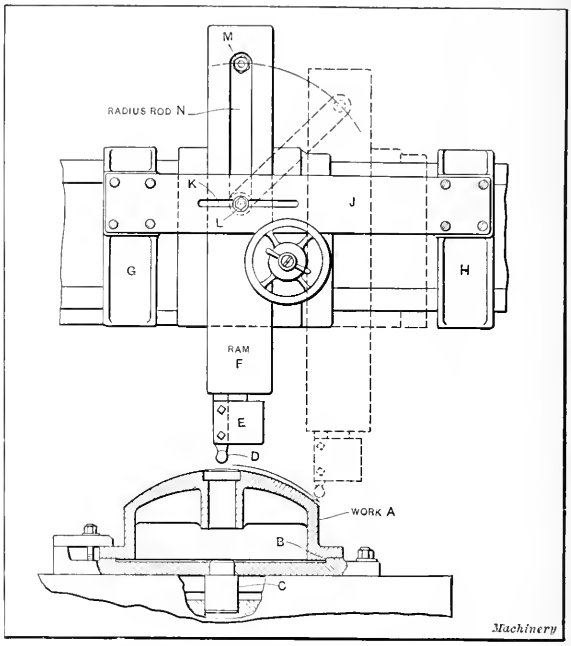

Fig. 17. Convex Turning in a Horizontal Plane

Convex Forming Attachment for the Vertical Turret Lathe

A simple arrangement for the vertical turret lathe which permits the simultaneous use of both the main head and side heads, is shown in Fig. 13. The work *A* is a tractor pulley of large size. This is held by the inside, in the jaws *C* which are mounted on the raising blocks *D*. The boring-bar shown may be used if desired, while the radius turning is taking place, as the radius attachment does not interfere in any way with the movements of the main head. The construction of this device is extremely simple and the results obtained by its use are very satisfactory. The upper and lower brackets

B and *N* are attached to the bed of the machine and carry the rods *K* and *M*, which support the forming plate *F*. This plate is cut at *G* to the desired radius, and the tool-steel roller *H* travels along the slot and forces the tool *E*, which is held in the side-head turret, to take a similar path, thereby producing the convex surface on the rim of the pulley. A tee-slot *J* is cut along the entire length of the side-head slide, and the roll *H* is fastened to a special bolt which can be adjusted to any position in the slot. The forming plate is also adjustable vertically, by sliding the rods up or down in the brackets.

Side-head Attachment using a Radius-bar

Another method for crowning the outside of a tractor pulley is shown in Fig. 14, a radius-bar being used in this case to

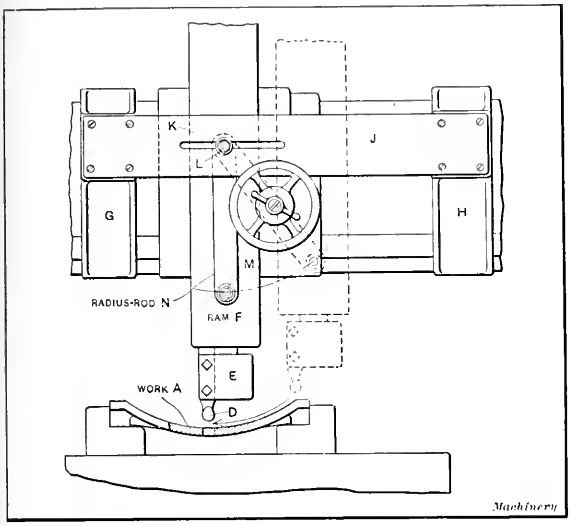

Fig. 18. Concave Turning in a Horizontal Plane

generate the desired curve. The work *A* is held, as in the previous instance, by the jaws *C* on the raising blocks *D*. The same brackets are also employed, but the plate *F* is not used for forming. It is slotted at *G* for adjustment only and a special screw or stud *H* is used in the slot as a pivot for the radius-bar *Q*. A tee-slot *J* is cut along the entire length of the side-head slide and receives a special stud *P*, to which the other end of the radius-bar is fastened. The down feed of the side-head is thrown into engagement when operating the device, and the tool *E* naturally follows the radial path controlled by the length of the radius-bar. This device is simple and good and only requires extra radius-bars in order to handle a great variety of work.

Vertical Boring Mill Attachment for Spherical Turning

The male member of a very large ball-and-socket pipe joint is shown at *A* in Fig. 15. The spherical portion, which is to be machined, has an outside diameter of forty-nine inches. This member fits the female portion shown in Fig. 16, and the attachments used for boring and turning are the same, although the locations and the tools are different. A special bracket *G* is mounted on the rail and is gibbed at the rear so that it can be adjusted easily. It is well gibbed at *H* to insure rigidity. The special ram *C* was made in the form shown, its lower end acting as a tool-holder for the tools *B* and *J;* the former is used for the outside turning and the latter for the inside boring. The ram itself is a steel casting of extra-heavy section on account of the excessive overhang required. The radius-rod *D* was fastened at the two ends by the screws *F* and *E*, and was made of the proper length to give the correct radius. A special arrangement, not shown in the illustration, permitted a side floating action to the saddle along the rail, when the down feed was engaged.

For handling the socket portion of the joint shown (Fig. 16), the entire mechanism was moved over on the rail far enough to bring the tools in the desired position for boring, the tool *J* being used for this purpose.

Attachment for Convex Turning in a Horizontal Plane

The work *A* shown in Fig 17 is a steel casting which has been previously machined at *B*. It is held on a fixture (located centrally on the table by the plug *C*) and clamped down by the three clamps around the flange. Two brackets *G* and *H* are mounted on the rail and serve to carry the supporting plate *J*. As these brackets necessarily extend some distance in front of the rail they are strongly ribbed, as shown in the illustration. The supporting plate *J* has a slot cut in it at *K* for adjusting the pivot stud *L* in a longitudinal direction. This stud supports one end of the radius-rod *N*, and the other end is attached to the upper portion of the ram *F* by pivot stud *M*. A regular tool-holder at the lower end of the ram holds the tool *D*. No special arrangement is necessary to allow the saddle to "float" in a transverse direction, as the horizontal feed-screw is used in this case, the vertical feed being simply thrown out of mesh. This permits the ram to float vertically, as controlled by the radius-rod *N*.

Attachment for Concave Turning in a Horizontal Plane

The steel casting shown at *A* in Fig. 18 is turned concave by the same device as that illustrated in Fig. 17, the only difference being that the radius-rod *N* is pivoted to the ram below the supporting plate instead of above. The operation of the mechanism is exactly the same as that for the convex surface.

Many variations of the devices described in this article have been used for generating radial surfaces, but enough have been described to enable the reader to select a method most suited to the particular problem that may require a solution. Adaptations may be readily made to fit almost any condition likely to be encountered in general manufacturing.

* * *

A LIGHTNING CALCULATION

BY UNCLE JOSH

Considerable amusement may be derived by this mysterious trick of "lightning calculators." The "professor" announces that five numbers will be written, three by the audience, and two by himself, and that after the audience selects the first number, he will immediately give the sum of the five *before the rest have been selected.*

Thereupon, one of the audience writes, for the first number, for instance, 4,962,783 and the professor immediately announces that the sum will be, 24,962,781. To illustrate:

The audience selects for the first figure............	4,962,783
The audience selects for the second figure..........	8,652,794
The professor writes for the third figure..........	1,347,205
The audience selects for the fourth figure..........	2,339,964
The professor writes the fifth number.............	7,660,035
The sum is found to be, as announced	24,962,781

This seems very mysterious, but is easily accomplished, as follows: For the sum, subtract 2 from the first number selected, and place the figure 2 to the left of it. Thus, subtracting 2 from 4,962,783=4,962,781, and placing a figure 2 before it makes it read 24,962,781.

The professor selects the third figure, by selecting such numbers that the figure in each column, added to the figure above it, will make nine.

Thus, the second figure being......................	8,652,794
He will write the third figure......................	1,347,205
The sum of each column = 9......................	9,999,999
The audience then writes the fourth figure..........	2,339,964
The professor proceeds as before, writing...........	7,660,035
The sum in each column being 9..................	9,999,999

[If the number of horizontal rows of figures is increased from five to seven, the sum can be obtained by subtracting 3 from the first number and placing the figure 3 to the left, whereas for nine horizontal rows, subtract 4 from the first number and place 4 to the left, etc.—EDITOR]

* * *

The life of shop brooms can be greatly lengthened by dipping the brush in hot water before using. The glue water is made by using one teaspoonful of good liquid fish glue for each quart of hot water.

ONE-PIECE ARMATURE DISK TOOLS*

UNUSUAL TOOLMAKING METHODS EMPLOYED BY THE ROBBINS & MYERS CO.

BY DOUGLAS T. HAMILTON†

Fig. 1. Armature Disk

Armature disks are made from a grade of sheet iron 0.025 inch thick called "electric" iron. This material is used because of its permeability—low resistance to an electric current—and though very soft, it is difficult to cut out, the wear on the dies being enormous. The shape of these armature disks, as Fig. 1 shows, is such that it has been considered inadvisable by many manufacturers, to make the dies or punches solid because the thin strips of metal remaining are likely to warp in hardening and break, and if made solid, the repairing of them would be difficult if not impossible. The Robbins & Myers Co., Springfield, Ohio, well-known manufacturers of the "Standard" line of fans, motor and generators, make all types of armature and field punches and dies up to 10 inches in diameter from one solid piece of steel, and machine them to the shape required. This not only calls for good tool work, but it also demands particular care in hardening and subsequent operations.

Construction of Solid Armature Disk Tools

The punch and die shown in Fig. 2 is not of the sub-press pattern, as is the usual practice followed in making sectional armature disk dies, but is of the plain blanking type of construction. The blanking die *G* is made from one solid piece of steel in which the required number of elongated slots are machined, as will be described later. The die fits in a counterbored seat in the die shoe *H* and is held in place by screws as shown.

The slitting punch *I* is made from a solid block of steel, which in this case is provided with a projection fitting in a recessed seat in the punch-holder *J*, to which it is held by screws. The punch *I* is also recessed to fit an additional plain blanking punch *K*, the latter cutting out a blank which is subsequently slit and made into a smaller sized armature disk *A*, Fig. 11. This method is used to economize in stock, and cut the scrap down to a minimum. The individual piercing punches *L* for the large armature disk *B*, Fig. 11, are driven into the punch-holder *J*, as illustrated. The prongs of the slitting punch *I* are formed by cutting a series of slots around the periphery of the blank and then shaping the individual prongs to the desired shape, as will be described later. The punch and die illustrated in Fig. 2 is the largest solid armature disk tool ever produced by the Robbins & Myers Co., and both the die and punch are made from solid pieces of "Ketos" non-shrinkable oil hardening steel.

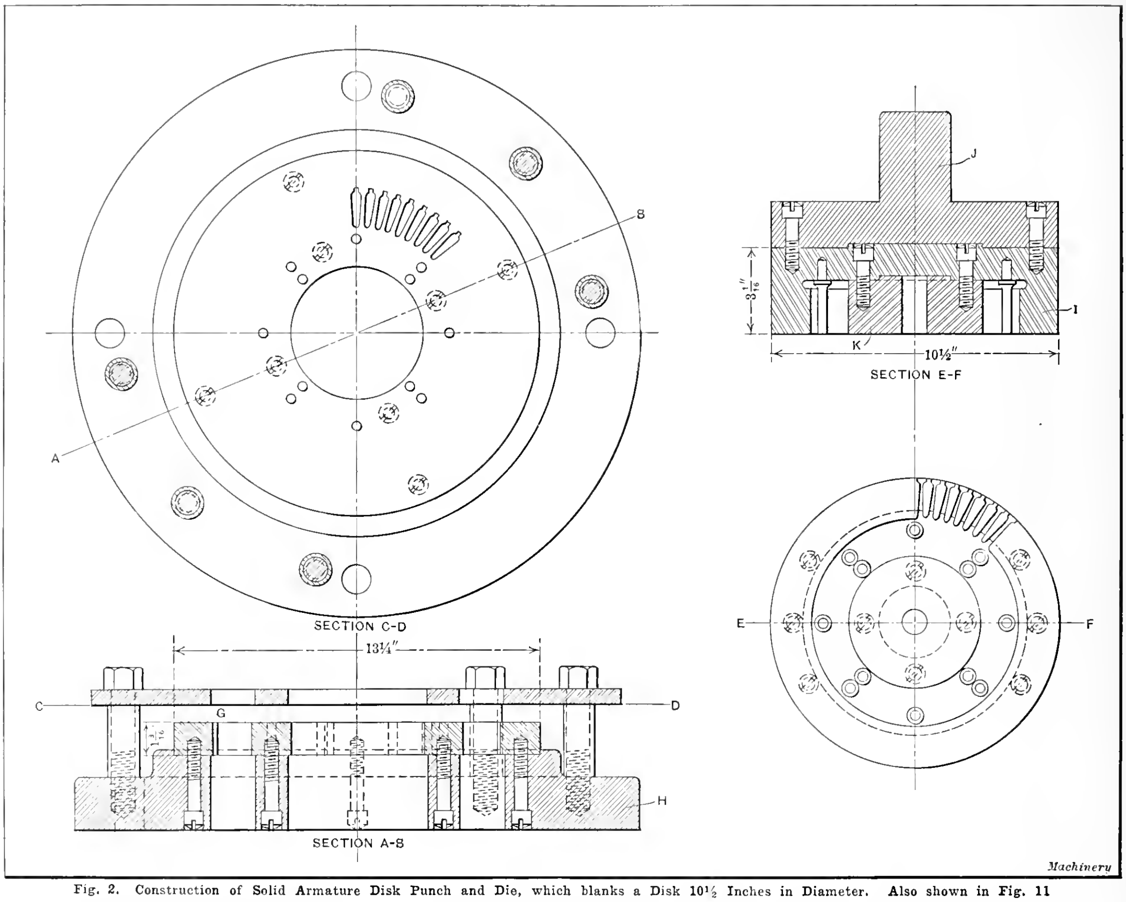

Fig. 2. Construction of Solid Armature Disk Punch and Die, which blanks a Disk 10½ Inches in Diameter. Also shown in Fig. 11

Making Solid Armature Disk Dies

Armature disk dies, as previously mentioned, are made solid up to 10 inches in diameter, and are cut from round bars of special non-shrinkable oil hardening steel. The blank, after the center hole has been drilled, is placed on an arbor and turned on the external diameter in the lathe; it is then ready for working out the elongated slots which form the projections on the armature disks. The first step in this operation is to drill a series of equidistantly spaced holes entirely through the blank as illustrated in Fig. 3. The die block *A* in this case is driven onto a taper arbor which is held in the dividing

* For information on punch and die work previously published in MACHINERY, see "Drawing and Forming an Automobile Clutch Cone" in the November, 1913, number, and articles there referred to.
† Associate Editor of MACHINERY.

head on the milling machine. A bushing type of drill chuck is then inserted in the spindle of the milling machine, carrying a drill of the required diameter. The internal ring of holes is usually drilled first, then the size of the drill is changed and an exterior ring of holes is drilled, these two rows of holes forming the approximate length of the slots. Following this, a series of holes is drilled so that they just break into each other, and thus remove the intervening webs.

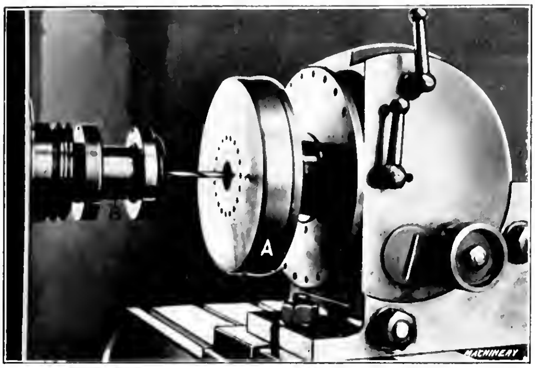

Fig. 3. Drilling Solid Armature Disk Dies in a Milling Machine

The next step is to finish-form the elongated slots, this operation being accomplished in the manner shown in Fig. 4. The die *A*, as before, is mounted on a tapered arbor, which is held in the dividing head on the milling machine, while slotting tools of the proper shape are held in the slotting attachment. The dividing head is held perpendicular and the slotting attachment is also set square, so as to produce a straight hole. The clearance angle is produced in a filing

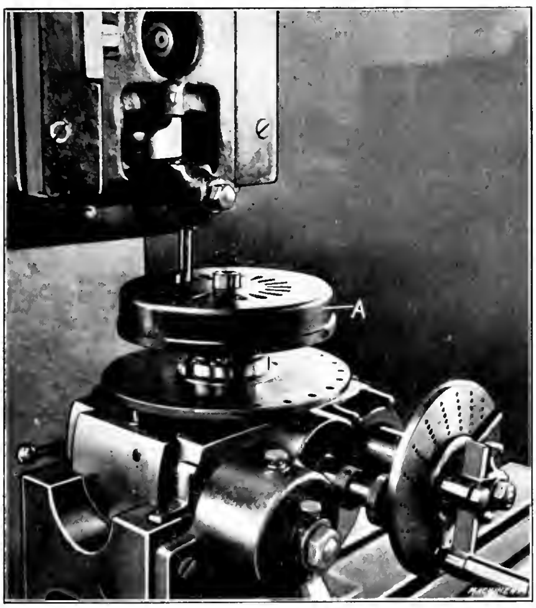

Fig. 4. Shaping Elongated Slots in a Solid Armature Disk Die, using a Slotting Attachment and Indexing and Dividing Head on a Milling Machine

machine as will be described later. The sides of the slots are machined first, after which the two arcs at each end of the oblong slots are machined. The outer arc has a slot cut in it. A tool of suitable shape is used to produce this slot after the arc has been finished and the slot cut to the desired length. The indexing attachment of the dividing head, of course, is used for spacing the holes correctly.

Finishing Operations on the Die Blank

After the elongated slots in the die have been machined to their approximate size, the final operation consists in filing them to the exact size. This is accomplished in the small bench filing machine as illustrated in Fig. 5. It consists of a table that can be set to the desired angle, which carries a file of such shape as to conform with the slots in the die. This machine is driven by an individual motor as illustrated, and in addition to bringing the slots to the proper shape it also produces the correct clearance angle. The clearance angle on armature disk dies is 0.003 inch on a side, the die blank being 1⅛ inch thick. It is necessary, therefore, to tilt the table over from the vertical line to an angle of about 7½ minutes.

The die blank is hardened and drawn before the punch is made and fitted to it. For hardening, a regular gas burning muffle furnace is used. The blank is placed in this furnace and brought to a temperature varying from 1375 to 1400 degrees F. The heating is done gradually and uniformly until the tools show a dark red throughout, indicating a temperature of about 1100 degrees F., before the heat is raised to the hardening point—1375 to 1400 degrees F. The tools are then dipped into linseed oil and left to cool, after which the temper is drawn very slowly to 250 degrees F. to relieve the strain. The hardening of solid armature dies calls for considerable ingenuity on the part of the toolmaker, as the least amount of shrinkage or warpage in the die would unfit it for use, and as it is of the solid type it would be practically impossible to do anything with it if distorted in hardening. It is therefore evident that not only must a good brand of steel be used,

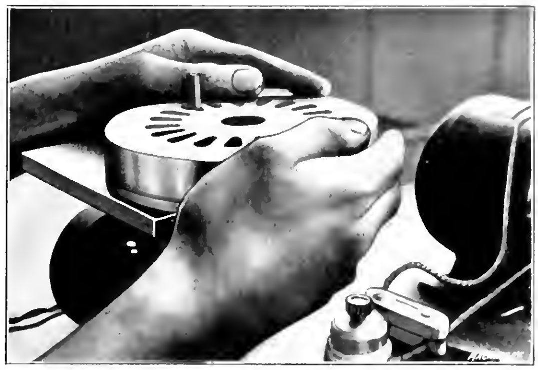

Fig. 5. The Final Machining Operations on a Solid Die—filing the Elongated Slots to the Proper Size and Shape

but considerable care has to be exercised in order to obtain satisfactory results. However, it may be stated that the Robbins & Myers Co. have been using this type of die for a considerable period, and they have not lost one tool during the past two years in the hardening operation.

Slotting Armature Disk Punches

The punch is made in a similar manner to the die in that it is cut off from a round bar of stock, drilled, turned and recessed in the lathe and is then slotted as illustrated in Fig. 6. The punch *A* in this case is driven onto a tapered arbor which

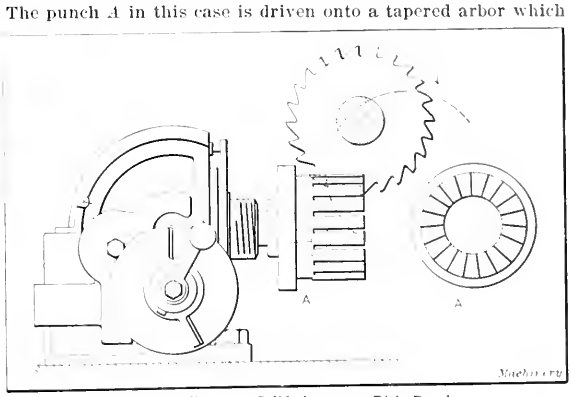

Fig. 6. Slitting a Solid Armature Disk Punch

is held in the dividing head of the milling machine and a slotting saw of the required thickness is used to form the individual members of the punch. Two cuts are taken; one cut is taken as indicated by the full lines in the illustration, after which the position of the cutter is changed and a second cut is taken. On some types of armature punches where the

slot between the individual members of the punch or prong varies in width at the inner and outer extremities, slotting saws of different thicknesses are used in order to reduce the amount of machining on the sides of the members. When this is necessary, the saw is not inserted as illustrated in Fig. 6, but is raised slightly, and the second saw also raised, the remaining web being machined out with a slotting attachment in the milling machine.

Finish-forming the Individual Members or Prongs

After the individual prongs of the armature punch have been formed by slotting, the next step is to form the inner and outer arcs. This is accomplished as illustrated in Figs. 7 and 8. In Fig. 7 the punch *A* is set up in a vertical position, for machining the inner arc of the prongs. Here it can be seen

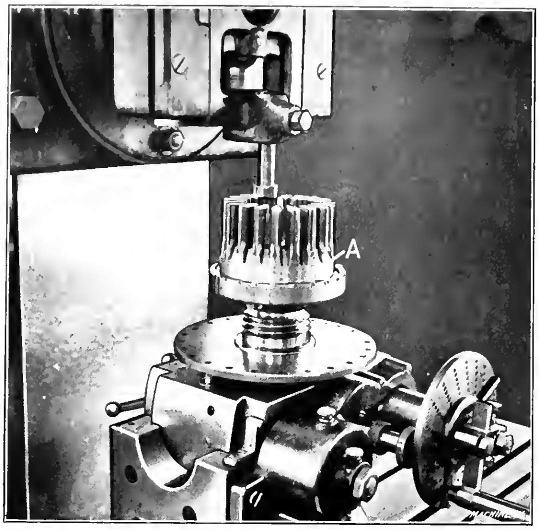

Fig. 7. Final Shaping Operation on the Inner Ends of the Punch Prongs, using a Slotting Attachment and a Dividing Head on the Milling Machine

that the dividing head is used for holding the punch, and the shaping tool is held in the slotting attachment of the milling machine. The shaping tool is so formed that it completes the arc on the inner edge of the prongs in one setting. The outer arc on the prongs is formed with the special milling cutter *B*, as indicated in Fig. 8, with the punch *A* held in a horizontal instead of a vertical plane. The milling cutter, in addition

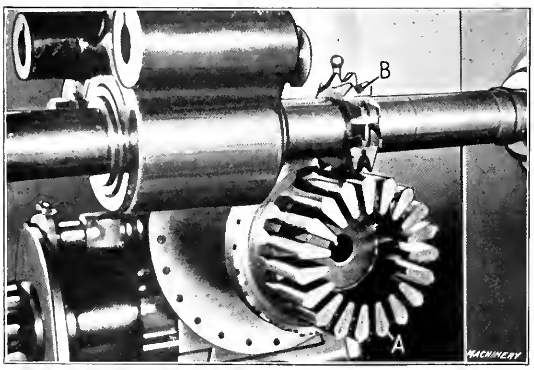

Fig. 8. Finishing the Outer Diameter of the Punch Prongs, using a Formed Milling Cutter

to forming the arc, also produces the slight projections on the punch that cut out the ring that will be left in the armature disk, or in other words, continues the oblong slot to the circumference. The milling cutter as illustrated completes this form of punch in one operation, and at the conclusion, with the exception of a slight touching up with the file, the punch is ready to be sheared into the die to obtain the final shape. The excess stock is filed away, and the punch sheared in several times until the shape has been produced for about 1/4 inch. After this the punch is taken back to the milling machine and the excess amount of stock removed as indicated in Figs. 7 and 8.

Different Types of Armature Disk Tools

Armature and field disks are made of several different shapes to conform with the motor or generator in which they are used. Fig. 9 shows a follow type of armature disk punch and die for producing the disk *A*. The sheet is first perforated

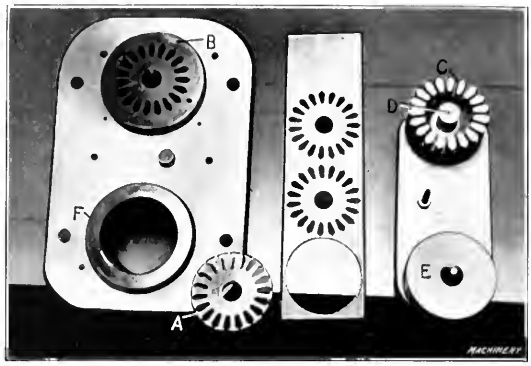

Fig. 9. Follow Type of Punch and Die for completing an Armature Disk in One Operation

by the solid die and punch *B* and *C*, respectively, and at the same time the hole is produced by the inserted punch *D*.

Owing to the relation of the blanking punch and die *E* and *F* to the perforating punch and die *C* and *B*, the punch press makes two strokes before a blank is cut out, when starting a new sheet. The chief reason for laying out the perforating

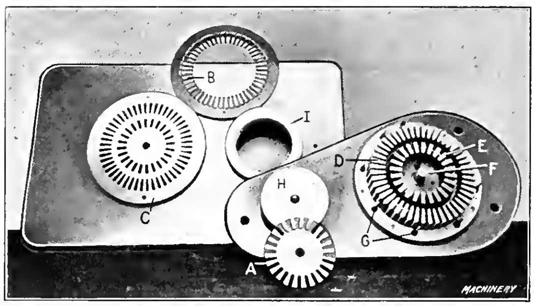

Fig. 10. Combination Follow Type of Punch and Die for completing an Armature Disk and slotting and piercing a Field Disk in One Operation

and blanking dies in this way is that it would be impossible to get them close enough unless made from the same piece of steel. Fig. 10 shows a follow type of die similar to Fig. 9, but of more interesting construction. These tools complete the armature disk *A* and slit and pierce the field disk *B* at each

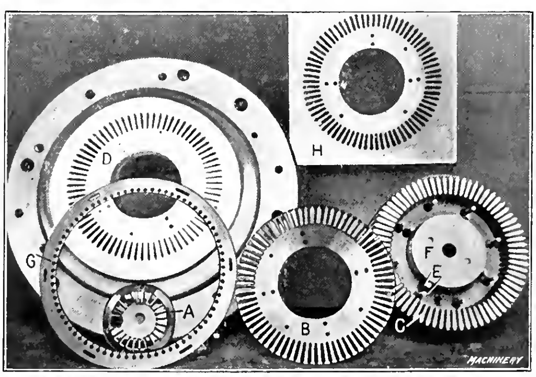

Fig. 11. Punch and Die for a Fan and Starter Field Disk and Other Pieces made from Same Sheet

stroke of the press. The field disk *B* is blanked out in a separate operation. The perforating die *C* is made from one solid piece of steel, while the punches *D* and *E* are made from two solid rings of steel fastened by screws to the punch-holder. The punch *F* which pierces the center hole in the armature

disk *A* is also an individual member. The piercing punches *G* for the field disk *B* are inserted around the outer periphery of the punch-holder as shown. Punch *H* and die *I* blank out the armature disk *A*.

Another interesting example of solid punch and die work is shown in Fig. 11. This illustration shows the punch and die presented in detail in Fig. 2, and also gives some idea of the number of blanks and the character of operations performed by it. The small field disk *A* is only blanked out by these tools and is pierced and slit in a separate operation. The large armature disk *B* is slit by the solid punch *C* and die *D* and is pierced by the inserted punches *E*, the center hole being produced by the separate punch *F*. It is blanked out from the sheet in a separate operation. The field disk *G* is another piece which is produced from the same sheet as the other parts shown in this illustration, but it is completed in a separate operation. The portion of the sheet *H* shows where the disk *G* is obtained.

An armature disk set of tools differing slightly from those previously shown is illustrated in Fig. 12. These tools are used to produce the armature disk *A* which is used in a 5 H. P. motor. The die *B* is one solid piece of steel machined out to the shape shown, while the punch is partly of segment

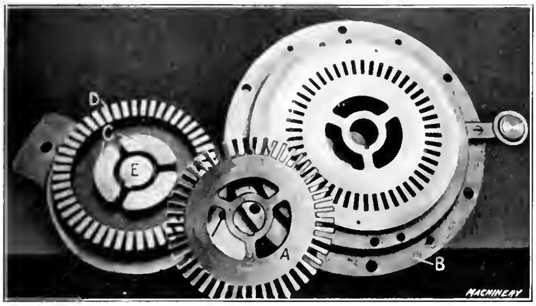

Fig. 12. Five Horsepower Armature Disk Punch and Die of a Semi-solid Construction

construction. Punches *C* for producing the arms are made from three separate pieces of steel let into the main slitting punch *D*, which is made from one solid piece of steel. Punch *E* is also an individual member. This armature disk is blanked out in a separate operation.

Fig. 13 shows an armature disk set of tools set up and in operation in a Toledo punch press. These tools are similar

Fig. 13. Solid Armature Disk Punches and Dies in Operation—Note Method of saving Stock

in construction to those shown in Fig. 10. They produce the armature disk *A*, and pierce and slit the field disk *B*, the scrap being a ring *C*. The field disk *B* is cut out from the sheet in a separate operation. The sheet of stock has been pulled out from beneath the punches to show the operations more clearly. This illustration shows the method used to reduce the scrap to a minimum.

Life of Solid Armature Disk Tools

One remarkable feature that is particularly noteworthy about these solid armature disk tools, and the steel used in making them, is their long life and the large number of blanks which can be produced between grinds. Fig. 14 shows two die blanks; the one to the right has never been used and

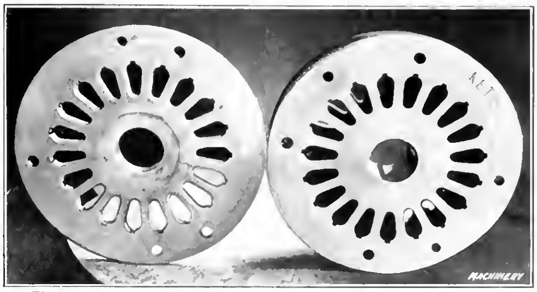

Fig. 14. Comparison of New and Old Armature Disk Dies. The Old Die has blanked 1,344,000 Armature Disks and has been ground down from 1⅛ to 3/16 inch in Thickness

is 1⅛ inch thick, whereas the one to the left has produced 1,344,000 blanks—16,480 blanks between grinds—has been ground eighty times, and reduced from 1⅛ to 3/16 inch in thickness. The solid punch also stands up satisfactorily and is ground an equal number of times. This is a rather unusual performance and is greatly in excess of what would be expected of the solid type of punches and dies as generally made. The clearance, as before mentioned, is only 0.003 inch on a side or 0.006 inch on the diameter of the elongated holes in the die. As the blank always retains the size of the punch—the scrap being the size of the die—the die can be worn down without affecting the character of the work produced by it.

* * *

SPEEDS FOR TURNING UNUSUAL MATERIALS

The *Practical Engineer* gives the following information on turning unusual materials: Slate, on account of its peculiarly stratified formation, is rather difficult to turn, but if handled carefully, can be machined in an ordinary lathe. The cutting speed should be about the same as for cast iron. A sheet of fiber or pressed paper should be interposed between the chuck or steadyrest jaws and the slate, to protect the latter. Slate rolls must not be centered and run on the tailstock. A satisfactory method of supporting a slate roll having journals at the ends is to bore a piece of lignum vitae to receive the turned end of the roll, and center it for the tailstock spindle. Rubber can be turned at a peripheral speed of 200 feet per minute, although it is much easier to grind it with an abrasive wheel that is porous and soft. For cutting a rubber roll in two, the ordinary parting tool should not be used, but a tool shaped like a knife; such a tool severs the rubber without removing any material. Gutta percha can be turned as easily as wood, but the tools must be sharp and a good soap-and-water lubricant used. Copper can be turned easily at 200 feet per minute. When machining commutators that is the speed commonly used. Light cuts are taken with a pointed tool and the surface is finished with a wooden buff lined with glass paper. This buff is in the form of a 90-degree segment and is approximately 1¾ inch thick. It is held against the commutator with the point of an ordinary tool and is fed back and forth across the surface. In this way the segments are gradually ground down until there is not the slightest gap or break between the copper segments and the mica insulation. Bath stone such as is used in the construction of pillars for balconies, etc., can be turned at 150 feet per minute, and the formation of ornamental contours is quite easy. Marble is a treacherous material to turn. It should be cut with a tool such as would be used for brass, but at a speed suitable for cast iron. It must be handled very carefully to prevent flaws in the surface.

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AUTOMATIC MACHINERY FOR DANGEROUS WORK

Machinery is designed to function automatically in order to insure uniformity of product and to reduce the cost of attendance. Another reason for designing automatic machines is to save life and limbs. The growing recognition of the fact—chiefly due to liability acts—that employers must bear the responsibility for accidents makes imperative the elimination of dangerous apparatus wherever possible. Some trades are inherently dangerous, and in these, simple automatic machines for performing the operations entailing risk to workmen should effect a considerable reduction of yearly casualties.

There are operations in the manufacture of ammunition which expose the workmen to danger of injury by explosion. They might cost no less if done on automatic machines, because the upkeep of the machines might wipe out the saving of attendance, but the greater safety of operation doubtless would make the change profitable both from a humanitarian and a monetary point of view.

Take, for example, the loading of the cases for a certain powerful explosive shell with cordite. Holes in the sides of the case must be provided, but on account of the difficulty of loading the cordite in cases having holes it seems necessary to load first and drill the holes afterward. Obviously, this is a very dangerous operation. A spark struck by the drill when passing through the wall into the chamber is sure to cause an explosion and probably the death or serious injury of the workman. Granted that the procedure must be as outlined, it seems little less than criminal not to provide automatic drilling machines in bomb-proof inclosures for drilling the holes. Such machines can be readily provided which would work rapidly and as efficiently as hand machines. One life saved by providing automatic drilling machines would be worth all the cost of the equipment.

* * *

BROACHING ROUND HOLES

Broaching keyways and holes of other shapes than round has been practiced many years, but not until the last decade in which automobile manufacturing has developed so greatly did broaching become a commercial practice of widely recognized importance. One of the unexpected applications of the broaching machine is for finishing round holes. The finishing of round holes by broaching instead of by reaming, may seem strange to those unfamiliar with the conditions met with in alloy steel gears, but some alloy steels are extremely difficult to finish satisfactorily by reaming. The steel is tough and the chips have a tendency to catch on the reamer blades and score circumferential grooves in the hole. The cost of reamer upkeep when working on alloy steels is heavy as compared with that for carbon steel.

The broaching process applied to finishing round holes in alloy steel parts is rapid and satisfactory. Not only is the tool upkeep cost lower than with reaming but the finish is superior to that obtained by reaming unless extraordinary care is taken. An advantage of minor importance is that the tool markings appear longitudinal instead of circumferential. This favors proper distribution of the lubricant and insures smooth and long wear of running parts.

* * *

STUDS VS. CAP-SCREWS

An important detail of steam and gas engines, air compressors, hydraulic machinery and other fluid-actuated mechanisms is the means employed for holding cylinder heads and valve covers in place. The choice of the designer lies between studs with nuts and cap-screws. What are the advantages and disadvantages of studs and cap-screws?

Studs are preferred to cap-screws, especially on heavy machinery for the following reasons: 1. A stud and nut can generally be screwed tighter than a cap-screw because of better alignment, smoother threads and reduced effect of torsional elasticity. 2. A stud and nut is less likely to break than a cap-screw when making repairs. In case a nut is rusted fast on a stud it can be split with a cold chisel, but a cap-screw "seized" in the casting is twisted off. This means that the broken part must be drilled out and a new cap-screw provided to take its place. The loss of time and extra labor incident to breakages of cap-screws are important disadvantages when making repairs. 3. Covers secured with nuts and studs can be loosened and tightened without serious deterioration of the fastening means. The nuts on studs can be loosened many times without appreciable wear of the threads, but not so with cap-screws. They soon wear the cast-iron threads and become loose and are likely to strip after being used a few times. 4. Studs have the advantage of holding gaskets in place while a cover is being applied. This is an important advantage in erecting when the parts are heavy and applied with difficulty. 5. A stud made from a round bar is stronger than a cap-screw turned down from a hexagon bar. The latter uses the weakest part of the metal at and near the center for the body.

The Ohio State University department of mechanical engineering will make a series of tests of studs and cap-screws with the view of determining all the advantages of each. Prof. William T. Magruder, head of the mechanical engineering department, will be glad to receive suggestions for the tests and arguments for and against the two types of fastenings.

* * *

ANTIQUATED TOOL-ROOM EQUIPMENT

We are sometimes surprised to find machine shops equipped with first-class tools in every department but the tool-room. In this important department are old lathes and other machines in good condition, but of old design. They did good work, but are too weak to take heavy cuts without excessive vibration and springing out of alignment. The management evidently believed that weak machines were good enough for toolmakers because they are seldom required to do heavy work. This is a mistaken notion. There is no reason why a tool-room lathe should take three or four cuts to reduce a piece when lathes in the main shop are doing the same work in two cuts.

The tool-room should be equipped with strong, heavy machines, for two very good reasons. First, in order to prepare the work quickly for the finishing operation, and second to take heavy reduction cuts when required with a minimum of chatter and spring. Toolmaking is, in the main, nothing more nor less than regular machinists' work with a touch of refinement in the finishing processes. Smoother finish and closer limits are the rule, and they are most efficiently obtained on machines that are sturdy as well as accurate.

STABILITY OF THE MACHINE TOOL BUSINESS

The growth of the machine tool business in the last twenty years has been unprecedented. In 1893 there were comparatively few American builders of lathes, planers, milling machines, boring mills, automatic screw machines, drilling machines, shapers, slotters and other machines for metal working, commonly known as machine tools and their accessories. The number has increased to about two hundred and the capital invested has increased in still greater ratio. At the beginning and during this twenty-year period there have been three distinct dull times, 1893, 1903 and 1907, but within the period the number of failures of machine tool builders was astonishingly small. Probably no other industry consisting of so many actively competing concerns building a long-lived product can show such a record. The record still holds. During the present year, which toward the close undeniably has been a dull time in the machine tool trade, there has not been so far one serious failure. This fact speaks volumes for the stability of the business and the conservatism with which it is conducted.

The last ten years have been marked by the development of a new vehicle—the automobile—and the past six or seven years by the building of enormous plants for its manufacture. The equipping of these plants with standard and special machine tools has created a great market that to a certain degree was unhealthy. It could not last indefinitely. With the slacking of demand for the higher-priced motor cars there have come several failures and discontinuances of automobile concerns which has resulted in throwing a considerable number of second-hand machine tools on the market. These tools have affected the market for new machinery detrimentally, of course. Thus, in the automobile business, the machine tool builders have had an enormous market to supply, for which a number of concerns have perhaps unwisely expanded. Now that the market is restricted and a few of the former buyers are now in a sense competitors, some hardship is inevitable.

The changes in the tariff naturally have caused a tightening of purse strings until such time as the ultimate effect can be seen. German machine tool competition may affect certain lines injuriously for a time, but years will be required for the German manufacturers to obtain a firm foot-hold in this country. During that time our manufacturers will be improving their methods and product so as to keep ahead of foreign countries. The future is full of promise with little to discourage the American machine tool builder. The development of American mechanical appliances for all sorts of purposes must go on, and that progress means unlimited demand for the basic means of production, that is for lathes, planers, drilling machines, milling machines, grinding machines, automatic screw machines, shapers, boring mills, boring machines, slotters and the special machine tools characteristic of modern machine shop equipment.

* * *

SPEEDS AND FEEDS FOR COLD SAWING METALS

The selection of speeds and feeds for cold sawing is one of the many phases of machine shop practice which cannot be regulated by fixed rules. The design and construction of the machine and saw, as well as the grade of material to be cut, cause wide variations in both speed and feed. The average output or number of pieces cut for each grinding of the saw is another factor to be considered. One prominent manufacturer of cold saw cutting-off machines states that for sawing 0.30 carbon, open-hearth machine steel bars 5 inches diameter, a feed of 1 inch per minute and a peripheral speed for the saw of approximately 45 feet per minute would be used. This speed and feed is regarded as economical when using the vanadium steel high-carbon blades. As an example of this rate of cutting, 1600 pieces were sawed off in one machine with an average output of 145 pieces for one grinding of the saw. For some classes of work a feed of 2 inches per minute and a speed of about 45 feet is employed, but under average shop conditions a feed of 3/4 inch per minute is considered conservative when cutting 0.30 open-hearth steel with a saw that is in good condition.

When selecting speeds and feeds, it is important to consider the output for one sharpening of the saw. In one shop 200 pieces of special analysis steel and 800 pieces of open-hearth steel (varying from 3 3/4 to 4 1/4 inches diameter) were cut at one grinding of the saw. While it may be feasible to cut various grades of steel at the rate of 1000 pieces with one grinding of a high-speed steel saw, the experience of the company referred to is that on high-carbon tool steel and special alloy steel, such as chrome-nickel, etc., the best economy in grinding the saw will be obtained by using a feed of about 1/2 inch per minute with a surface speed for the saw of approximately 30 feet per minute. When using the speed and feed mentioned, if the saw averages 100 pieces per grinding the output is considered satisfactory. It has been found that some of the special analysis steels cut quite freely as, for example, 3 1/2 per cent nickel steel which is sawed as easily as open-hearth 0.30 per cent carbon steel. On the other hand, some of the softer grades of stock, such as open-hearth machine steel having about 0.15 per cent carbon, do not cut as freely as stock with a higher percentage of carbon. This is because the softer steel is inclined to roll up into the throats of the saw teeth and, if too much heat is generated in the cutting the chips will fuse more or less to the teeth. A good deal of this soft stock, in bars 8 inches diameter, has been cut with a saw speed of 45 feet per minute and a feed of about 5/8 inch per minute. This rate of cutting is considered the most economical for the saw when using vanadium high-carbon blades. Some grades of chrome-nickel stock seem to cut quite freely, whereas steel of another make is cut with difficulty and, in some instances, the use of a high-speed steel saw is necessary. Moreover, steel of one make may cut quite differently from that of another make, although the analysis in both cases may be the same; consequently, the speed and feed that will prove most economical must finally be determined by actual tests. Of course it will be understood that the size and power of the machine must also be considered. As to phosphor-bronze, some grades can be cut very easily whereas some of the bronzes used for gears, etc., are very hard to cut and the edge of the saw is inclined to glaze over; hence it is difficult to give even a general idea of the speeds and feeds.

Another well-known manufacturer of cutting-off machines gives the following data on the time for cutting various sizes of steel stock: Eighty-one pieces 3 3/8 inches diameter, 2 hours 27 minutes; 210 pieces, 4 inches diameter, 7 hours 27 minutes; 54 pieces, 5 inches diameter, 2 hours 22 minutes; 57 pieces, 6 inches diameter, 2 hours 58 minutes; 684 pieces, varying from 3 3/8 to 6 inches in diameter, 26 1/2 hours. In the last example, the smallest number of pieces of the same size was 2 and the largest 210. The feed was 2 inches per minute and cutting speed 48 feet. The time for cutting 46 pieces of axle steel 7 1/4 inches in diameter was 3 1/4 hours, the feed being 1 3/4 inch per minute. When cutting flat stock 1 1/8 by 9 1/8 inches, several bars were stacked and cut simultaneously, a total of 246 pieces being cut off in 1 hour 37 minutes. The material was low-carbon steel, the feed 3 7/8 inches per minute, and the cutting speed 85 feet per minute.

Still another concern gives time data for various grades of metal: Time for sawing steel forging, 6 1/8 inches in diameter containing 0.74 carbon, 1.12 manganese, 0.30 nickel, 7 1/2 minutes; tool steel bar 2 1/2 inches diameter, 4 minutes; tool steel bar 0.50 per cent carbon, 3 1/2 inches diameter, 3 1/2 minutes; Krupp chrome-nickel steel bar 4 1/2 inches diameter, 5 minutes; Krupp chrome-nickel steel bar 6 inches diameter, 8 to 10 minutes; 6 1/2-inch bar, 0.20 per cent carbon, 5 minutes; 6-inch bar, 0.30 per cent carbon, 4 1/2 to 6 minutes; 8-inch bar of high-carbon steel, 13 minutes; 8-inch diameter hard bronze ingot, 6 minutes.

All these data represent actual practice and are given as a general guide, although it is necessary, of course, to make considerable allowance for the design of the saw as well as the size and power of the machine.

A STUDY OF THE STUB TOOTH SYSTEM OF GEARING*

DETERMINATION OF THE LEWIS FORMULA FACTOR y FOR STUB TOOTH GEARS

BY LLOYD G. SMITH†

Owing to the demand for stronger and smoother running gears in machines where the power transmitted is high and the space limited, there is now coming into common use the stub-tooth system of gearing in which the angle of obliquity is increased to twenty degrees and the length of the teeth decreased to about eight-tenths that of the standard 14½ degree involute tooth. Accurate information regarding the strength of these teeth is lacking and it was the purpose of this investigation to determine correct values of the factor y in the Lewis formula for the strength of gear teeth as applied to this system of gearing. The two forms of stub teeth used in this country—that recommended by the Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt., and that recommended by the R. D. Nuttall Co., Pittsburg, Pa.—are the ones with which this investigation is concerned.

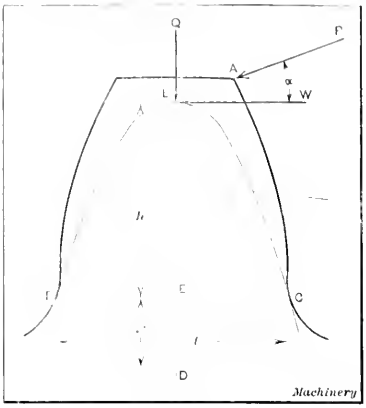

Fig. 1. Diagram illustrating Derivation of the Lewis Formula

The Strength of Gearing—Lewis Assumptions

In 1893, Mr. Wilfred Lewis, after making a considerable study of the subject of the strength of gear teeth, derived a formula for the safe load that could be transmitted by a gear. He was the first investigator to take into consideration the form of the tooth profile and the fact that the line of action of the pressure is always perpendicular to the surface. When gears are cut accurately, his formula gives very satisfactory results and with a few corrections for the number of teeth in contact, etc., it is almost universally used in gear design.

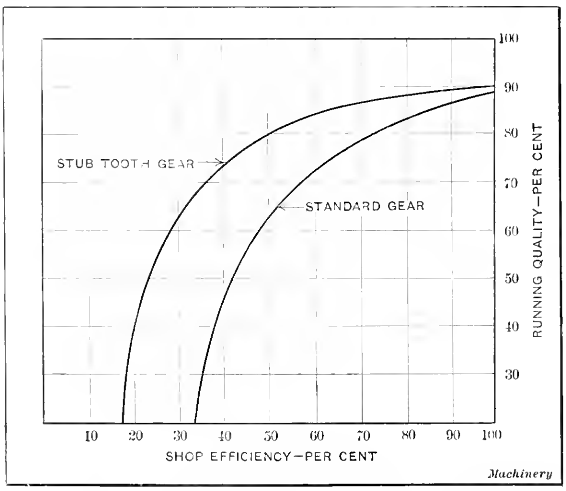

Fig. 2. Diagram from Transactions of A. S. M. E. for 1908 showing Relative Efficiency of Stub Tooth and Standard Gears

Mr. Lewis assumed that all of the load on the gear was concentrated at the end of one tooth, its line of action being perpendicular to the surface AC as shown in Fig. 1. The actual force P was resolved into a tangential force W and a radial force Q. The tangential force produces a bending stress in the tooth, while the radial force produces a uniformly distributed compressive stress. When the material of which the gears are made is stronger in compression than in tension, this radial component is a source of strength, but when the material is of about the same strength in tension and compression it is a source of weakness. For small angles of obliquity α this compression does not amount to more than 10 per cent of the total stress and on this account was neglected by Mr. Lewis. The tangential force W he assumed to be equal to the force transmitted at the pitch circle. This last assumption, although perhaps as much as 10 per cent in error for small pinions, gives values of the stress on the safe side and so may be considered accurate enough for practical purposes.

TABLE I. PROPORTIONS OF FELLOWS STUB TOOTH GEARS

Pitch	Thickness of Tooth, Inches	Addendum, Inches	Clearance, Inches	Whole Depth, Inches
4/5	0.3927	0.2000	0.0500	0.4500
5/7	0.3142	0.1429	0.0357	0.3214
6/8	0.2618	0.1250	0.0312	0.2812
7/9	0.2244	0.1111	0.0278	0.2500
8/10	0.1963	0.1000	0.0250	0.2250
9/11	0.1745	0.0909	0.0227	0.2045
10/12	0.1571	0.0833	0.0208	0.1875
12/14	0.1309	0.0714	0.0179	0.1607

Machinery

Force Analysis

To obtain the weakest section of the tooth, Mr. Lewis constructed a parabola CBF (Fig. 1) passing through B, the application point of the tangential force W, and tangent to the tooth profile at C and F. This parabola encloses a cantilever beam of uniform strength and it can be readily seen that the weakest section of the tooth lies along CF. The resisting moment of this section is:

$$\frac{SI}{C} = \frac{Sft^2}{6} \qquad (1)$$

where S = allowable fiber stress;
f = face width of the gear.

The bending moment is Wh, hence:

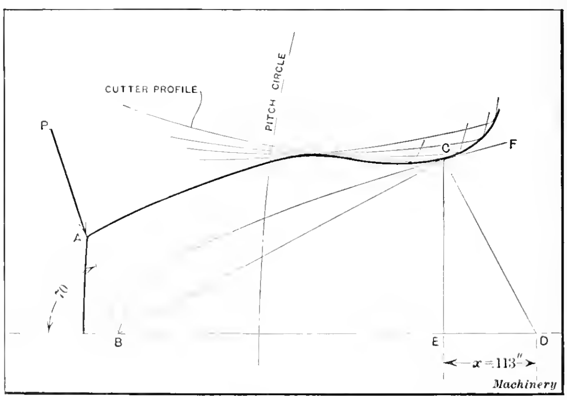

Fig. 3. Method of laying out Gear Teeth to determine Values of x and y

$$Wh = \frac{Sft^2}{6} \qquad (2)$$

From the geometry of the figure:

$$h = \frac{t^2}{4x} \qquad (3)$$

* For further information on the subject of stub tooth gearing see "The Stub Gear-Tooth," published in MACHINERY October, 1911; "Design of Automobile Transmission Gears," October, 1910; "The Stub Tooth Gear," April, 1908; and "Calculations for Short Tooth Gears," July, 1907.

† Address: 5474 Greenwood Ave., Chicago, Ill.

Then $$W = \frac{2Sfx}{3} = Sfp' \times \frac{2x}{3p'}$$
where p' = the circular pitch.

Representing the ratio $\frac{2x}{3p'}$ by the symbol y, we have:

$$W = Sp'fy \qquad (4)$$

The value y is thus seen to be dependent upon the tooth profile and the pitch of the gear. By drawing the tooth pro-

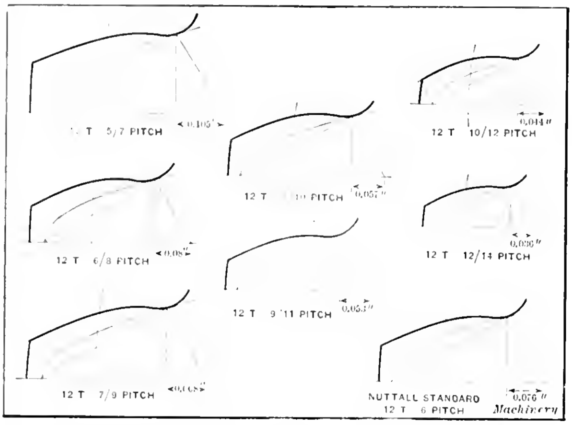

Fig. 4. Tooth Profiles and Values of x for Different Pitches

files for gears with various numbers of teeth, Mr. Lewis was able to calculate the value of y for the standard involute system, and he found that the following equation very closely fitted the values he obtained.

$$y = y_r - \frac{a}{n} \qquad (5)$$

in which y_r = the value of y for rack teeth;

a = constant depending upon angle of obliquity;

n = number of teeth in gear.

A mathematical analysis of a rack tooth outline shows that the value of y_r is given by the following equation:

$$y_r = 0.1273\,p\left(\frac{t}{0.728} - z\right) \qquad (6)$$

in which t = thickness of tooth at pitch line;

z = addendum;

p = diametral pitch.

Stub Tooth Systems

To meet the demand for gear teeth that are stronger than the standard 14½ degree involute, various methods of increasing their strength may be resorted to. Two of these methods are as follows: (1) shortening the addendum and keeping the standard angle of obliquity; and (2) increasing the angle of obliquity and preserving the standard height of the tooth. The stub tooth system is a combination of these two methods, in which the height of the tooth is decreased to about 0.8 the standard height and the angle of obliquity increased to 20 degrees.

The chief advantage of this system is that the teeth will transmit greater loads, and this fact is taken advantage of in the construction of machine tools, hoisting machinery and automobiles, because with the same quality and amount of material, greater strength can be obtained. The stub tooth gears run smoother than gears with the standard 14½ degree involute teeth, due to the decreased impact, because for a given strength and length of face, the pitch is smaller and consequently the number of teeth in mesh is greater. Stub tooth gears are almost universally used by automobile manufacturers, and they report that the action is smoother and the wear less than with standard gears. Mr. Norman Litchfield in the Transactions of the American Society of Mechanical Engineers for 1908 reports that they have given excellent service on the New York subway trains. Mr. E. R. Fellows in the same volume of the Transactions presents the chart shown in Fig. 2, which is based on actual experience. The curves apply to stub tooth and standard gears with "shop efficiency" plotted against "running quality." By shop efficiency he means the relative conditions under which the gears operate and that 100 per cent would only be attained under laboratory conditions, 90 per cent representing first-class commercial conditions and 70 per cent the common conditions in an average shop. By running quality is meant the relative noiselessness of the gears, 100 per cent signifying absolutely noiseless operation and 90 per cent the best condition actually obtainable. The curves show that under the very best conditions the two gears operate about equally well, but under average commercial conditions, the stub tooth gear is decidedly superior.

Forms of the Stub Tooth System

In this country, there are two forms of the stub tooth system in common use, both using an angle of obliquity of 20 degrees, but differing in the length of the addendum. The older of these is that recommended by the Fellows Gear Shaper Co. in which the pitch is designated by two numbers written as a fraction, the numerator of which represents the diametral pitch and the denominator the diametral pitch of

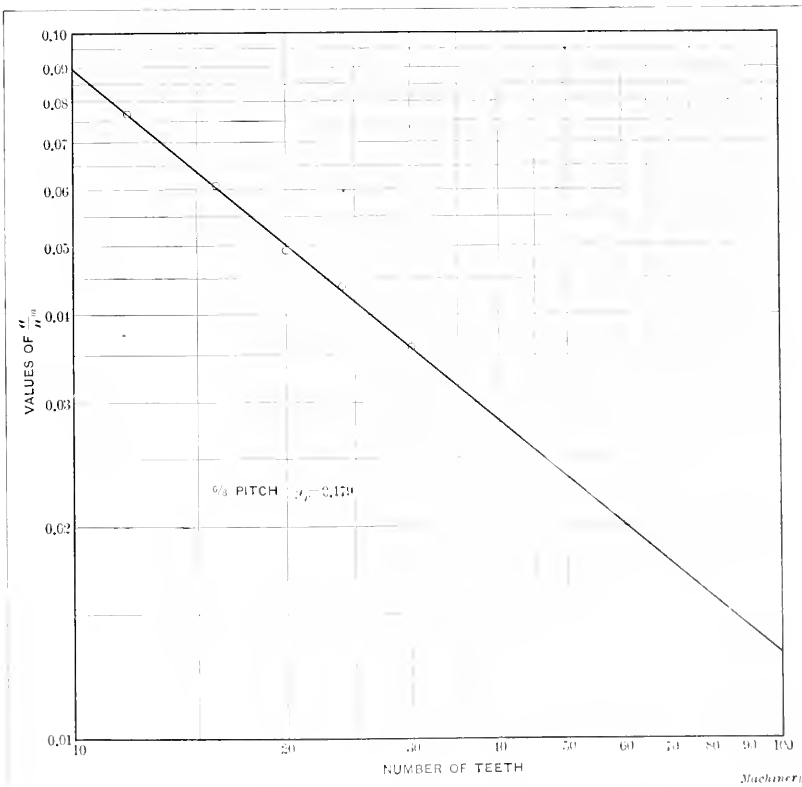

Fig. 5. Diagram showing Values of a ÷ n raised to mth power from which Values of n raised to mth power and Factor y are derived for the 6/8 Pitch Gear

a standard gear having the same addendum. Thus in the 4/5 pitch, the gear would have a diametral pitch of four and an addendum the same as on a standard gear of five pitch, *i. e.*, 1/5 of an inch. Table I gives the proportions of the Fel-

lows stub tooth gears. The other system was originated by Mr. C. H. Logue of the R. D. Nuttall Co., and he uses an addendum equal to 0.25 of the circular pitch and a dedendum of 0.30 of the circular pitch. In the Fellows system the ratio of the addendum to the circular pitch varies from 0.228 to 0.272, and in order to make his system uniform, Mr. Logue took a mean value of 0.25.

Determination of the Strength Factor and Method of Drawing Profiles

In order to determine the value of y for a certain gear of a given pitch, it is necessary to lay out a tooth to some magnified scale in the same manner that Mr. Lewis did (illustrated by Fig. 1) measure the distance x and compute y. In this investigation, this has been done for a great many pitches, using a scale of 10 to 1, except for the large pitches where the drawings would become too large. For pitches 5/7

TABLE II. VALUES OF a AND m

Pitch	4/5	5/7	6/8	7/9	8/10	9/11	10/12	12/14	Nuttall System	Standard 20-degree Involute
a	0.505	0.535	0.605	0.760	0.690	0.490	0.540	0.440	0.592	0.540
m	0.760	0.800	0.830	0.930	0.890	0.780	0.800	0.720	0.820	0.790

Machinery

and 6/8 a scale of 8 to 1 was used and for 4/5 pitch a scale of 6 to 1. Fig. 3 illustrates the method of laying out the teeth. Before laying out the teeth the profile of the cutter tooth was drawn on tracing paper with the addendum equal to the dedendum of the stub tooth gear, and the diameter equal to that of a 24-tooth gear. The gear cutter was taken this size on the recommendation of the Fellows Gear Shaper Co. The tooth profiles of gears with various numbers of teeth were then drawn accurately on tracing paper, with the face from the base circle out a true involute and the flank and fillet generated by the point of the cutter tooth, as the pitch circles of the gear and cutter were rolled together.

Having thus obtained the profile, the action line AB (Fig. 3) of the force at the end of the tooth was drawn normal to the involute, *i. e.*, at 20 degrees to the vertical. In order to get the parabola BCF passing through B and tangent to the profile, a considerable number of parabolas, differing but slightly from each other, were drawn on cards, so that they could be slipped in under the tracing paper and adjusted to enable the point of tangency C to be determined. The line BC was then drawn and CD and CE drawn perpendicular to BC and BD, respectively. The length x was measured as accurately as possible with a Starrett steel scale and the value of y computed. Two or more profiles of the same tooth were sometimes drawn and it was found that the values of x usually checked within 1 or 2 per cent. Fig. 4 shows the tooth profiles and values of x for various pitches.

Method of Plotting

We have already determined an exact method of computing y_r in Equation (5):

$$y = y_r - \frac{a}{n}$$

If any method could be found for obtaining the value of $\frac{a}{n}$, the problem of determining the value of y would be very simple. The use of logarithmic cross-section paper makes the plotting of all such functions as $y = bx^a$ very simple, because the curve becomes a straight line with a slope a. In Equation (5) $\frac{a}{n}$ is a function of the same character, and when so plotted for different values of n, it should give a straight line with a slope of -1. Advantage was taken of this peculiar property of logarithmic paper by first carefully computing y and y_r for five different gears for each pitch, and then plotting the corresponding values of $\frac{a}{n}$. Due to unavoidable errors in calculating y, the points did not all lie exactly in a straight line, but somewhat as shown in Fig. 5, which gives values of $\frac{a}{n^m}$ for the 6/8 pitch teeth, and so it was considered best to use five points and draw an average line through them instead of drawing a line through just two determined points.

It was found that instead of the function being $\frac{a}{n}$ it was $\frac{a}{n^m}$ for stub tooth gears with the slope of the line, *i. e.*, the value of m, lying between 0.72 and 0.93. Values of a and m are given in Table II.

The values of y in Table III were then obtained by simply subtracting the value of $\frac{a}{n^m}$ obtained by means of the proper chart from y_r. If this method of plotting had not been used, it would have been necessary to lay out gears with from 12 to 200 teeth and measure x on each drawing, a task which would have taken five or six times as long to do.

Conclusions

One of the interesting facts that came out in this investigation was that the function $\frac{a}{n}$ as given by Lewis does not apply to stub tooth gears, and that a function of this nature to be correct should have an exponent other than unity in the denominator. In view of this discovery, it was thought strange that for standard teeth this exponent should be exactly unity and the function be $\frac{a}{n}$, or as Lewis gives it for

TABLE III. VALUES OF y IN LEWIS FORMULA FOR STUB TOOTH GEARS

No. of Teeth	Fellow's System								Nuttall System
	4/5	5/7	6/8	7/9	8/10	9/11	10/12	12/14	
12	0.096	0.111	0.102	0.100	0.096	0.100	0.093	0.092	0.099
13	0.101	0.115	0.107	0.106	0.101	0.104	0.098	0.096	0.103
14	0.105	0.119	0.112	0.111	0.106	0.108	0.102	0.100	0 108
15	0.108	0.123	0.115	0.115	0.110	0.111	0.105	0.103	0.111
16	0.111	0.126	0.119	0.118	0.113	0.114	0.109	0.106	0.115
17	0.114	0.129	0.122	0.121	0.116	0.116	0.111	0.109	0.117
18	0.117	0.131	0.124	0.124	0.119	0.119	0.114	0 111	0.120
19	0.119	0.133	0.127	0.127	0.122	0.121	0.116	0.113	0 123
20	0.121	0.135	0.129	0.129	0.124	0.123	0.118	0.115	0.125
21	0.123	0.137	0.131	0.131	0.126	0.125	0.120	0.117	0.127
22	0.125	0.139	0.133	0.133	0.128	0.126	0.122	0.118	0.128
23	0.126	0.141	0.134	0.135	0.129	0.128	0.123	0.120	0.130
24	0.128	0.142	0.136	0.136	0.131	0.129	0.125	0.121	0.131
25	0.129	0.143	0.137	0.138	0.133	0.130	0.126	0.123	0 133
26	0.130	0.145	0.139	0.139	0.134	0.132	0.128	0.124	0.134
27	0.132	0.146	0.140	0.140	0.135	0.133	0.129	0.125	0.136
28	0.133	0.147	0.141	0.141	0.136	0.134	0.130	0.126	0.137
29	0.134	0.148	0.142	0.143	0.137	0.135	0.131	0.127	0 138
30	0.135	0.149	0.143	0.144	0.138	0.136	0.132	0.128	0 139
32	0.137	0.150	0.145	0.146	0.140	0.137	0.134	0.130	0.141
35	0.139	0.153	0.147	0.148	0.143	0.139	0.136	0.132	0.143
37	0.140	0.154	0.149	0.149	0.144	0.141	0.138	0.133	0.145
40	0.142	0.156	0.151	0.151	0.146	0.142	0.140	0.135	0.146
45	0.145	0.159	0.154	0.154	0.149	0.145	0.142	0.138	0.149
50	0.147	0.161	0.156	0.156	0.151	0.147	0.144	0.140	0.151
55	0.149	0.162	0.157	0.158	0.152	0.149	0.146	0.141	0.153
60	0.150	0.164	0.159	0.159	0.154	0.150	0.148	0.143	0.154
70	0.153	0.166	0.161	0.161	0.156	0.152	0.150	0.145	0.157
80	0.155	0.168	0.163	0.163	0.158	0.154	0.152	0.147	0.159
100	0.158	0.171	0.166	0.166	0.160	0.156	0.154	0.150	0.161
150	0.162	0.174	0.170	0.169	0.164	0.160	0.158	0.154	0.165
200	0.164	0.176	0.172	0.171	0.166	0.162	0.160	0.156	0.167
Rack	0.173	0.184	0.179	0.176	0.172	0.170	0.168	0.166	0.175

Machinery

20 degree involute teeth $\frac{0.912}{n}$. Consequently Lewis' values of $\frac{a}{n}$, derived from his values of y, were plotted and it was found that the function really is $\frac{0.54}{n^{0.79}}$; but as the function $\frac{0.912}{n}$ is so much simpler to calculate, and is correct within 5 per cent, one might be justified in using it.

Owing to the varying ratio of the addendum to the circular pitch in the Fellows system, the values of y are different for

each pitch, but in the Nuttall system this ratio is constant, y being the same for all pitches. The values of y in Table III indicate that stub tooth pinions with less than 25 teeth are about 25 per cent stronger than the standard 20 degree involute and 40 per cent stronger than the standard 14½ degree involute. For larger gears the difference is in favor of the stub tooth but is not quite so marked.

A table of the values of y for the Fellows stub tooth gears appeared in MACHINERY for October, 1910, computed by Mr. M. Terry. They were derived from Lewis' values for the 20 degree involute tooth by multiplying them by the ratio of the addendum of the standard gear to that of the stub tooth gear. His assumptions, which at first glance seem to be fairly reasonable, are altogether unwarranted when the original method of finding the weakest section of the tooth and computing y is considered. Mr. Terry's values are entirely too high for every gear except the 12-tooth pinions, the values for the larger gears being as much as 10 per cent to 15 per cent too large. The chance for error in determining the distance x would seem to be considerable, since the fillet must be generated by rolling the pitch circles of two gears together, and the point of tangency of the parabola determined by a somewhat approximate method; but as a matter of fact, when two or more lay-outs were made of the some tooth, the values checked very closely.

* * *

DIAMETER INDICATOR STOP FOR TURRET LATHES

The usual practice followed in producing duplicate formed work in a turret lathe is to control the movement of the cross-slide by a stop and thus hold the work to the required diameter. An experienced operator with an ordinary cross-slide stop can hold the work to within 0.0005 inch plus or minus limits on the diameter, but when an inexperienced operator is

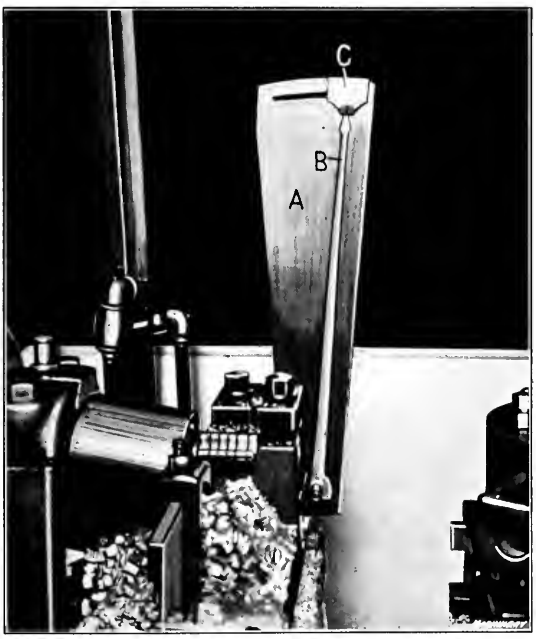

Fig. 1. Diameter Indicator Stop for Turret Lathes

put to work on a turret lathe, these limits are rather close. It takes some time for the inexperienced operator to get just the right feel on the screw of the slide.

In order to eliminate defective work, the Mail-om-eter Co., Detroit, Mich., has worked out an ingenious device which has been applied to all its turret lathes. The device shown in Figs. 1 and 2 comprises a steel plate A which is fastened by cap-screws to the cross-slide and consequently moves with it. This plate carries an indicator needle B and an adjustable datum plate C, the latter being held in place by a thumb-screw shown in Fig. 2. The lower end of the indicator needle B, which is bent at right angles, passes through the plate A and is beveled to an angle of about forty-five degrees in a vertical plane. Working against this vertical beveled face of the indicator needle is a fulcrumed lever D mounted on a bracket fastened to the plate. The lever is kept in contact with the tapered end of the indicator needle by a coil spring E and is operated by an adjustable stop F, which is held in a bracket fastened to the face of the cross-slide carriage.

When in operation the forming tool is advanced toward the work and fed in to the correct depth, the lever D is brought

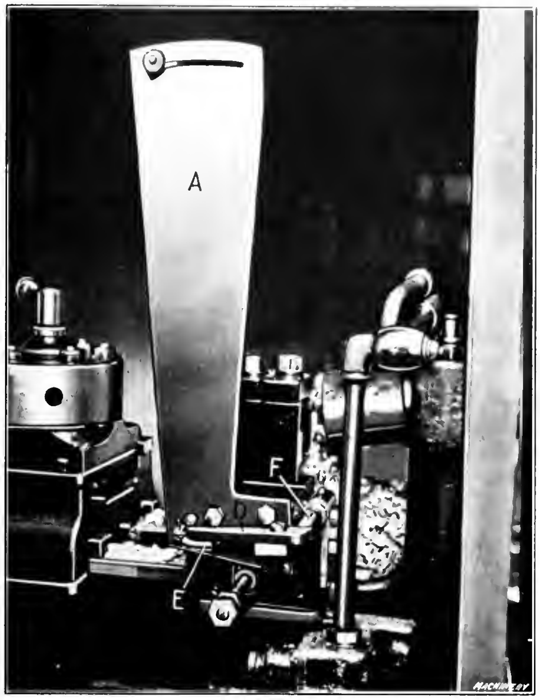

Fig. 2. Rear View of Diameter Indicator Stop showing how it is operated

in contact with the stop F, transmitting a movement to the needle B which moves across the face of the plate indicating when the correct diameter is reached. The movement of the indicator is worked out on a ratio of about 10 to 1, and as a rule where extremely accurate work is required (no limit of variation being allowed) only one line is provided on the adjustable datum plate.

The machine is set up for any particular job by the foreman of the department and then all the operator has to do is to bring the cross-slide forward until the indicator points to the mark indicating the correct diameter. With this arrangement it is easily possible for an inexperienced operator to hold the work within limits of 0.0005 inch, plus or minus, and without any difficulty at all, keep within a variation of 0.001 inch. As soon as the tool becomes dull, which would mean that the work would be made larger in diameter, this condition is easily noted by the finish left on the work. The tool is then taken out, sharpened and the indicator reset. While it would appear that the machine could not be operated as quickly with the indicator needle as with the ordinary cross-slide stop, this is not the fact in actual practice, especially where accurate work is demanded. When nearing the correct diameter, with the ordinary cross-slide stop the operator has to cut slowly so as not to put any unnecessary strain on the slide; while with the indicator stop the slide can be brought forward at an even rate until the needle points to the predetermined point. It is therefore evident that as far as rapidity of operation is concerned, this device does not retard production. D. T. H.

* * *

As a general rule, it seems that there is too much architecture and too little utility about many of our public buildings, and too much utility and too little architecture about most of our factories.

ETHICS OF CONTRIBUTING TO THE TECHNICAL PRESS

SOME OPINIONS OF READERS ON THE RELATIONS OF EMPLOYERS AND EMPLOYES REGARDING PUBLICITY

The article in the November number on "Ethics of Contributing to the Technical Press" brought out several interesting contributions. The opinions of the different writers may be summarized as follows

An employe is not justified in publishing patentable ideas, but it is not wrong to describe general manufacturing methods - publicity would show progressiveness of firm. J. L.

Before making public manufacturing methods, an employe should have an agreement with his employer, provided the methods are special and only used in that particular plant. Workmen should not be barred from describing general methods. Other things being equal, the man who can express his ideas in writing is more valuable to his employer. W. R. H.

When an employe designs improved apparatus for an employer, or offers a valuable suggestion, he should ask permission to publish, even though no compensation has been received. If the suggestion or improvement is ignored by firm, employe has moral right to make public. W. C. B.

The right of an employe to describe manufacturing methods in the technical press depends largely upon the value of the methods. Nothing should be published that would be objectionable to employer. The employe should be competent to exercise his own judgment as to value of methods. N. G. N.

This is not so much a question of ethics as of the attitude of executives. If the article deals with developments of firm, the attitude of those in charge should be ascertained; if it does not, the employer has no moral right to interfere. The liberal-minded employer knows that the subordinate who writes articles is not only interested in his work, but is training himself to think clearly and express his ideas accurately. J. S. M.

The article by Mr. Brickner in the November number of MACHINERY is no doubt interesting to many who have contributed to the technical press. Of course, an employe who worked on certain machinery where patentable ideas were being developed, would not be justified in giving out any information. He would be expected, as a part of his work, to keep in confidence these improvements. As far as general work is concerned, it does not seem that an employe would be doing wrong to write articles describing methods of manufacture and improved tools used. The value to the employer of the methods, tools, etc., would not be impaired by publication, but publicity would rather reflect the efficiency and progressiveness of the firm. The employer may say that the articles would give his competitors an opportunity to apply the ideas developed with his money to their own work. This argument, however, would not hold good, because workmen going from shop to shop to work would prevent methods from being kept private. A certain class of work for which an employer may have spent considerable time and money in designing up-to-date tools, may be handled in another shop in different ways with just as efficient results as to accuracy and rapid production. The question of an employe withholding ideas from an employer would seem to depend upon the nature of the improvements. If they were of a different nature than his regular work, the ideas would, without doubt, be his own property. If his improvements applied directly to the machinery on which he worked, it would seem that his efforts were due largely to the experience and study of his special work. In this case, it would appear that the just thing to do would be to offer his ideas to his employer who should recognize his loyalty and ability in a substantial way. If an employer did not do this, his employes would have no incentive for developing anything of value.

Camden, N. J. JOHN LEAFSTROM

In his communication on the "Ethics of Contributing to the Technical Press," in the November number, Mr. A. J. Brickner is undoubtedly right in assuming that many writers are frequently in doubt as to just what they are privileged to write for publication.

The question, as Mr. Brickner says, is a moral rather than a legal one, but this fact in itself is of slight importance, for an employer has it in his power to make it exceedingly unpleasant, to say the least, for the employe who acts in opposition to his rules or wishes, without the assistance of the law.

It is safe to assume that no contributor cares to antagonize his employer in any way. This being the case, it would seem best in all instances for the employe, if he does not thoroughly understand his employer's views in the matter, to "sound" him and come to some mutually satisfactory agreement, before undertaking to make public methods or processes of manufacture peculiar to his employer's establishment. It makes no difference by whom the methods or processes were devised; if they are a part of the manufacturing system of this particular employer, they belong to him and he alone has the right to publish them or to permit them to be published.

If the employe designs a tool, a fixture, die, or a special machine to perform a certain operation on his employer's product, any new idea incorporated in the tool is universally considered the employer's. As a rule, a workman is asked to sign an agreement to that effect before he is employed, in many manufacturing establishments. This does not mean that an employe is not privileged to write for publication what he pleases when the subject has no exclusive relation to his employer's plant or product. He would be a narrow-minded manufacturer, indeed, who would, on general principles, deny an employe the right to contribute to the technical press. The workman who is not only inventive and original but who can express his ideas in writing, is a more valuable man, other things being equal, than the man who cannot, and writing for the technical press is of great value in helping a man to express his thoughts clearly.

If an employe has original ideas or knows of methods in use in more than one establishment which have not been described, he has as much right to make them public as he would have to publish his personal views in a local newspaper. In other words, if the idea is wholly his, or belongs to no one in particular, there can be no question at all in the matter, either legal or moral. If the employe, in the course of his work, applies some device or idea of his own to a machine or process of his employer's and if the same device or idea could be applied generally to similar machines or processes and does not have any particular relation to the employer's plant, then the employe might consider himself free to write on the subject. Still, as previously remarked, if there is the slightest doubt on the contributor's part as to his employer's attitude on the subject of contributing, the wise course naturally would be to settle the doubt before it is too late.

Rochester, N. Y. W. R. HUMELBAUGH

When an employe makes a suggestion, or designs an improved apparatus for a manufacturer, even though no material compensation has been received by the person making the suggestion or design, it is advisable to ask permission to submit it for publication. If no compensation has been given, permission to publish would probably be granted, but if a firm accepts a suggestion or design and pays something for it, then the one making the suggestion has no right to submit it for publication or even ask such a privilege, as it is then the firm's property. Again, suppose John Henry makes a suggestion and it is not accepted or is totally ignored (this has been done by the officials of some concerns), although John knows it to be a big improvement over the method in use; then he has a moral right to publish the information and Blank & Co. have no "kick."

The writer would like to narrate an incident which occurred in a place where he was once employed. John Henry was a young draftsman, who got the writing "bee in his bonnet" and started out to write up the whole equipment of the shop. Early in the game one of his articles came under the superintendent's notice, whereupon John received a summons to his sanctum, where he received a lecture and advice. On another occasion, John wrote an article by permission of the superintendent, which came under the president's notice. The article was of an unimportant nature and John told the head of the firm that he had permission to write it and wanted to know what harm had been done. The president remarked that he did not believe in the "education of the masses." This gives an idea of the sentiment of at least one firm in regard to writing for the technical press. As a rule, the officials of concerns do not like to have anything pertaining to the equipment published, even though it is generally known.

New Britain, Conn. W. C. Betz

Concerning A. J. Brickner's queries in the November number, the writer has made it a point to contribute nothing that, in his opinion, an employer might find objectionable or harmful. Permission of my superiors to make "kinks" public is rarely requested, on the grounds that in my regular everyday work I am given credit for being able to exercise judgment in the company's interests and, therefore, am certainly competent to use that same judgment in matters that are less difficult to decide.

Much depends upon the value of the method to the employer. For example, my company makes use of a process of machining that no one else, to my knowledge, uses. The method is quicker, more economical, and more accurate than the usual methods, yet the company is not keeping it in strict secrecy. We are simply given to understand that the method is "new" and that it is one of the reasons why the company is able to maintain its present good scale of wages. Would I write a description of this process for the technical press? No, I did not have a hand in its development. We give our chief engineer credit for the method, and I feel that if anyone has a right to make it public he has. As the company is honest and square, the employes should be just as honest and square in return. The company and the chief engineer would have good grounds for objecting to the exploitation of this process, although, in my opinion, competitors would be rather slow to adopt it because of the expense that would necessarily be entailed in changing from old to new methods.

An associate once described a manufacturing method in detail, giving cost figures, test data, and every point of importance. He had first obtained his employer's permission. A competitor read the article, was naturally much interested, and managed to secure an interview with my friend. He seemed much surprised that his competitor would consent to the publication of matter of such seemingly vital importance. As it happened, however, the manufacturing costs of the two companies were about the same, so the only thing they had to fear was the small competitor who might be able to undersell the larger concerns by getting a line on costs through such publicity. The second large competitor sent a verbal message through my associate to the first competitor, to the effect that he "admired his nerve," but believed it better policy to keep certain things under cover, especially costs. Both of these companies are still the largest in their line of manufacture.

Another friend recently described an improved method for tabulating and plotting data, and in the article he gave credit to no one but himself, incidentally mentioning the fact that a large corporation was using the system with success. Because he did not ask permission and give his superiors due credit, he was rather severely censured, but it was admitted that the publication of the article would do the company no harm and perhaps would be beneficial to other companies that might be looking for more efficient tabulating and plotting methods. My friend still insists that he had a moral right to do as he did. As he expressed it, "——— is sore because I beat him to it. He would have written it up himself had he thought of it first." He assumed all credit because he believed the article would thus receive better editorial attention.

An employer certainly has a right to refuse publicity of his methods. The government recognizes the right of privacy in taking census data, in assessing, and in other ways, but if an employe chooses to make public what he knows about his employer's business there is usually nothing to stop him but his own conscience or his own judgment. So, according to my way of thinking, the whole matter hinges on personalities and conditions. No fixed rule can be made.

N. G. Near

The articles on "System Carried to Extremes" and "The Ethics of Contributing to the Technical Press" in Machinery for November, each seem to call for some comment. While these subjects appear to be widely separated they are often really correlative, because much which is wrong in the attitude of many concerns on both subjects is traceable to the same causes, *viz.*, lack of cooperation, hence lack of understanding or *vice versa*, and incompetence. Lack of proper understanding of motives, aims and purposes is probably responsible for more that is deplorable than any other single cause.

It is the plain duty of any department head to cooperate with the other department heads and rectify anything wrong in mutual relations which may come to his notice. The chief engineer who permits a rule that there should be at least three views on all drawings, no matter how simple the part, is certainly not cooperating with the one who established the rule. If he was, there would be no such rule. The person who established the rule had a lack of understanding as to what constitutes a good and sufficient drawing. In this respect at least he appears to have been incompetent and to have failed to ask the advice of someone who was.

A man once dreamed that he was pursued by the "Evil One" and was making a hasty flight across fields. He impatiently kicked a jack-rabbit to one side saying, "Get out of my way and let someone run who can." Systematizers and others establishing rules often have such dreams in regard to their own ability, it would appear, and, being over self-confident, fail to cooperate.

The episode of the time cards also indicates a lack of understanding. Two of the main objects of such cards are to secure fairly accurate costs and to show up things which are abnormal and therefore require attention. In the case cited, a draftsman charged time spent in studying up improvements on a small detail to another larger job because he feared the time actually spent would be criticised. He thus defeated the purposes for which the cards were intended. Now if the results obtained were worth the time expended he should have charged all the time to the job. If the correct record on the cards was the means of starting an investigation he could have frankly stated his case, which, being creditable, should do him no harm.

The foregoing is based upon the idea that the right should prevail, as it does under fair-minded, honest and competent executives. Of course, we all know that there is the other variety and most of us have, at times, been hampered and annoyed by their short-sighted tactics, until it sometimes seems that too much honesty is not always the best policy, especially if it causes things to move with more friction.

It would seem from M. T.'s story that the troubles observed were mainly due to foolish rules, probably established by incompetents, or what amounts to about the same thing, good rules foolishly interpreted or too inflexibly applied. A little cooperation between fair-minded competent men should speedily adjust such matters. In the absence of such cooperation the best attitude toward such rules is often to believe in the old saw, "rules are made but to be broken," and when it seems justifiable consider yourself at liberty to break them with impunity. The establishing of rules is not the office or aim of system, and the establishing of a rule fixing a limit to salaries for any class of work (which is mentioned by M. T.) is not only in direct opposition to the ideas upon which most modern systems are based, but seems both foolish and uncalled for, because it serves no good purpose and does much

to discourage the employes. What is the use of establishing such a rule when it may be found both expedient and highly desirable to break it? To be consistent, if you limit the earning power of your employes you should also limit your own earning power and say: This concern will not earn over ten per cent of the capital invested per annum. Anything over this amount earned will be returned, pro rata, to the customers. If you consider an employe as a mere machine, do you imagine that the cost of developing this machine to its present state of perfection when taken as capital invested can be multiplied by a percentage of profit and by adding the proper cost of maintenance thus arrive at a just limit to salaries? If you do you have neglected to take into account that the probable duration of the mechanism has, in this case, a value to the machine itself. Even if you tried to be fair in this particular your ideas of proper maintenance and those of the machine are very likely to vary widely. Modern system may attempt to fix the rate for the performance of a certain amount of work but it should not attempt to limit the earning power of the individual if he gives value received in what he produces, whereas the fixing of a limit to salaries is an attempt in this direction.

Now regarding the ethics of contributing to the technical press, this is also a matter run largely by rules and in its practical workings is often not so much a real matter of ethics as of the attitude of the officers of the concern, their personality and the rules they may have established. The main difference between such rules and the variety mentioned in the foregoing, is that a rule regarding the publishing of matter is an arbitrary statement of the concern's policy in this respect and the breaking of such a rule would probably be classed as insubordination—an offense calling for reprimand or discharge. When no such rule exists the only logical thing to do is to ascertain the attitude of those in charge, if the proposed article deals with their work. If it does not, and is not prepared on the employer's time, the writer fails to see wherein the employer is concerned. There is, however, a class of executives who seem to think that if a man is on a salary basis instead of an hourly rating, his entire time belongs to the company. This class looks with a jealous eye upon any activities other than those from which they can see a direct benefit to the concern. The writer does not believe an employer has any moral right to assume this attitude unless he clearly states it before engaging the employe, and even then, unless the emoluments are so exceptional as to justify such an attitude, its ethical aspect is cloudy because it is an unnatural restriction upon the personal liberty of the employe.

The attitude of employers on the subject presents many inconsistencies, personality entering as a dominant factor in many cases. Some cases within the writer's experience are given in the following:

Mr. A is a public spirited citizen of the type who says he can get all the office boys he wants at three dollars a week but that he knows a boy cannot live on three per, so he pays him five. A's chief engineer, C, is the sort who raises a man's salary before asking for it. Says he does not believe it should be necessary for a man to use "a better position proffered" as a club to secure an advance.

Now C promised B a photo-print of a cut from A's catalogue, to illustrate an article B proposed publishing. A would not permit this, saying that it was the general policy of the company to have nothing published relative to their work excepting what was used in connection with their advertising literature. Whether A feared the use of the picture in question would rob his publicity experts of some of their fire, or whether he doubted the ability of B to write a creditable article is unknown, but some weeks later halftones of the device appeared in the dailies in connection with a discussion of labor troubles. B published his article minus the desired illustration, as he was bound to do under the circumstances, while the reporter for the daily, not being in A's employ, simply used his camera. Both A and C were liberal minded men, yet the ruling seemed narrow to B.

Another example: Concern D maintains an expensive bureau of safety, employs two physicians (one always on the job), equips wash rooms, furnishes storm coats for outside work, etc., "for the good of the service," but the concern is so secretive about its business that any information whatever about the equipment is absolutely refused. Even a twist drill salesman could not find out approximately how many drills they used a year as a basis upon which to quote prices. An employe publishing an article dealing with their work would undoubtedly be discharged. With this concern one need not be in doubt as to their attitude, but whether they gain or lose by it is problematical.

Another sidelight on the subject is illustrated by the following: Draftsman E had done considerable work on a special machine for chief engineer F. In the course of developing the designs, E learned a number of interesting things about the practical application of theory to design which would have made a good article. E proposed writing such an article but F said he, himself, wished to read a paper on the subject before a society of engineers, after which he had no objection to E's proposed handling of the subject. However, F never prepared the paper, E finally lost interest in the matter and the readers of MACHINERY lost a good article. Frequently the officers of a concern have no objection to the proper variety of articles, but the man who could and would prepare them is prevented by someone a little higher up, who thinks he himself should have the glory, but who actually does nothing; a sort of bow-wow-in-the-manger's attitude whether so intended or not.

Sometimes the official who passes upon the desirability of publishing articles mistrusts the ability of the one proposing to prepare it. Therefore, for an initial attempt it is probably best to prepare the article before asking permission, then submit it to your immediate superior with a request for his opinion. By this procedure you can demonstrate your ability and probably secure his cooperation. The liberal-minded man is glad to know that his subordinates are taking an intelligent interest in things, and he knows that the writing of articles is a mighty good training toward clear thinking and concise expression, as well as a means of developing correct ideas instead of erroneous ones; and, knowing that the old days of the trade secret bunco-game are gone forever, he generally lends a helping hand instead of placing obstacles in the way of the aspiring technical writer.

Some concerns are as hungry for free advertising as an opera star and, if permitted to do so, would monopolize much space in the technical journals by laudatory descriptions of their methods and product. Now properly managed periodicals do not cater to this spirit. They are looking for articles of merit only, which, in their judgment, will interest and benefit their readers. If an article incidentally reflects credit upon a concern or an individual, they are fair minded and desirous that all credit should be given where due, and occasionally make favorable editorial comment; but it is on a basis of what appeals to them as being meritorious. In view of this, it is desirous in the preparation of articles to eliminate as much as possible, mention of the men or concern where the work is done and stick closely to the development of the subject in an impersonal manner, which lessens the chance of giving offense to anyone's ideas on the ethics of the matter.

If an article is properly prepared, does not deal in personalities, violates no confidences, does not hand out "back door information," and presents matter worth while in a readable form, the author's own judgment as to the ethics involved in publishing it should be as good as anyones, but he should remember that the attitude of his superiors is very likely to be an arbitrarily assumed one instead of being based upon ethical considerations.

Philadelphia, Pa. JOHN S. MYERS

* * *

A furnace lining which will resist very high heat may be made from 40 parts, by weight, of fine asbestos, and 60 parts of water glass. The asbestos and water glass are mixed with enough water to make the whole pasty so that it can be worked. This mixture, says the *Brass World*, is useful for patching or plugging cracks, as it does not crumble as readily as other compositions made from fire-clay.

LUBRICATING SYSTEMS FOR CUTTING TOOLS—1

VARIOUS METHODS OF SUPPLYING AND DISTRIBUTING LUBRICANT TO CUTTING TOOLS

BY JOSEPH G. HORNER*

The lubrication of cutting tools, like many other details of machine tool practice, has made great advances during recent years. Systems and methods that were at one period considered special and adapted only to a certain class of machine, are now applied commonly to various other types. New developments have also had their effect in increasing the demand for better methods of lubrication. There is considerable variation in the methods of lubricating tools, not only on different classes of machines, but on machines of the same type, the reason being two-fold: Either the work does not require the application of a lubricant, or the amount and manner of supplying the lubricant varies, ranging from a slight drip to a profuse flooding under pressure; this depends upon the nature and extent of the cut. For example, a light milling operation with a single cutter may need no more than a small supply from a drip-can, whereas, on the same machine, the operation of a gang of cutters for deep roughing cuts will require a large stream to flood the work thoroughly and wash the chips away. Some machine tools, such as brass-finishers' machines of many types, cylinder-boring machines, some lathes for machining castings only, and some

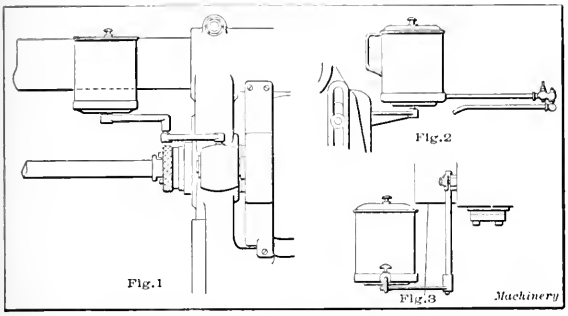

Fig. 1. Drip-can mounted on Pivoted Bracket. Fig. 2. Drip-can with Jointed Delivery Pipe. Fig. 3. Drip-can arranged for Vertical Adjustment

of the reciprocating types of machines for brass or cast iron only, have no arrangements for lubrication of the tools. In many, a compromise is made so that the addition of a lubricating system is easily effected. In order to avoid a multiplicity of designs, some firms build certain of their machines with the channels, trays, etc., essential to the flooded system, and omit or supply the pump and piping as wanted.

The Amount of Lubricant

There are three principal reasons for the adoption of a lubricating system: One is to cool the tool or cutter, another

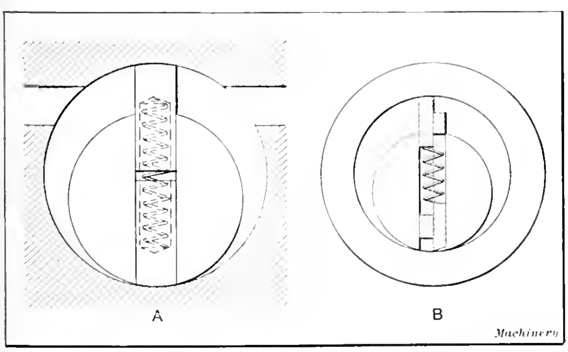

Fig. 4. Two Types of Wing Pumps for Cutting Lubricant

to impart a smooth surface to the work, the third to wash away the chips. The first-named is frequently the only reason for the application of a lubricant. For instance, in many operations on brass and other alloys the surfaces would be tooled just as smoothly without the lubricant, but the tools would heat up, and the work would also become too warm if the operation were long-continued; hence the accuracy would be impaired, while the cutting edges would not endure for a sufficient length of time. On the other hand, drilling, particularly in deep holes, sometimes cannot be done at all unless the lubricant is fed with sufficient force to eject the chips as fast as they form. A quantity much in excess of the requirements for cooling alone is therefore required.

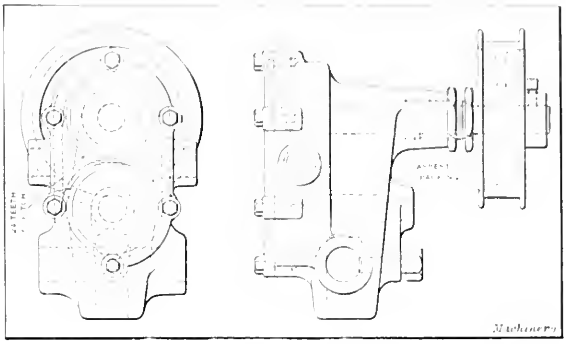

Fig. 5. Rotary Pump of Gear Type

When a metal or alloy cannot be tooled with a smooth finish unless lubricant is employed, it may not be necessary to use a large quantity, so long as the edges of the tool and the portion of the work adjacent thereto are covered. The necessity for an increased supply soon arises, however, as speeds and feeds are increased; otherwise the film of lubricant will be too attenuated to spread as fast as the metal is cut into, and the result will be that intervals of dry cutting will occur, and the heat will evaporate the film to such an extent that it becomes useless. A further development is reached when the heat, caused by cutting, raises the temperature of the cooling medium to such an extent that the latter ceases to act effectually. This happens when the total amount of

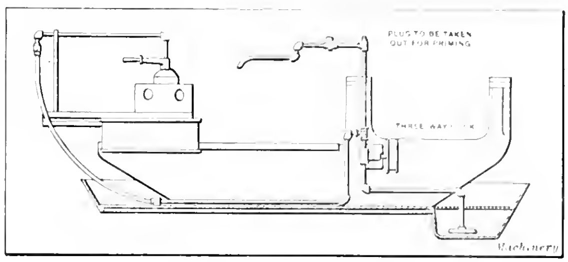

Fig. 6. Lubricating Arrangement of Bardons & Oliver Turret Lathe

liquid is not large enough to provide for cooling in the intervals between successive applications to the cutting tool. The remedy is a much larger amount of liquid, and preferably a return tray of ample surface area, so that the maximum amount of area shall be exposed to the air. In extreme instances, two tanks may be utilized, each holding a large body of lubricant, which are drawn from alternately, thus affording intervals for each to cool somewhat.

The essentials involved in any system of lubrication are the supply, collection and separation from cuttings, and method of return. The first two requirements include many devices and modifications, ranging from the time-honored drip-can to elaborate pump and piping arrangements, and from a simple can hung beneath a table to a complete series of rims, chutes, troughs, pipes and strainers. The distinction between the two extremes is due to the quantity of lubricant required, since a simple system that is capable of feeding and collecting a few pints of liquid used at a slow rate is totally inadequate for the flooding method; neither is it automatic in action but necessitates frequent attention.

The amount and nature of the chips also materially affects the mode of collection and one method is not suitable for

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all cases. Large curling chips, and fine swarf (such as from a hacksaw) are very different as regards the separation of the lubricant from them, the swarf being much more difficult to separate. The bulk of the chips is also important in considering the method of collection and separation. If they occur in small quantities, very little extra accommodation beyond that necessitated by the liquid is wanted, but if there is a large bulk of chips to be received, the sizes of pans and trays must be varied accordingly and supplementary boxes or trays on wheels are essential for frequent removal.

Drip-can Method of Supplying Lubricant

Various methods of supply and collection are illustrated in connection with this article by drawings of various machines, but these are only a fraction of the immense number of modifications which exist in practice. The drip-can is the oldest form of continuous supply and is still employed extensively for operations where its limited feed is suitable and sufficient. It is often included on machines which have a pump outfit as well, for use when the ample flow provided by a pump is unnecessary, the can being preferred when the class of work for which it is suited has to be done for a considerable time. The usual design is that of a cylindrical vessel, preferably with a cover, and an inside strainer of gauze (unless the liquid is strained previously). The can body is made of either sheet metal or cast iron. If the capacity of a cylindrical can is insufficient, a rectangular tank is sometimes used instead, as on some shafting lathes with multiple rests. Variations occur in the manner of holding the can, and the position and number of outlets. As a can, in most cases, is placed quite close to the point of application of the liquid, a short pipe is all that is necessary; this may be single- or double-jointed, to bring the spout to the location desired. The can is either placed upon a flanged tray, supported upon a pillar fixed in any convenient position, or it is held either by a band, or stem and wing-nut on a slotted arm beneath, to permit of radial or vertical adjustment. The vertical adjustment is not of so much importance because the lubricant can be directed to fall on the work, but considerable adjustment in a horizontal direction is desirable, especially in machines where the cutters or tools occupy varied positions. Figs. 1, 2 and 3 illustrate common methods of adjustment. Fig. 1 shows pivoted arms, on the outer one of which the can is held; Fig. 2, a fixed bracket with jointed pipe, which gives much the same result; and Fig. 3, a suspension rod. The latter is employed on vertical milling machines, etc., to permit radial and vertical adjustments.

When the construction of a machine will not permit placing a can close to the tool, use is often made of flexible tubing of rubber or metal for connecting the can and spout.

Pumps for Cutting-tool Lubricating Systems

The drip-can ceases to meet requirements when the quantity of lubricant that must be delivered exhausts the contents of the can in a few moments. A pump which is automatic and under the control of the attendant, is then the only method of providing a sufficient supply. Four types of pumps are in use: Centrifugal, plunger, wing, and geared, the latter being in the majority. The centrifugal pump is not used to any great extent but is sometimes preferable when there is grit in the lubricant. The plunger pump is employed only to a limited extent, although in the early days it was probably the only kind used for supplying drills and boring tools for deep-hole work in lathes. Where a large supply is desired or where the parts of the machine run at such a slow speed that there is no opportunity for drawing a rotary pump at a proper speed, the plunger type is still used, the most notable example being that of certain bolt-threading machines.

The construction of the wing type of pump comprises a casing with a chamber bored eccentrically (see Fig. 4) with relation to the spindle bearing. The enlarged head of the spindle is slotted to receive a pair of flat plates or wings, pressed apart by a brass spring or springs, so that as the spindle rotates, the ends of the plates maintain contact all around inside the chamber, thus drawing the liquid in and discharging it in one direction or the other according to the way in which the spindle rotates. These pumps will lift the lubricant a slight distance, but it is better to submerge them to avoid priming. A modification of the ordinary method of making the wings as illustrated at *A*, is shown at *B*. The latter type is manufactured by Messrs. C. Wicksteed & Co., Ltd., of Kettering (England) for use with their hacksawing machines. The wings, instead of meeting at the center, are thinner and pass right through the spindle head. Slots are cut in each section, as shown, so that a single spring presses the halves apart equally. The wings are tapered at the ends so that when a full discharge is not required, the pressure of the liquid will press the wings back. This renders the use of a relief or overflow valve unnecessary.

The geared pump, a type employed to a far greater extent than any other, is of simpler construction, the essential parts being a pair of spur gears revolving inside a closely

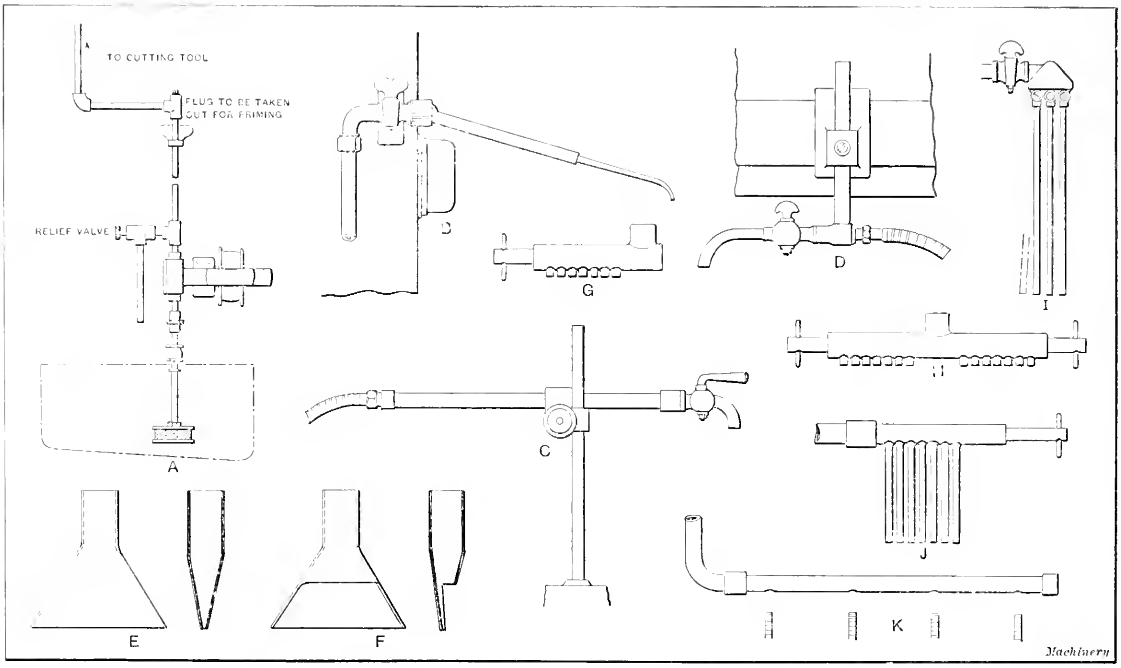

Fig. 7. Various Arrangements of Piping and Nozzles for distributing Lubricant to Cutting Tools

fitting case and drawing the liquid around in the tooth spaces. This type has no delicate parts to get out of order, and if properly built, enables high pressures—up to 1000 pounds per square inch—to be obtained. These high pressures are, of course, not necessary for feeding to external cutting tools, but for deep-hole drilling, in which great force is necessary to remove the chips, they are utilized. The low pressure pumps work to 100 pounds per square inch or less. For the average machine, it is merely necessary to raise the liquid and overcome the friction in the pipes and distributor; any surplus pressure is only useful for washing away chips, the need for which varies with the class of operation. Some kinds of chips fall naturally out of the way whereas others tend to clog the work and the cutters. Some materials will stick to the cutters or work if lubricated to a moderate extent, and may require a larger stream and greater pressure to dislodge them. The removal of long curling chips, especially heavy ones, is not facilitated by the force of the stream, unless they are forced out of a hole.

The geared pump, an example of which is seen in Fig. 5, is rated to deliver a certain quantity at a definite number of revolutions per minute, and it may be run at higher or lower speeds if desired, with a varying output. The pump shown is made by Messrs. H. W. Ward & Co., Ltd., of Birmingham, (England). In place of the usual foot, it has holes to slip over a piece of shaft secured to the machine in any convenient location. This permits of setting the pump in three different positions, according to the belt location. The following table gives the capacities of two sizes of Brown & Sharpe geared pumps, with driving pulleys of 3½ inches and 5 inches diameter, respectively:

	Revs. per Min.	Capacity, Quarts per Min.	Suction	Discharge
No. 1	300	4	$\frac{3}{8}$ inch	$\frac{1}{4}$ inch or $\frac{3}{8}$ inch
	500	8		
No. 3	300	20	$\frac{3}{4}$ inch	$\frac{1}{2}$ inch or $\frac{3}{4}$ inch
	500	40		

The lift ranges up to 20 feet, but it is preferable to put the pump as near the level of the tank as it convenient, the exact location depending upon the type of machine and the facilities for attachment to the side of the framing or the edge of the tank or pan. The method of driving depends partly upon the position of the pump and partly upon the designer's ideas. The belt or cord drive is the most common. Spur gearing and chains are also used to a lesser extent, the advantage of these being that there is no bother with slipping belts nor trouble due to the splashing of oil. It is often more convenient to drive the pump by gears or chain from some constant-speed shaft on the machine, than

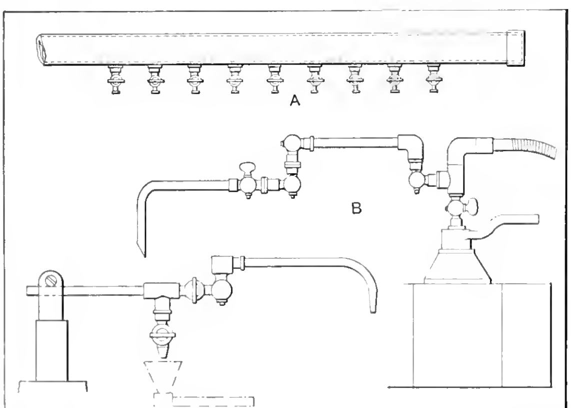

Fig. 8. A. Distributor with Row of Taps. B. Combined Supply Pipe for Interior of Turret and External Tools. C. Supply Pipe feeding into Funnel on Box-tool

by a belt from the countershaft; when a motor drive is installed, the gear or chain method is especially applicable. The pump is thrown out when necessary, by sliding the gears out of mesh or by disengaging a clutch, if a chain is used. Generally, pumps run in one direction, provision being made to drive them from a shaft or countershaft which does not reverse, but when the machine reverses at intervals, as with certain automatic screw machines, the pump is slightly modified to enable it to run in either direction.

The fittings which are directly connected with the pump system include a strainer, which is submerged in the liquid and prevents access of grit or chips, and a relief valve, which is closed by spring pressure but opens when the flow is reduced or stopped at the delivery outlet, allowing the lubricant to run back to the tank through a by-pass. Sometimes a check valve is placed between the pump and the tank, but not invariably. Fig. 6 shows the piping for a Bardons & Oliver turret lathe, including a flexible supply pipe to the turret center for feeding hollow tools, and the diagram A, Fig. 7, shows the piping for a Brown & Sharpe milling machine. These two views represent, in principle, the arrangement of many machines. A pump for each unit is dispensed with in certain cases, as, for example, "batteries" of automatics or of sensitive drills, which are fed from a common supply instead of having a pump for each machine.

Methods of Distribution

The two points which we now have to consider are: (1) The means of distributing the lubricant to the tool or tools;

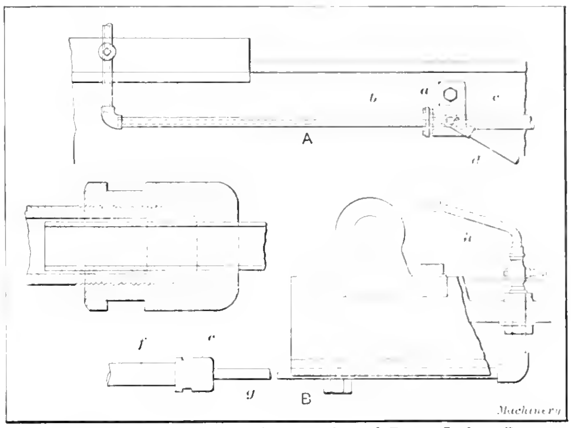

Fig. 9. A. Sliding Pipe and Stuffing-box of Turret Lathe. B. Telescopic Pipe Connection for Carriage of Gear-cutting Machine

and (2) the means for catching the lubricant and returning it to the tank. The methods of distributing and returning the lubricant vary greatly on account of the varying conditions of cutting and different arrangements of tools, slides, machine framings, etc.

In regard to the method of distribution, the choice lies between rigid pipes, flexible pipes, and jointed pipes; between a single outlet, two or more outlets, a perforated distributor, a pipe with a number of taps or pipes leading from it, or an overhead reservoir fitted with outlet pipes. Means may be provided in the case of multiple outlets to shut off any or all of these according to the amount of lubricant desired and its place of delivery. The flow may be allowed to fall from above, or it may be directed precisely to a certain spot by a pipe, or through a hollow tool or spindle, or a spout or chute may catch the lubricant and pour it onto a precise location.

Rigid pipes are chiefly applicable to machines which have no great changes of tools or adjustments of slides, so that a fixed position of the pipes is suitable, but these are the exception, and it is better to have an adjustable pipe, for convenience in moving it out of the way if necessary. The degree of movement depends on the range of possible locations of the cutting tools. Piping with three or four joints is frequently necessary, including horizontal and vertical swivel adjustments. The alternative is the flexible pipe, which however, is likely to be in the way in many instances. A flexible pipe is more useful as a means of connecting rigid or jointed pipes to the supply or drawing-off arrangements.

A single outlet is all that is necessary for most of the single-point cutting tools, for narrow milling cutters, drills, and similar tools, but two or more outlets are required for pairs or gangs of cutters and multiple tools, unless the

alternative of a single wide spout is utilized. The main support of a jointed pipe is placed according to circumstances, sometimes consisting of the supply pipe itself, sometimes of a separate rod to which it is attached, the rod being bolted or screwed in any convenient position. The main pipe or rod must be put where it is not likely to be in the way of large work, jigs or fixtures; in some cases, a portable fitting may be necessary to meet these requirements. An alternative to the gas-bracket type of jointed pipe is one having a ball-joint and telescopic second tube (see *B*, Fig. 7).

A preferable method of securing flexibility is to use a short piece of pipe equipped with a tap, and hold this in a clip against a part of the machine or on a rod, and connect to the pump with flexible tubing. This arrangement is useful when no great range of adjustability is essential and also when considerable horizontal or vertical range is required. In the first case, it obviates the use of a jointed pipe, and in the second it enables adjustments of several feet to be obtained without encumbering the tool with three or four jointed pipes. Typical examples are shown at *C* and *D*, Fig. 7, *C* showing a rigid pipe held by a split clamp to a rod screwed into a machine boss and connected to a flexible tube, and *D* a stem extending from the connection and clamped in a bracket horizontally adjustable along a slide. As the flexible pipe can be carried down at the rear or side of the machine, it need not interfere with the operation of the machine; moreover, if cutting is done without lubricant, the clamps may be released and the piping laid out of the way altogether. Arbor ful for gang mills on an arbor which is steadied by a central support) and *J* has extension tubes hanging down to reach in between tools which interfere during part of their stroke, with a directly vertical flow. This type of distributor is also used where the air from a belt or other rapidly moving part would disturb the vertical stream of lubricant and blow it out of its proper path. At *I* the tubes are pivoted to swivel to one side and direct the liquid to a particular place. A shut-off may or may not be provided for each tube.

The standard distributing pipes occasionally fail to meet special conditions, and it becomes necessary to cut a piece of tubing and drill it specially, as at *K*, where four slitting saws are set rather far apart and a pipe is drilled with holes to suit. If much of this class of work is likely to be done, it may be preferable to drill a larger number of holes in the pipe and plug up those not wanted. Long distributing pipes are sometimes provided with holes drilled fairly close together and having spring bands which are partly rotated to block those holes which are not required. Another special arrangement for some classes of work where a guard is fitted over the cutters is to use the hollow top of the guard for conducting the lubricant directly upon the cutters. Box-tools are also sometimes made with hollow frames, with an outlet close to the cutters, giving a broad stream at the best possible location. This is a mode of distribution that must be designed to suit the tools, and is not of general application.

An alternative to the practice of stopping off or plugging up unused holes in a distributing pipe, is to provide

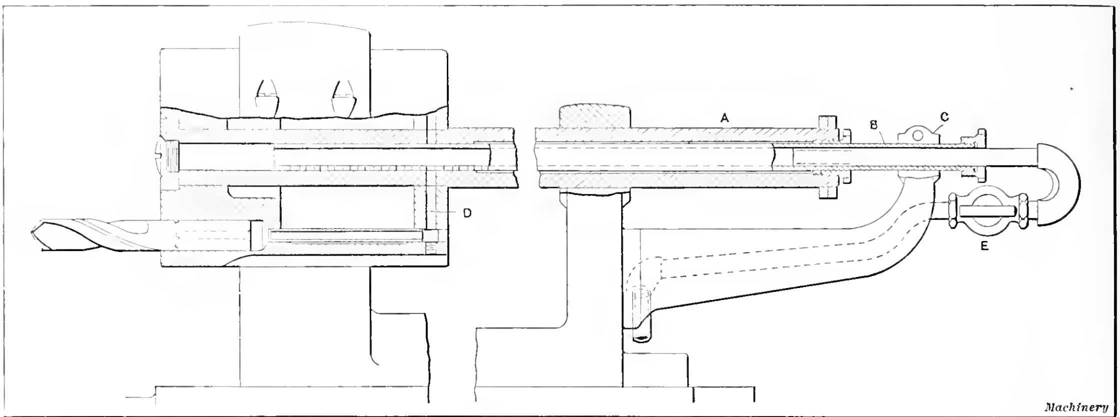

Fig. 10. Sectional View showing Method of supplying Oil to Turret of Cleveland Automatic

supports or overhanging arms on the machine are often used for attaching pipe clamps.

A cutter of considerable width, or a hob, must have an ample supply of lubricant along its entire length, if lubrication is to be effective and even, and cooling uniform. A good device for hobs and cutters for heavy duty is the fan nozzle. This is set vertically, or at an angle, just above the cutter, and delivers a broad copious stream. The closed type *E*, Fig. 7, is employed in the case of slab millers having the cross-slide face set at an angle, the nozzle being pointed inward or toward the back of the machine. The partly open kind *F*, is suitable for horizontal delivery or delivery at a slight angle. These nozzles are attached to the delivery pipe, but in a few instances the nozzle is used separately, being clamped to a part of the machine or to the tool itself and fed by a flexible pipe brought over it, thus affording a wide stream without modifying the outlet for ordinary operations.

Adjustment for width of flow is provided for in some nozzles, the opening being blocked to any desired extent by sliding a plug along to suit the width of the cutter. When there is no adjustment to the supply pipe to accommodate the varying lateral positions of cutters on their arbors, the nozzles may be pointed to right or left, as desired, by fitting it with a swivel joint. Perforated distributing pipes which give a flow of lubricant to suit the length of work or cutter are shown at *G*, *H* and *J*, Fig. 7. They have sliding plugs to shut off some of the holes, thus reducing the supply. Pipe *G* is an ordinary form, *H* is double-ended (a type use- regular taps for turning off the lubricant. This method is common to slab or "plano-millers" on which a pipe of ample capacity is secured to the cross-rail and has a number of taps screwed in at close intervals, as shown at *A*, Fig. 8. If the pipe runs along at the back of a machine or below a cross-rail, as in many multiple-spindle drilling machines, pipes connected to each tap will be essential in order to bring the oil to the drills, a swivel-joint permitting each pipe to be placed in the position desired.

The case of two or more pipes having outlets separated more widely than in the distributors referred to, is often met with, such as when two tools or cutters are working on different parts of a piece or on two pieces of work. Either rigid or swiveling pipes are used, according to requirements, or provision for variation between the outlets is made by a length of flexible pipe. Certain multi-spindle drilling machines and multi-spindle automatic screw machines carry a pipe partly around the spindles or around the turret, and various bent pipes or distributors lead off from this common supply pipe to feed each drill or turret tool. At *B*, Fig. 8, is an example of a double supply, one pipe leading to the center of the turret for lubricating hollow tools, and the other continuing for feeding external tools held in the turret. A somewhat similar arrangement is shown at *C*; the tap nearest the turret feeds into a funnel which is connected to a slot distributor attached to one of the box-tools having a long cutter for forming steel taper pins; this arrangement insures a proper flow all along the broad-faced cutter.

Portions of machines which move intermittently or continuously along a bed, and must be fed with lubricant in any position they occupy, require the use either of jointed pipes, flexible connections, or telescopic tubes. Both of the latter are used largely. The flexible tubes are likely to get in the way and become a nuisance, while the telescopic pipes can be arranged in snug fashion and occupy a minimum of space; moreover, they are not as liable to become damaged as flexible tubes. It is chiefly in those types of machines where the tool has a horizontal feeding movement, that the provision of adjustable piping is required. Gear-cutting machines and turret lathes are the most frequent examples, the cutter-slide of the one, and the turret-slide of the other requiring a supply of lubricant at all working positions. Certain other machines of less importance in point of numbers, such as horizontal drilling machines and slot-drills with traveling cutter-heads, also require adjustable piping. The telescopic device *A*, Fig. 9, which also shows the back of a turret lathe with a portion of the turret saddle, has a fixed bracket *a*, fitted with a stuffing-box through which the sliding pipe *b* is free to move. The latter passes into the closed end of pipe *c*, which is fed by the pipe *d*, from the pump.

Connection to the sliding cutter-carriage of a gear-cutting machine is made either by the somewhat clumsy means of a flexible pipe, or by a sliding pipe which is arranged, preferably, below the base, as at *B*. (From the practice of Messrs. J. Parkinson & Son, Shipley, Yorkshire.) The packed gland *e* (shown enlarged in section above) is screwed on the end of the stationary pipe *f*, and admits the sliding pipe *g*, which is united to a short vertical pipe fixed to the cutter-carriage. From this vertical pipe the short length of flexible steel tube *h*, directs the stream onto the cutter.

Another system of distribution for movable parts is that requiring a supply to tools in a turret, one or perhaps two or more of which may require the lubricant to be fed through their hollow bodies during their period of operation only. This is effected by causing the rotation of the turret to turn on and cut off the oil as the tools come into their working position. The arrangement for the Cleveland automatic screw machines is shown in Fig. 10, and will serve to illustrate the principle. The feed takes place when the drill shown is at the lowest or working position. The turret shaft *A*, in its to-and-fro movements, controls the feed in the following manner: An oil tube *B* extends inside the shaft and can be clamped in the bracket *C*, wherever desired. This tube has a series of holes in its lower side, continuing for a distance equal to the turret stroke. These holes communicate with a single hole *D* connecting with a tube inserted in the turret hole which carries the tool. The position of tube *B* determines when the oil will begin to flow; it can be adjusted to start at the beginning of the stroke, or later. Valve *E* is to regulate or shut off the oil. Can action is employed in some machines to turn the oil on and off.

BUILT-UP UNIVERSAL GEAR PATTERNS

One of the problems confronting a manufacturer of gears, especially when he makes a practice of furnishing gears of all shapes, types and sizes, is the tying up of a large amount of his capital in patterns. Of course, it is evident that where the sizes are close to some standard, slight alterations can be made in the mold before the gear is cast, but where the difference exceeds limits greater than those which can be handled in this manner it is necessary to make a pattern in each case.

The Foote Gear & Machine Co., Chicago, Ill., has worked out a system of built-up interchangeable patterns which reduces the number of patterns made to a minimum. These patterns are built up from a number of standard parts, and as shown in Figs. 1 and 2 the only part common to all is the center *A*. This center portion is made from a cast-iron shell to prevent the pattern from being wrecked in the foundry, and is arranged with projecting bosses, equal in number to the arms required in the gear. In these projections the removable arms *B* are held, simply being pointed and driven in place and then fastened by screws. The arms can be procured in strips machined to the required shape and it is only necessary for the patternmaker to cut them off to the required lengths. The rim *C* of the pattern is made from two circular members consisting of segments which are provided with holes clear through. These holes are formed by the halves of each groove in the circular segments, which are parted at the center so that the arms can stick out, thus enabling gears of various outside diameters to be cast from the same pattern by simply shifting the position of the rim on the arms. Six inches is about the maximum projection that can be allowed without interfering with molding. The hub of the gear pattern consists of two circular blocks which have projecting bosses that fit in the hole in the center portion of the pattern. The core prints *E* are then screwed to the built-up hubs, and the pattern is complete.

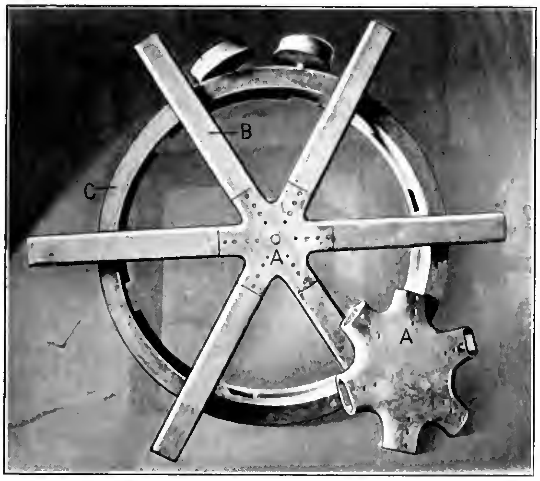

Fig. 1. Component Parts of Built-up Universal Gear Pattern

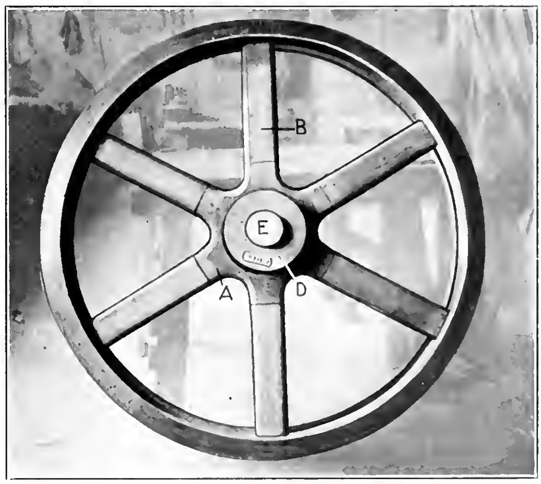

Fig. 2. Pattern assembled and ready for use

This standard pattern, by the addition of the built-up portion previously mentioned, can be used for practically any special gear that comes into the plant, and the number of parts are so few that the problem of storing is greatly simplified. When an order comes in for a gear for which no pattern is made up, it is only necessary for the patternmaker to look through his stock of hubs, rims, arms, etc., and pick out those which approximate the requirements. This not only makes it possible for the manufacturer to produce a cheaper gear, especially when ordered in small lots, but it also enables him to fill the order much more quickly than if it were necessary for him to make up a pattern for each size of gear.

D. T. H.

* * *

A lining for plating tanks, to protect them from the influence of acids, is made from a mixture consisting of 75 parts, by weight, of pitch; 9 parts plaster-of-paris; 9 parts ocher; 15 parts beeswax, and 3 parts litharge.

AN EFFICIENT FILING SYSTEM FOR THE DRAFTING ROOM

BY G. E. CAMPBELL*

Considering the number of questions the engineering department is called upon to answer daily, and the numerous drawings which have to be referred to in order to give correct information, the necessity of an efficient system for filing drawings and keeping a record of blueprints that are given out is apparent. In this day when sectional filing cabinets with drawers of convenient size can be bought ready for use, it is possible for a drafting-room of any size to have a first-class and efficient filing system which will enable the draftsman to find any drawings in the room immediately and keep a complete record of all blueprints given out. The system which the writer is about to describe has been installed in two different manufacturing plants and both are pleased with the results obtained.

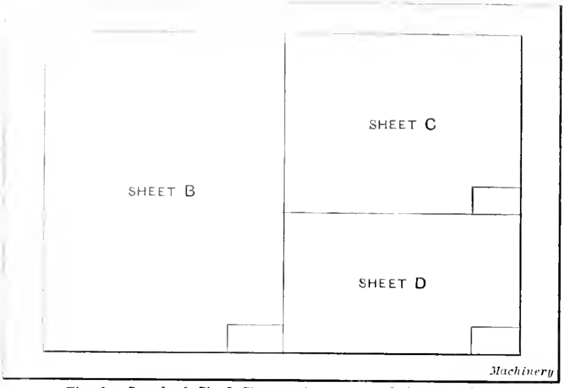

Fig. 1. Standard Sized Sheets of Paper used for Drawings

Size of Drawings

The first thing necessary is to adopt standard sized sheets for drawings, and these sizes will depend upon the material used in making the drawings. As a general proposition, it is preferable to make new drawings on Crane's No. 25 bond paper, as they can be inked directly on this paper, thereby saving considerable time and avoiding the mistakes made in tracing drawings. This quality of paper also makes excellent blueprints. Paper without the "water mark" comes in sheets 27 by 40 inches in size and this will be known as sheet *A*. By cutting the sheet in the center, two sheets 27 by 20 inches in size are made, and each of these will be known as sheet *B*. Again cutting sheet *B* we get sheets *C*, 15 by 20, and *D*, 12 by 20 inches in size. Every sheet has a title in the lower right-hand corner, as shown in Fig. 1, and if the inside measurements of the drawers in filing cases are 31 by 41 inches there will be just enough room for partitions between the different sized sheets.

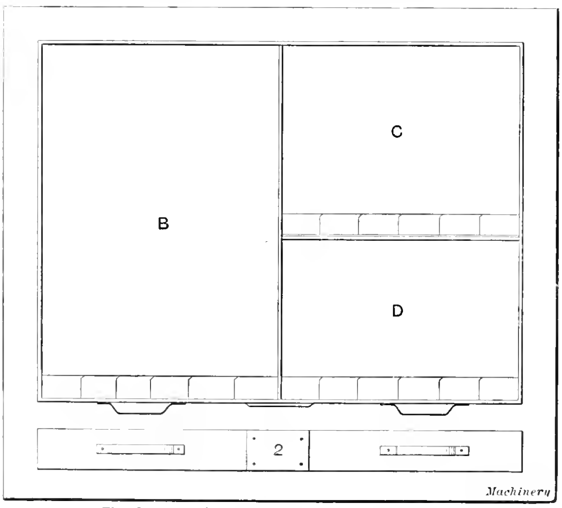

Fig. 2. One of the Drawers in the Filing Cabinet

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The System

Let us suppose a line of standard machines of different sizes is being manufactured and that each machine requires drawings of the different sizes previously mentioned. It is very convenient to have all the drawings of each machine filed together, and in order to do this, each drawer in the filing cabinet should be provided with partitions of heavy manilla paper or light cardboard. Those partitions should have tabs bearing the name of the machine contained therein, as illustrated in Fig. 2. The drawers are then numbered consecutively on the front.

Numbering the Drawings

Each drawing bears a number just under the title and this number consists of a letter denoting size of sheet, number of drawer in which sheet is filed, and number of sheet in the drawer. For instance, the number *B* 232 means that the sheet is size *B*, or 27 by 20 inches, that it is filed in drawer No. 2 and is the thirty-second drawing filed in this drawer. It will be filed under the tab bearing the name of the machine for which the drawing was made. If the drawing happens to be a detail drawing of a part used on more than one machine, blueprints are made and marked "Record Prints," and these prints are filed under the tab for the machine intended. In this way, a complete set of drawings for each machine is always at hand and filed together for ready reference.

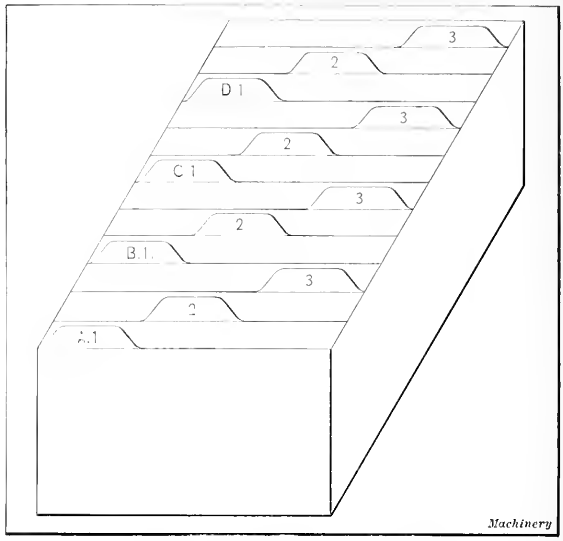


Fig. 3. The Numerical Index of Drawings

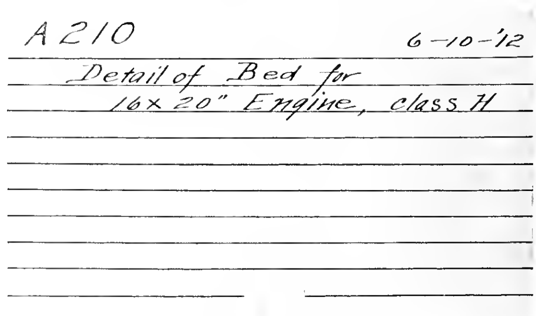


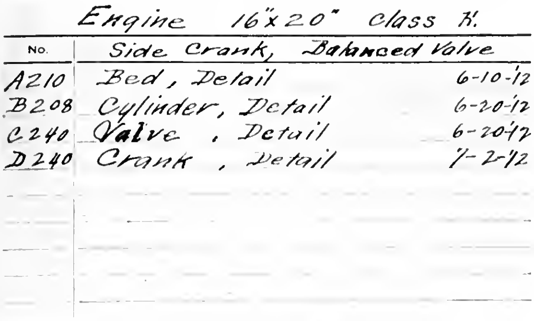
Fig. 4. Card used in the Numerical Index

The Card System

As a check against mistakes, and to complete the record, three sets of cards are kept, each under a different head, *viz.*,

"Numerical Index," "Machine Index" and "Customer's Index." The numerical index cards should be made before drawings are filed and the finished index will appear as shown in Fig. 3.

One of the individual cards is shown in Fig. 4. This card would be filed in section A after 2, and by numbering these cards consecutively and in advance there is no danger of having the same number on any two drawings, as this index must be referred to before numbering a drawing. For example, a size A drawing for drawer 2 is to be numbered, and

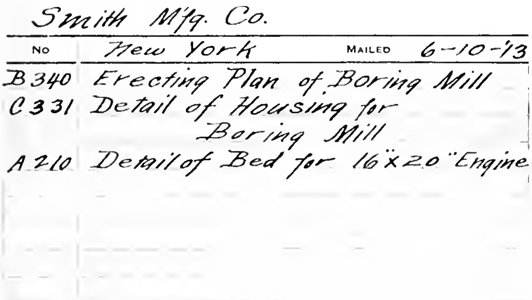

Engine 16"x20" Class K.

No.	Side Crank, Balanced Valve	
A210	Bed, Detail	6-10-12
B208	Cylinder, Detail	6-20-12
C240	Valve, Detail	6-20-12
D240	Crank, Detail	7-2-12

Fig. 5. Card used in the Machine Index

by referring to index under A 2 we see that A 210 is the last number used; therefore we use blank card A 211 and put this number on the drawing. The title of the drawing is also written on this card. Frequently only the number of the drawing is referred to and in order to locate and identify the drawing, this index is very valuable.

The machine index is simply an index bearing the name of machines alphabetically arranged, the cards being ruled as shown in Fig. 5. The advantage of this card is chiefly as a check, and when all of the drawings for a machine are wanted, it is well to refer to this card for the complete list, as there is always a chance of someone putting a drawing away in the wrong place. By referring to the card, you


Smith Mfg. Co.

No	New York	Mailed 6-10-13
B340	Erecting Plan of Boring Mill	
C331	Detail of Housing for Boring Mill	
A210	Detail of Bed for 16"x20" Engine	

Fig. 6. Card used in the Customer's Index

know that you have a complete set of drawings. It is also handy for the man getting up a complete set of blueprints for a machine.

The customer's index is a record of blueprints mailed to the customer. The cards are ruled as shown in Fig. 6 and are filed in an index which is arranged with the customers' names in alphabetical order. This will be found valuable in order to locate the exact blueprint mailed to a customer.

* * *

Effective ventilation means first of all that the air in a room is kept in motion. It does not necessarily mean that the air is being rapidly displaced by the outer atmosphere. Workmen will be comfortable in a warm shop if the air is kept in motion so that a perceptible breeze is felt. To merely change the air is not enough. For this reason, it is a mistake to design a shop, especially a blacksmith shop, with the window openings six or seven feet above the floor. At this height, the direct effect of the air coming in is not felt by the men, who, as a result, are likely to suffer severely, notwithstanding the fact that the air is constantly changing. They do not feel the breezes and the drying of perspiration is slow.

STRESSES IN BRICK PRESS MOLD BOXES

BY SAMUEL B KANOWITZ*

In the design of mold boxes for repressing clay products to their required form, designers have not had any rational formula to follow, since the stresses transmitted to the frame vary with the plasticity of the clay. As the writer has had occasion to use various sized mold boxes, the following formulas were developed, the coefficients given having been derived from experimental tests. For all practical purposes, we may consider that each side of the frame of the mold box (see Fig. 1) is subjected to two stresses—one a bending stress due to the distributed load acting on the side direct, and the other a tensile stress due to the reactions of the adjacent ends, as shown in Fig. 2.

The bending stress can be found from the formula for a uniformly loaded beam fixed at the ends, or

$$p_1 = \frac{Pl}{12Z} \tag{1}$$

where p_1 = stress per square inch;
P = total load on beam;
l = length of beam;
Z = section modulus.

In the case under consideration let

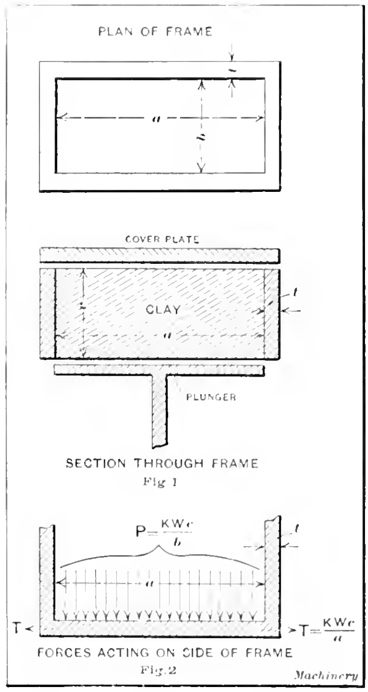
W = total upward force of plunger;
a = inside length of frame;
b = inside width of frame;
c = depth of frame;
t = thickness of metal.

In the case of a fluid where the pressure is distributed uniformly in all directions, we have the following formula;

$$p_2 = \frac{W}{ab} \tag{2}$$

where p_2 = pressure per square inch in all directions.

In dealing with a clay, however, we find that the pressure is not distributed equally in all directions and that the unit pressure on sides and ends can best be expressed by the following formula



Diagrams illustrating Brick Press Molds

$$p_2 = \frac{KW}{ab} \tag{3}$$

In this formula, K is a constant depending on the nature of the clay and amount of moisture in the material to be repressed. The following values of constant K were obtained from experiments on brick at different stages of drying:

Nature of Material	Percentage of Moisture 10	15	25	35	50
	Values of K				
Soft plastic clay	0.68	0.73	0.82	0.90	0.91
Medium plastic clay....	0.62	0.68	0.78	0.85	0.90
Coarse plastic clay	0.58	0.65	0.76	0.84	0.90
Fireclay, kaolin........	0.50	0.55	0.64	0.72	0.80

The area of side A of the frame = ac (see Fig. 1); there-

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fore, the total load on side A equals $\frac{KW}{ab} \times ac$, or,

$$P = \frac{KWc}{b} \quad (4)$$

The section modulus of side A about the neutral axis is equal to $Z = \frac{1}{6} ct^2$. Substituting the values of P and Z in Equation (1) and noting that $l = a$, we have the following result:

$$p_1 = \frac{KWa}{2\,bt^2} \quad (5)$$

From this equation we note that the bending stress varies with values a, b and t but is independent of the values c.

The tensile stress on side A is due to the outward pull exerted upon it by the load on the two adjacent ends. The area of each of these equals $b \times c$, and the load per square inch from Equation (3) equals $\frac{KW}{ab}$; therefore, the total load on each end equals $\frac{KW}{ab} \times bc = \frac{KWc}{a}$ or, calling the tensile force that pulls on side A, T, then

$$T = \frac{KWc}{a} \quad (6)$$

The area over which T acts equals $c \times t$; therefore, we have

$$p_3 = \frac{T}{tc} = \frac{KWc}{atc} = \frac{KW}{at} \quad (7)$$

where p_3 = the direct tensile stress.

Combining Equations (5) and (7) we obtain

$$p = p_3 + p_1 = \frac{KWa}{2\,bt^2} + \frac{KW}{at} \quad (8a)$$

where p = the resultant stress in the frame due to flexure and tension. Equation (8a) can be reduced to the following form:

$$p = \frac{KW}{ab}\left(\frac{a^2 + 2\,bt}{2\,t^2}\right) \quad (8)$$

In designing a frame, the combined stress in the longer side only is considered, since the combined stress in the longer side is greater than the combined stress in the shorter side. The bending stress in the longer side is also greater than the bending stress in the shorter side, since their ratio is, from Equation (5),

$$\frac{KWa}{2bt^2} \div \frac{KWb}{2at^2} = \frac{a^2}{b^2}$$

Although the tensile stress in the shorter side is greater than the tensile stress in the longer side, still their ratio is, from Equation (7),

$$\frac{KW}{bt} \div \frac{KW}{at} = \frac{a}{b}$$

From the above equations, we see that the ratio of the bending stresses in the longer to the shorter side, varies as the square of $\frac{a}{b}$, while the ratio of the tensile stress in the smaller to the longer side, varies as the first power only, so that the sum of the combined stresses in the longer side is greater than the sum of the combined stresses in the shorter side.

Solving Equation (8) for t we obtain

$$t = \frac{KW}{2\,ap} + \sqrt{\left(\frac{KW}{2\,ap}\right)^2 + \frac{KWa}{2\,pb}} \quad (9)$$

In the above equation, if a is much longer than b, the quantity $\frac{KW}{2\,ap}$ can be neglected and Equation (9) reduced to the following form:

$$t = \sqrt{\frac{KWa}{2pb}} \quad (10)$$

This same result can be obtained by solving Equation (5) for t, thus showing that under the above conditions, the tensile stress can be neglected in comparison with the bending stress.

The data given in the foregoing is applicable not only to ordinary hand and power re-presses, but also to brick-forming machinery such as soft-mud machines and dry-press machines; in the latter type, the forces required are enormous. The question of brick machinery design and installation has been very much neglected, due particularly to the general inefficiency of the average brick plant but, principally, because the average brick machinery designer has a very meager knowledge of clays and depends mostly upon guesswork. The stresses to which the mold box of a press is subjected, especially when comparatively dry clay is compressed to the form of a brick, are much greater than is generally supposed. Take the case of a "face brick" made on a dry press. Dry pulverized clay is used, and, after being poured into the mold boxes of the press, enough power has to be applied to compress this clay into bricks having smooth surfaces and sharp edges; these bricks must also be hard enough to allow stacking them in a kiln thirty high, without losing their shape. Certain clays require a pressure of from 40,000 to 50,000 pounds per square inch, before these results can be obtained.

An idea of the stresses set up and the forces that have to be applied in brickmaking, may be obtained from the following quotation taken from the catalogue of a well-known manufacturer of brick machinery. "A press that will turn out 2800 dry pressed bricks per hour, weighs 51,000 pounds, requires 25 H. P., and the guides which receive the thrust of the plungers are built to withstand a tensile strain of 6,078,000 pounds." Re-presses which are used to press bricks after they are already formed, also require very high pressures in order to press out all cavities and produce bricks having smooth surfaces and well defined edges. For some clays a unit pressure of 2000 to 3000 pounds is required.

* * *

DON'TS FOR DRILLING MACHINE OPERATORS*

BY JAMES E. COOLEY†

Don't forget when using a head counterbore to try the head of the screw in a hole often, to see if it is cutting the right depth.

Don't take it for granted that the drill you called for at the tool-room has been given you; look at it and see if it is the right size.

Don't brush cast-iron chips off the table onto the floor but catch them in a box; this action raises a dust which gets into the machine bearings.

Don't run a tap in a hole with the tapping fixtures, unless you have first measured the hole to see if it is drilled large enough.

Don't use a knee or angle-plate or parallels without first assuring yourself there are no nicks in them to make the work out of true.

Don't forget to slightly prick several places around on a scribed circle with the center punch; they will show after the circle has become rubbed out.

Don't push down hard when tapping a hole but give the fixture time to feed the tap in; tapping fixtures are broken by forcing and not because they won't work.

Don't use a drift that passes entirely through the broach in the spindle, because the hammer will strike the spindle on the last stroke or when the drift passes through.

Don't, when using several drills, let a drill follow a very small one or *vice versa* if you can avoid it; use the drills in the order of their nearest diameters if possible.

Don't ever fail to look at the opposite end of a drilled hole to see if there is a ridge on one side of the edge; if there is, it shows that the drill has been ground off the center.

Don't forget to watch and see if the drill is sending up solid or powdered chips; if the latter, the feed is not on tight enough, or the feed belt is loose, or the drill is dull.

* See "Don'ts" for Drilling Machine Operators," published in the November, 1913, number of MACHINERY.

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GRINDING WHEEL PROTECTION DEVICES*

REPORT ON INVESTIGATION OF DEVICES MADE BY THE NORTON CO.

BY R. G. WILLIAMS†

Recent discussions in the technical press and publications devoted to industrial safety and welfare work, have forcibly brought to the attention of those most interested, the fact that there is no uniformity or standardization of grinding wheel protection devices. This lack of uniformity has been a serious handicap in the development of safer manufacturing conditions. Attention has also been drawn to the fact that there are no recorded data or observations on which standardization and safety rules can be based. For the purpose of obtaining data and observations on the relative protection offered by an approved type of protection hood and approved beveled steel flanges, the Norton Co., through its research laboratories, conducted a series of tests.

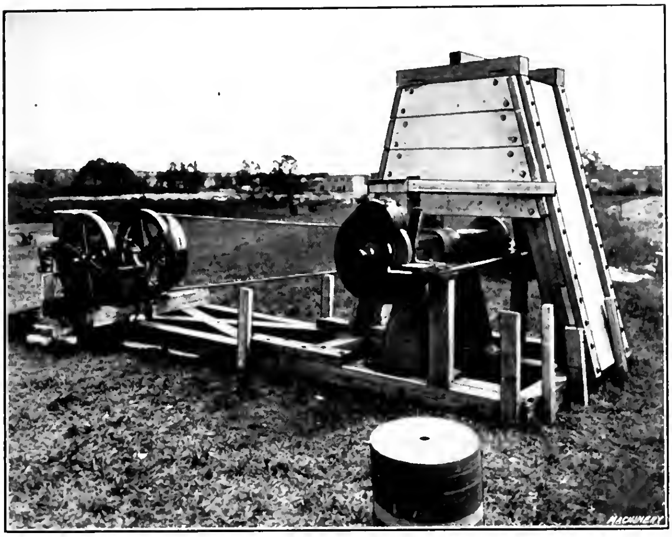


Fig. 1. Testing Equipment consisting of Norton Floor Stand operated at a Speed of 6000 Surface Feet per Minute for All Tests

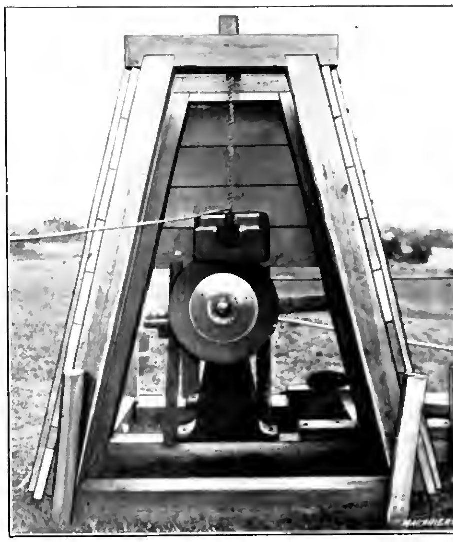


Fig. 2. Wheels broken by swinging 130-pound Weight against the Side

The testing equipment consisted of an up-to-date grinding wheel stand driven by a 7½ horsepower gasoline engine (see Fig. 1). A wooden framework of heavy timbers was built over the side on which the flanges were tested, to intercept pieces of the wheels which might possibly break off outside the flanges. In all tests, the wheels were operated at 6000 peripheral feet per minute, the speed being very carefully regulated immediately before each test.

*Paper presented before the American Society of Mechanical Engineers at New Haven, Conn., November 21, 1913.
† Safety Engineer, Norton Co., Worcester, Mass.

Hood Tests

The wheels used for the hood tests were 16 by 2 by 1¾-inch, alundum, vitrified, of various grains and grades and had parallel sides. The hood was a modern type, and the wheels were mounted between relieved cast-iron flanges 8 inches in diameter. One layer of blotting paper of standard thickness was used between the wheel and each flange. The nut on the spindle was not tightened excessively, but drawn up enough to hold the wheel firmly. The wheels in the hood tests were broken by dropping a steel wedge between the rest and the side of the wheel, in such a manner as to provide a severe blow. The object was to duplicate, as nearly as possible, one of the most frequent causes of accident, *viz.*, that of the work being caught between the rest and the wheel.

Flange Tests

The wheels used were all 24 by 2½ by 1¾-inch alundum, vitrified, grain 14, Grade O, tapered both sides ¾ inch to the foot, with a flat at the center of 4 inches diameter. One thickness of standard blotting paper was used between the wheel and each flange. In these tests, five sets of relieved steel flanges, tapered ¾ inch to the foot, were used, the diameters being 12, 14, 16, 18 and 20 inches, respectively.

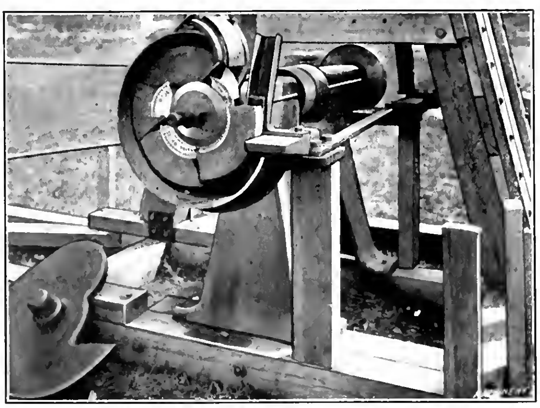


Fig. 3. Wheel; 16- by 2- by 1¾-inch Alundum, 20-K Vitrified; Speed, 6000 Surface Feet. None of the Broken Pieces escaped from the Hood

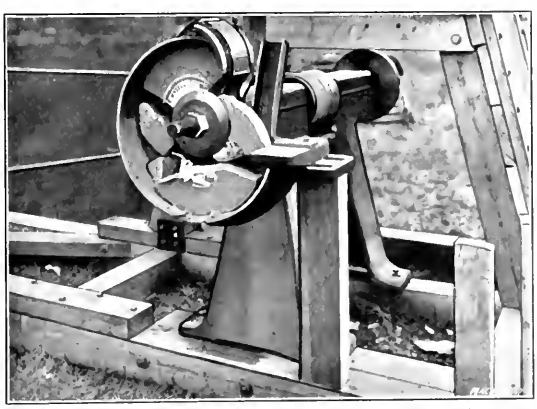


Fig. 4. Wheel; 16- by 2- by 1¾-inch, Alundum, 30-K Silicate; Speed, 6000 Surface Feet. None of the Broken Pieces escaped from the Hood

The wheels in these tests were broken by swinging a 130-

pound cast iron weight against the side of the wheel (see Fig. 2). This method of breakage corresponds to a common cause of accident when heavy castings, which are suspended by tackle above the wheel, are carelessly allowed to strike the side of the wheel with enough force to cause breakage. The manner in which a wheel is broken is not important when pro-

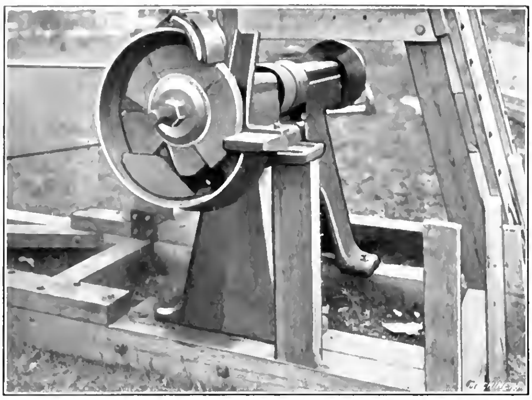


Fig. 5. Wheel; 16- by 2- by 1¾-inch, Alundum, 24-K Vitrified; Speed 6000 Surface Feet. None of the Broken Pieces escaped from the Hood

tection devices for grinding wheels are being studied, so even though the wheels were broken by different methods in the hood tests and the flange tests, the results obtained are comparative from the point of view of protection to an operator.

Observations

In none of the hood tests did a piece of the wheel leave the hood in a way that could have caused damage. The tests show conclusively that a well designed protection hood, made of the right material and properly adjusted, affords ample protection for straight-side wheels even when they are mounted between standard straight relieved flanges having a diameter equal to one-half the diameter of the wheel.

It is possible to break pieces from a wheel by a severe blow when there is only 2 inches of the wheel projecting beyond

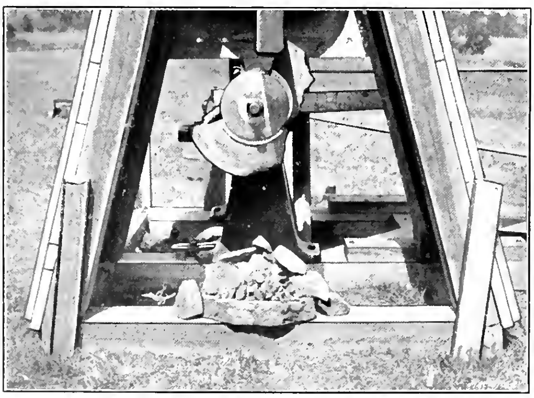


Fig. 6. Wheel; 24- by 2½- by 1¾-Inch, Tapered ¾ Inch to Foot, Alundum, 14-0, Vitrified; Speed, 6000 Surface Feet. Flanges; Steel, 12 Inches Diameter, Relieved, Tapered ¾ Inch to Foot. Wheel broke into Forty-two Pieces and approximately Two-thirds of Wheel escaped from Flanges

the flanges. With protection flanges, no matter how little the wheel projects beyond the flanges, an operator has no protection from injury in case a piece of the wheel breaks off outside of the flanges, whereas with a hood, protection is almost absolute.

Requirements for Hoods and Flanges

It was not the intention to obtain data from which standard specifications for hoods and flanges could be drawn; nevertheless, the tests as a whole brought out a number of points which could be so used. Specifications for hoods for rough grinding should not only require a certain strength, as determined by the design and material used, but they should also require that the top end of hoods have some sliding-tongue device, which can be adjusted as the grinding wheel wears, and thus offer at all times the maximum protection possible. They should also contain a definite statement as to the maximum exposed grinding surface allowable for the common varieties of grinding. For example: Can 60, 70 or 80 degrees of grinding surface be exposed on the type of machine known as the floor stand? Such specifications should also state the minimum size wheel allowable in a hood of given dimensions.

In a majority of instances where protection flanges are now used, ample protection can be obtained by means of hoods without such flanges. However, there are conditions where a hood is not practical and where flanges offer the next best method of protection. The amount of protection offered by flanges is dependent upon the following:

1. The capacity of the flanges to resist the wedging action of a broken piece of the wheel.

Fig. 7. Wheel; Same as Fig. 6. Flanges; Steel, 14 Inches Diameter, Relieved, Tapered ¾ Inch to Foot. Wheel did not break into as many Pieces as One in 12-inch Flanges. Approximately Three-fourths of Wheel escaped from Flanges

2. The size of flanges.
3. Bevel of the wheel.
4. Peripheral velocity of the wheel.
5. Mass of the wheel.
6. Degree of safety.

Degree of safety, as here used, expresses the relationship between the thickness of the wheel at the hub and the thickness of the wheel at the point where the outer edge of the flanges bears on the wheel. In other words, it is an expression which indicates how much the flanges must spread in order to let out a broken sector of the wheel. If the force acting upon the

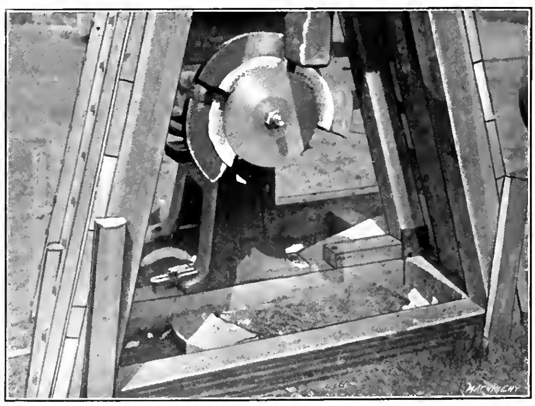


Fig. 8. Wheel; Same as Fig. 6. Flanges; Steel, 16 Inches Diameter, Relieved, Tapered ¾ Inch to Foot. Blow of Weight was not on Piece of Wheel which left Flanges and dropped to Ground. The Part of Wheel struck by Weight was held in Flanges

sector of a broken wheel is great enough to spread the protection flanges a distance equal to B minus A inches (see Fig. 11), then there is not adequate protection. Sufficient protection can be obtained by (*a*) increasing the thickness of the flanges, (*b*) using flanges of a material with a greater modulus of elasticity, (*c*) increasing the diameter of the flanges, (*d*) increasing the taper per foot of the wheel.

Some figures obtained from the 16-inch diameter flange test, give a basis on which standard specifications may be formulated. The combination of factors present in this case resulted in what could be termed a critical condition. The wheel broke into four almost equal pieces, the weights of which were about 23½ pounds. The peripheral velocity of the wheel was 6000 feet per minute. The wheel was tapered ¾ inch to the foot, the taper ending 2 inches from the center of the wheel. In order for a sector to fly out of the 16-inch flanges, they had to spread a total of ¾ inch. After the breakage, it was found that the sectors had moved out a little over 5½ inches and the flanges had spread a little over 11/16 inch, or nearly the required distance to let out the sectors.

The shape of the flanges used was such that it has been found impractical to consider them as cantilevers of the same cross-sectional area, and, therefore, the acting forces in the above case, and the exact factor of safety, cannot be calculated readily. For this reason we cannot deduce definite formula relations between the several factors involved. We can, however, find a proportional relation which expresses the relative degree of safety with different size wheels and flanges.

Fig. 9. Wheel; Same as Fig. 6. Flanges; Steel, 18 Inches Diameter, Relieved, Tapered ¾ Inch to Foot. The Piece of Wheel on the Ground was not knocked off by Blow of Weight, but thrown from Flanges by Centrifugal Force and hurled through Opening at Top of Framework into Air about 50 Feet

Flanges 20 inches in diameter must open one inch to let out a sector. This distance is 33 1/3 per cent more than in the case previously cited, so that 20-inch flanges of the same stiffness as the 16-inch flanges would just about hold the quarter sector of a wheel of 33 1/3 per cent greater mass.

Fig. 10. Wheel; Same as Fig. 6. Flanges; Steel, 20 Inches Diameter, Relieved, Tapered ¾ Inch to Foot. All Segments were retained by Flanges which are only 4 Inches less than Wheel Diameter

The size of a 24-inch wheel of 33 1/3 per cent more mass than a 24 by 2½-inch wheel, would be about 24 by 3⅜ inches. Since 20-inch flanges are as large as is practical to use on wheels 24 inches in diameter, it is quite obvious that 24-inch wheels of a thickness greater than 3½ inches are not safely guarded by means of ¾-inch taper protection flanges, unless the flanges are made more rigid than most existing flanges. Standard specifications should require a factor of safety of at least 2. This requires a greater taper than ¾ inch to the foot, or the use of very heavy steel flanges.

Conclusions from Tests

The tests conducted and the mathematical deductions given above, show that protection hoods provide greater safety than do safety flanges. The protection offered by any given taper decreases with decreased diameter of the wheel. To provide equal safety on all sizes of wheels would require, therefore, a graduated difference in taper. A hood with an adjustable tongue furnishes equal protection for a wide range in the diameter of wheels.

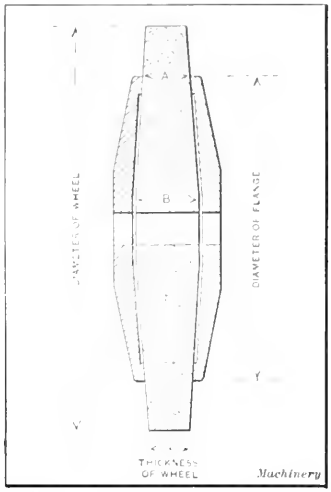


Fig. 11. Sectional View of Tapering Grinding Wheel and Protection Flange

Second to safety, the cost of operating a given grinding machine is of vital interest. In this respect, adjustable hoods have the better of the argument for, as the wheel wears, protection flanges must be changed frequently. Such change involves the removal and remounting of the two flanges and wheel, whereas, in the case of a hood, the change would merely involve set-screw adjustment.

To provide adequate protection for wheels 3 inches and thicker, the thickness (hence the weight) of flanges would have to be increased beyond that of any flange now on the market. This would mean added momentum to the revolving spindle, which, in turn, would require greater rigidity and strength than is to be found in the majority of present-day grinding machines.

Since the face of a tapered wheel becomes wider as the diameter decreases, serious inconvenience is caused in all grinding where the wheel must work in a slot. Tapered wheels do not permit the grinding of right-angle shoulders as do straight wheels. Laws in almost every country require the removal of dust from grinding. This requires the use of a hood, and if a hood must be used, it might just as well be strong enough to offer protection in case of accident. A proper hood offers complete protection. Protection flanges cannot offer this complete protection, but in instances where a hood would interfere with the proper use of the wheel, flanges offer the next best method.

* * *

RUSSIAN EXPORT TRADE

Are American machine builders who are looking for an export trade fully aware of the fact that Russia, at the present time, offers one of the greatest opportunities for trade expansion? Germany is working this field very diligently and has a firm grasp on the Russian machine trade. Russia, in fact, is one of Germany's most important customers in the machine field. Sweden also exports to Russia a large percentage of the machinery built in that country, and many of the machine industries in Sweden depend largely upon the Russian market. Whether or not the abrogation of the treaty between the United States and Russia would have any influence on the conditions of trade between the two countries is difficult to say; but there seems to be no reason why Russia should not be just as willing to do business with American exporters as with Germans, unless the absence of the treaty makes a material difference in our trade with Russia. Germany and Sweden have no advantage except the proximity of territory. This, of course, counts for something, but in these days of rapid transportation, the odds against American manufacturers on this account should not be insurmountable.

GEARS FOR MACHINE TOOL DRIVES*

MATERIALS RECOMMENDED FOR THE VARIOUS GEAR COMBINATIONS MET WITH IN MACHINE TOOL DESIGN

BY JOHN PARKER†

The basis of this paper is the consideration of the six following questions relating to the use of gears for driving machine tools:

1. Under what conditions is it advisable to use cast-iron or steel gears for machine-tool drives?

2. Are the objections to cast iron on the ground of wear or breakage?

3. What tooth pressure is safe for cast-iron gears?

4. What grades of steel give best results and how should they be treated?

5. How hard is it advisable to make steel gears before machining them?

6. Are they to be hardened after machining, and if so, to what scleroscope test?

Conditions Governing use of Cast-iron and Steel Gears

There are a number of well established gear conditions that are common to the majority of machine tools, which, if noted, may prove somewhat of a guide in selecting the proper material for the gears, considered from the standpoints of economy, efficiency and durability. The conditions may be classified, as in the accompanying table.

GEAR CONDITIONS COMMON IN MACHINE TOOLS

		Material
A Gears always in mesh, the wear on the teeth being constant	(a) Slow speeds, light duty	Cast Iron
	(b) Slow speeds, heavy duty	Machine steel
	(c) Fast speeds, light duty	Machine steel
	(d) Fast speeds, heavy duty	Machine steel, casehardened
B Gears in sets that are removable and interchangeable with each other, distributing the wear over a number of gears	These are change gears used in thread cutting on lathes, spiral cutting on milling machines, indexing on automatic gear cutters and feed and speed change gears; speeds and pressures are generally moderate	Cast iron, excepting the smallest, which may require to be of steel
C Gears in sets that are non-removable and partially interchangeable, distributing the wear over a number of gears. Changes made while gears are in motion*	Used as quick-change feed gears —changes made by levers; speeds and pressures moderate	Machine steel, casehardened
D Gears in sets that are non-removable and partially interchangeable, distributing the wear over a number of gears. Changes made when gears are at rest†	Used as quick-change speed gears — changes made by levers; high speeds and heavy pressure	Machine steel, casehardened
E Gears that are employed only part of the time the machine is working, and are engaged and disengaged when the machine is stopped	This condition applies to back-gears for the spindle drive. Gears are made large diameter, coarse pitch and wide face; speeds moderate and heavy pressure	Hard, close-grained cast iron

* If the changes were made when the machine was at rest, the gears would not require hardening. But custom demands that changes be made while the machine is running.

† Although the changes are supposed to be made when gears are at rest, careless workmen will violate this rule, with the possibility of breaking the engaging gears. Some makers use an alloy steel in their spindle train to prevent breakage, but a better way is to provide means whereby it is necessary to stop the machine before throwing in the gears. This applies to the tumbler type of change gearing.

The objections to cast iron cover both wear and breakage. If the speed is excessive, say about 500 feet per minute, they are likely to wear quite rapidly; and on slow speeds and heavy pressure breakage will occur, unless they can be made of adequate size, as in the case *E*, where the back-gears are so located in the machine that it is possible to employ large diameters, coarse pitches and wide faces.

Safe Tooth Pressure for Cast-iron Gears

The question of tooth pressures in cast-iron gears is somewhat problematical. The Brown & Sharpe Mfg. Co. has in successful operation a gear in the spindle drive of its largest milling machine, made from a hard, close-grained cast iron having a tensile strength of 23,000 pounds per square inch, which, when running at the slowest speed, sustains a pressure on the teeth of 8250 pounds. It is calculated that two teeth are always in contact, which gives 4125 pounds pressure per tooth. The area in cross-section of each tooth is 1¼ square inch, equaling 3300 pounds per square inch. When the gear runs at the fastest speed the pressure is about 1000 pounds per square inch. It is not known whether the pressure could be increased to any considerable extent, but it has been overloaded to at least 30 per cent without injuring it; this was when testing out the machine and the overload was of short duration. It might be said that this gear is not subjected to any sudden shock; if it were, the allowable tooth pressure would be considerably less.

Grades of Steel that give Best Results and Heat-treatment

For gears that are of small proportions and yet are subjected to heavy duty, it has been found that in cases where the more common steels have failed, excellent results have been obtained from using a 5 per cent nickel steel. This steel casehardens with a very hard surface and still has a strong and tough core, making it an ideal steel to use where the pressure is heavy or the gear is subjected to shock. Experience shows that drop-forgings are more uniform in texture than bar stock. This grade of steel is given an oil treatment and is also annealed before machining. The oil treatment is as follows: heat to 1550 degrees F. and quench in oil. To anneal, reheat to 1350 degrees F. and cool very slowly. The steel is then ready to machine.

After machining, it is carbonized as follows: Pack in any good carbonizing material and cover very carefully to exclude air; place in furnace and heat to 1700 degrees F., and hold long enough to get the desired depth of casing. Care should be taken to have the steel heated entirely through. Ordinarily from three to four hours is sufficient. Then remove the steel from the furnace and cool in the boxes; then remove from the boxes and place in a furnace or bath; reheat to 1550 degrees F. and quench in oil. Again reheat to about 1380 degrees F. and quench in oil or water, according to the size and shape of gear. If the gear is of generous dimensions and free from sharp corners, water is preferable. Small slender gears are quenched in oil, on account of the liability of cracking if water is used. For ordinary gears the scleroscope test should show 80 to 85 points of hardness. If the gears are used as clash gears they should be drawn to 475 degrees F., or about 70 to 75 points of hardness, by scleroscope test, to avoid chipping.

Hardness Advisable for Steel Gears before Machining

The kinds of steels used for gears are of such a nature that they do not call for heat-treating before machining, but where extra toughness in shafts is required to withstand torsion and bending strains, 3½ per cent nickel steel is satisfactory and is heat-treated as follows, after being rough-machined: Place in an open furnace or bath, heat to 1500 degrees F. and quench in oil. It is advisable to experiment with a small quantity in each batch, before subjecting a whole lot to the drawing out heat, which should begin at about 700 degrees F. If the scleroscope registers between 50 and 58, the correct hardness has been obtained; if higher than 58, the parts should be reheated to a higher temperature than before; if lower than 50, the parts must be rehardened. After this treatment,

* Paper presented before the American Society of Mechanical Engineers, December, 1913.

† Address: Brown & Sharpe Mfg. Co., Providence, R. I.

the pieces are finish-machined. No further hardening is necessary. When machining, slow speeds and feeds must be used.

Hardening after Machining, and the Scleroscope Test

Practically all alloy and all low-carbon steels are hardened after machining and finished by grinding after hardening. About 0.010 inch on the diameter is left for this operation. All gears should run true, and to obtain this result not only are the holes ground true with the pitch circle, but the hubs are ground on their faces so they will set square with their shafts when tightened up by nuts. The scleroscope test for 30 to 35 point carbon machine steel is anywhere from 80 to 90, and for 5 per cent nickel steel for ordinary gears, 80 to 85, and for clash gears, 70 to 75. All steels are tested by the file in addition to the scleroscope. The file test by an expert is very reliable and some feel that possibly more confidence can be placed on his judgment than on any testing instrument.

The above notes apply to spur and bevel gears. For worm and worm-wheel drives, the worm should be made of machine steel, casehardened, and the wheel of a hard bronze. Both should run in a bath of oil, especially if under high speed and heavy duty. Spiral gears should be used only where the duty is light. The material should be the same as for a worm and worm-wheel, and they should also run in oil to avoid cutting.

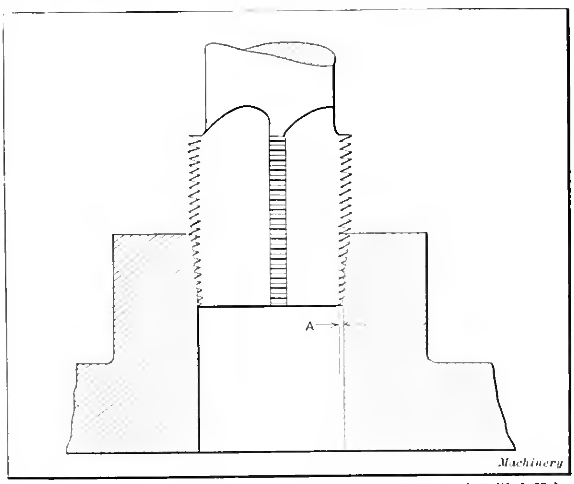
For index mechanisms where accuracy is essential, if the worm is hardened, the thread must be ground afterwards. This is done in all the spiral heads of Brown & Sharpe's make. Generally, the worm, which is made of tool steel, is left soft. Worm-wheels used for indexing purposes only are usually made of cast iron, and invariably if of large diameter. High-multiple threaded worms for indexing mechanisms should not be used; a double thread can be tolerated, but not more, if accurate indexings are required.

* * *

TAP DRILL SIZES

BY ALBERT A. DOWD*

The correct size of drill which should be used for a hole that is to be tapped subsequently, seems to be somewhat variable, and the result of this uncertainty is that the amount of thread remaining after the hole has been finished is sometimes insufficient to perform its function. Nearly all factories have tabulated lists for reference in the "tool crib," giving correct tap drill sizes for standard holes. These are of great value in the general run of manufacturing where the tapping is to be done on a tapping machine or by means of a tapping attachment. There are cases, however, where the



Illustrating Clearance between Thread Root of Tap and Wall of Drilled Hole

drill sizes given are so proportioned that the tap clearance at the root of the thread is insufficient for machine tapping, although it may be all right for hand tapping. When this is the case, taps are frequently broken. In other instances the tap drill size specified is too large, resulting in the saving of taps but giving an inferior product on account of lack of thread surface.

The illustration shows a drilled hole with the tap in position, indicating at A the amount of clearance between the thread root of the tap and the wall of the drilled hole. This clearance should vary in proportion to the pitch of the thread, for if not so proportioned the relative strength of the different pitches will not be the same. In determining this clearance, two points must be considered, *viz.*, the diameter of the hole and the strength of the tap. For example, a ½-inch tap, 40 pitch, is obviously much stronger than a ⅛-inch tap of the same pitch. We must also bear in mind that for machine tapping the clearance should be greater than for hand tapping, in order to avoid the breaking of taps as much as possible. The formulas given herewith are proportioned for both machine and hand tapping and will be found of considerable assistance in determining drill sizes.

Formulas for Tap Drill Sizes

T = tap size specified;
MTD = tap drill size for machine tapping;
HTD = tap drill size for hand tapping.

Then

$$MTD = T - 0.8\left(\frac{1.299}{\text{pitch}}\right)$$

$$HTD = T - 0.9\left(\frac{1.299}{\text{pitch}}\right)$$

For example, let it be required to ascertain the correct tap drill size for a ⅜ 16-pitch thread, for machine tapping. Applying the formula we have:

$$0.375 - \frac{0.8 \times 1.299}{16} = 0.31005,$$ and the nearest drill size is 5/16, or 0.3125 inch.

CONSTANTS FOR TAP DRILL SIZES

Threads per Inch	U. S. Standard Constants	Machine Tapping Drill Constant	Hand Tapping Drill Constant	Threads per Inch	U. S. Standard Constants	Machine Tapping Drill Constant	Hand Tapping Drill Constant
64	0.0203	0.0162	0.0182	16	0.0811	0.0649	0.0730
60	0.0216	0.0173	0.0194	14	0.0927	0.0742	0.0835
56	0.0232	0.0185	0.0208	13	0.0999	0.0799	0.0899
50	0.0259	0.0207	0.0233	12	0.1082	0.0866	0.0974
48	0.0270	0.0216	0.0243	11½	0.1129	0.0903	0.1016
44	0.0295	0.0236	0.0265	11	0.1180	0.0944	0.1062
40	0.0324	0.0259	0.0292	10	0.1299	0.1039	0.1169
36	0.0360	0.0288	0.0324	9	0.1443	0.1154	0.1299
32	0.0405	0.0324	0.0365	8	0.1623	0.1299	0.1461
30	0.0433	0.0346	0.0389	7	0.1855	0.1484	0.1670
28	0.0463	0.0371	0.0417	6	0.2165	0.1732	0.1948
27	0.0481	0.0384	0.0433	5½	0.2361	0.1889	0.2125
26	0.0499	0.0399	0.0149	5	0.2598	0.2078	0.2338
24	0.0541	0.0433	0.0487	4½	0.2886	0.2309	0.2598
22	0.0590	0.0472	0.0531	4	0.3247	0.2598	0.2922
20	0.0649	0.0519	0.0584	3½	0.3711	0.2969	0.3340
18	0.0721	0.0577	0.0649	3	0.4330	0.3164	0.3897

Machinery

The formulas given above will take care of any condition or pitch of thread, but for small diameters, say from ⅛ to ¼ inch, it is advisable to select a drill from 0.002 to 0.004 inch larger than the figured dimensions.

Formulas for Tap Drill Sizes using Constant Table

The table gives constants which may be used for the more frequently used pitches and will be found convenient. These are subtracted from the outside diameter of the tap or screw to find the diameter of the tap drill for machine tapping and hand tapping.

T = nominal size of tap specified;
C = double depth of thread;
MD = constant for machine tapping;
HD = constant for hand tapping;
MTD = tap drill size for machine tapping;
HTD = tap drill size for hand tapping.

Theoretical size of tap drill required = $T - C$

$$MTD = T - MD$$
$$HTD = T - HD$$

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TESTS FOR STRENGTH OF GEAR TEETH

The report of tests for strength of gear teeth given in the accompanying table was supplied by Mr. Andrew C. Gleason to supplement his paper on "The Use of Heat-treated Gears in Machine Tools" (see page 290, engineering edition, of the December number).

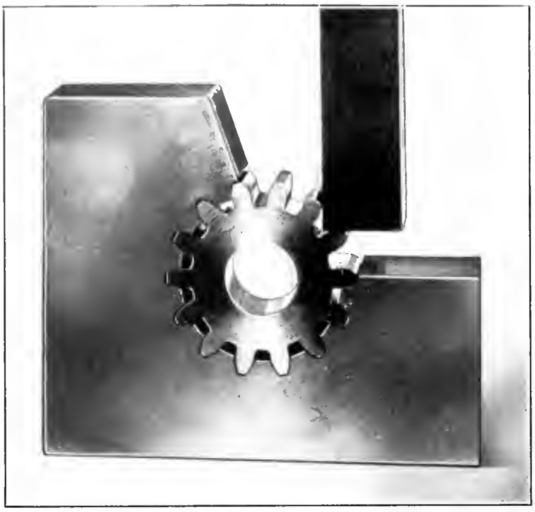

Fig. 1. Method of applying Load to Edge of Tooth for testing Strength

ULTIMATE STRENGTH AND ELASTIC LIMIT OF GEAR TEETH FOR DIFFERENT STEELS AND HEAT-TREATMENTS

Heat-Treatment	Elastic Limit	Breaking Strain
0.20 Carbon, Open Hearth Casehardening Steel		
No. 1. Soft	3500	
No. 2. Casehardened with one tempering heat of 1450° F., 90 scleroscope hardness	8400	9000
Same drawn to 400° F., 85 scleroscope hardness	8000	9450
No. 3. Casehardened with two tempering heats of 1600° F., and 1450° F., 85 scleroscope hardness	8200	9675
Same drawn to 400° F., 80 scleroscope hardness	8000	9800
1½ per cent Nickel, 0.18 Carbon, Natural Alloy Steel		
No. 1. Soft	4000	
No. 2. Casehardened with one tempering heat, 92 hardness	9000	10,150
Same drawn to 400° F., 87 hardness	8600	10,450
No. 3. Casehardened with two tempering heats	8750	10,600
Same drawn to 400° F., 82 hardness	8400	10,750
3½ per cent Nickel, 0.13 Carbon, Open Hearth Nickel Alloy		
No. 1. Soft	4000	
No. 2. Casehardened with one tempering heat of 1350° F., 90-95 hardness	9700	11,400
No. 3. Casehardened with two tempering heats of 1550° F., and 1350° F., 90-95 hardness	9500	11,650
Same drawn to 400° F., 85 hardness	9250	11,950
5 per cent Nickel, 0.15 Carbon, Open Hearth Alloy Steel		
No. 1. Soft	4500	
No. 2. Casehardened with one tempering heat of 1350° F., 90 hardness	13,000	13,880
Same drawn to 400° F., 85 hardness	12,700	14,800
No. 3. Casehardened with two tempering heats of 1550° F., and 1350° F., 90 hardness	13,000	14,100
Same drawn to 400° F., 85 hardness	12,800	14,850
(A) Chrome-nickel Tempering Steel		
No. 1. Quenching heat 1425° F., drawing temperature 475° F., 65-70 hardness		22,450*
No. 2. Soft	5000	
(B) Chrome-nickel Tempering Steel		
No. 1. Quenching heat, 1480° F., drawing temperature, 525° F., 75-78 hardness		17,640*
No. 2. Quenching heat, 1480° F., drawing temperature, 850° F., 60-65 hardness		19,440*
No. 3. Soft	5200	

* No set before breaking.

These tests represent average results obtained from a considerable number of test pieces subjected to the different heat-treatments specified in the table. The test pieces were spur pinions having fourteen teeth of six pitch, 2 1/3 inches pitch diameter, 1-inch face width and 1-inch bore. All teeth were of standard depth and shape. During the tests the pinions were held in a special chuck as shown in the accompanying illustrations, the load being applied to the edge of the teeth as indicated in Fig. 1. The initial displacement or elastic limit was determined by following up the load with a vernier tooth caliper which showed when permanent set had occurred (see Fig. 2). All carbonizing was 1/32 inch deep, and the furnace temperature varied from 1450 to 1500 degrees F., for eight hours, and was held at 1600 degrees for from three to five hours—a total of eleven to thirteen hours.

It will be noted that the increased strength, as a result of the double heat-treatment after carbonizing, is comparatively slight, particularly in the nickel-alloy steels. This is undoubtedly due to the long and low carbonizing heats and the low hardening heats. The various hardened test pieces of the "straight-carbon" steel showed a variation in strength of 10 per cent above and below the records given. This stock was selected especially for casehardening and, according to our experience, the ordinary run of machine steel of the same carbon content would vary, in some cases, twice as much as this. The same may be said of the so-called "natural nickel-alloy steels," as we find that they vary as much as the straight-carbon steels. The higher grade of alloy steels did not vary more than 10 per cent either way, and the average was closer.

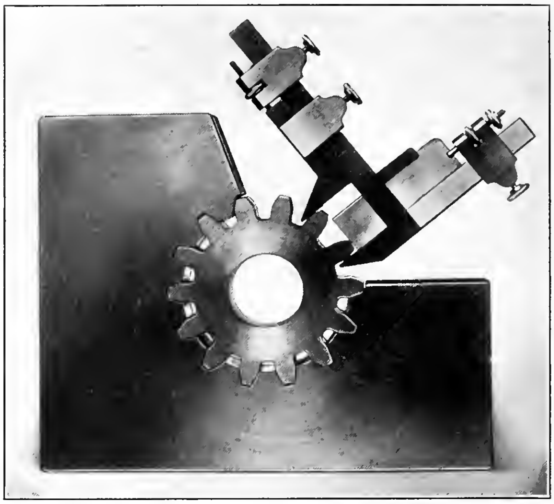

Fig. 2. Gear Tooth Caliper used to determine when Permanent Set occurred

* * *

LOOK OUT FOR THE "BORROWER"

Some time ago we were favored with a visit from a man claiming to be C. E. Watson who was connected with the Case Crane & Engineering Co., Columbus, Ohio to whom we recently made shipment of a machine. He knew all about some minor defects of the machine and we had no reason to question his integrity, and as he was short of funds, we cashed a check for $35 on one of the Columbus banks. The check was returned protested "Not Known." Since that time we have received letters from the Laughlin-Barney Machinery Co., of Pittsburg and the Detrick & Harvey Machine Co., of Baltimore, advising us that the same man had obtained money from them, in the same manner, only that he claimed to be connected with the Babcock & Wilcox Co., of Barberton, Ohio. This "worthy" gentleman was connected with the Case Crane & Engineering Co., as we found out from them and was formerly connected with the Crucible Steel Company of America and we believe he was at one time an engineer in the Navy. We think it is high time that notice was given, so that other people will not be duped the same as we were.

Philadelphia, Pa. NEWTON MACHINE TOOL WORKS

CAST IRON FOR MACHINE TOOL PARTS*

A STUDY OF FOUNDRY MIXTURES USED AND RECOMMENDED BY MACHINE TOOL BUILDERS

BY HENRY M WOOD†

When considering what sort of iron to use for various purposes, the machine tool manufacturer is interested chiefly in the results attained by the foundryman, *i. e.*, the strength, soundness, hardness, etc., of the casting, rather than the foundry methods used in accomplishing such results. Nevertheless as an investigation of the character of the casting is made through chemical analysis, it is well first to consider the effect of each of the elements usually present in cast iron.

Influence of Chemical Elements

The five elements present in ordinary cast iron are carbon (both free as graphite and combined), silicon, sulphur, manganese, and phosphorus.

Carbon. Carbon exerts a more important and direct influence on the quality of the metal than does any other element. The percentage of carbon in the casting and the form in which it exists are dependent upon the melting conditions, the thermal treatment, and the amounts of other elements present. Therefore it is necessary to take account of the effects of the carbon itself and the way its influence is modified by the presence of varying quantities of other elements. To obtain a proper relation between combined and free carbon is the most important point. The percentage of total carbon usually ranges from 3.5 to 4 per cent.

Graphitic Carbon. Graphite is merely mixed with the iron instead of being in chemical combination. Since it is only mixed with the metal it cannot exert any direct influence upon the properties of the molecules of the iron. So far as the graphite itself is concerned, the toughness, hardness and melting point of the grains of the iron will not be altered. The tensile strength will, however, be greatly affected, since the interposition of the flakes of graphite will act as partings between the grains of the metal and reduce the cohesion. Iron high in graphite is soft and can be machined readily, but is of low tensile strength.

Combined Carbon. The carbon which is in chemical combination affects directly and greatly the properties of ordinary cast iron. It is the principal factor in determining the hardness, tenacity, soundness, and freedom from internal stresses of the castings. In general, the percentage of combined carbon ranges from 0.05 in the softest cast iron to about 0.60 in iron of the highest elasticity. With suitable iron mixtures the amount of silicon and sulphur present, regulates the separation of carbon as graphite so that the amount of silicon present is an index of the relation between the free and combined carbon. Many analyses submitted do not state the percentage of carbon, perhaps because the foundrymen do not appreciate the importance of it, or perhaps because they consider the quantities of silicon, manganese and sulphur, which influence the quantity of combined carbon, make it unnecessary to determine the latter.

Silicon. Silicon tends to cause separation of the carbon as graphite. As the hardening effect of the silicon necessary to do this, is less than that of the combined carbon converted into free carbon, the net result of adding silicon is softer iron. Under conditions which are easily regulated by selection of materials and in other convenient ways, the general influence of silicon can be utilized to render the cast iron suitable for various purposes, but it must be used with due regard to the other constituents of the metal.

Sulphur. The influence of sulphur is opposite to silicon, in that it makes the iron harder and more brittle. It makes the iron more sluggish when pouring and is liable to cause unsound castings. Sulphur increases shrinkage, resulting in internal stresses of unknown value and sometimes producing distorted castings. This element should be kept low, especially in small castings.

Manganese. One effect of manganese is to combine with sulphur and go off in the slag. Another is to retard the separation of graphite by combining with carbon, and in this its influence is opposite to that of silicon, rendering the iron harder, stronger and perhaps closer.

Phosphorus. Phosphorus lowers the melting point and increases the fluidity of the molten iron. On the other hand, phosphorus makes the casting harder, more crystalline and brittle, and reduces the tensile strength.

Special Mixtures

Semi-Steel. This mixture is obtained by charging mild steel scrap into the cupola. It is common practice to use about 20 per cent steel, but any amount up to 70 per cent may be used. The 20 per cent mixture usually gives the desired results for machine tool work. Semi-steel is lower in total carbon than cast iron, seldom having more than 3 per cent. The fine grain of semi-steel is due to low percentage and fineness of graphite. It is used for parts requiring good appearance, tensile strength, and ability to resist shock. It is often used for large gear blank castings for various machine tools, for milling-machine tables, knees, and saddles, for lathe reverse plates, compound rests, etc. The tensile strength is relatively high and the grain of the casting is close.

Alloys. Elements sometimes introduced into cast iron for special purposes are vanadium, titanium, nickel and chromium. Vanadium increases the resistance of the casting to wear. Titanium combines with nitrogen and goes off in the slag, thus acting as a scavenger and making closer and cleaner iron. While nickel and chromium are now used to a limited extent in heavy chilled castings such as car wheels and rolling-mill rolls, the writer has been unable to find instances of the use of these metals in cast iron for machine tool parts.

Mixtures used by Representative Machine Tool Makers

In the belief that valuable information could be secured by a comparison of the present practices of representative machine tool manufacturers, the writer asked a number of machine tool makers in different lines and in different sections of the country if they would be willing to submit an outline of their practice. The following is quoted from their replies:

Two Plain	
Manganese	0.60 to 0.90
Phosphorus	0.50 to 0.80
Sulphur	0.05 and under
No. 3	
Silicon	1.00 to 1.50
Manganese	0.50 and over
Phosphorus	0.50 to 0.80
Sulphur	0.07 and under

In addition to the above we use materials as follows: No. 1 machinery scrap, mild steel scrap, manganese steel scrap. The last carries 12 per cent of manganese with quantities of the other elements so small that they are negligible in gray iron foundry work. Our mixtures are figured out on the actual analysis of each car, insuring in the castings uniformity of analysis and consequently of physical characteristics, such as strength, density, and machining qualities. In general practice we use three different mixtures suited to our needs.

In our first mixture we include our lighter castings such as pulleys, small gears, washers, handwheels, brackets, and the like. In this mixture we try to have the following analysis:

Silicon	1.90
Manganese	0.60
Phosphorus	0.70
Sulphur	0.08

This is usually secured by the use of a mixture of 50 per cent of two or three lots of "two plain" iron and 50 per cent of scrap. The proportions of the different pig irons are adjusted to produce the proper analysis in the mixture, and the scrap is partly our own foundry return, the balance being No. 1 machinery scrap.

Our second mixture covers all our heavy work, such as planer beds, posts, tables, faceplates, frames, etc. These castings require strength and sufficient density to permit the

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† Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

machined surface to take a high polish. The analysis is:

Silicon	1.40
Manganese	0.60
Phosphorus	0.60
Sulphur	0.09

This mixture consists of 45 per cent of two or more "No. 3 irons" and 55 per cent total scrap, shop and No. 1 machinery together. Should this mixture fail to yield sufficient manganese, the addition of 1 to 2 per cent of manganese steel scrap is made to correct it.

The third mixture is semi-steel, used principally for large blank gears and castings requiring special strength. Its analysis is:

Silicon	1.20
Manganese	0.90
Phosphorus	0.45
Sulphur	0.09

Its average makeup is:

Machinery scrap	30 per cent
Mild steel scrap	20 per cent
Manganese steel scrap	5 per cent
No. 3 pig iron	45 per cent

All materials are weighed before charging into the cupola and all due precautions are taken to insure proper melting conditions and perfect mixtures of the various materials.

A Manufacturer of Precision Machinery: In our work we run various grades of iron to meet the conditions existing in the machines or in the parts of machines under consideration. In a general way our mixtures, in per cent, run as follows:

Silicon	Manganese	Phosphorus
3.00	0.60	0.08
2.40	0.65	0.70
2.00	0.65	0.60

The first is for the average run of castings of smaller size; the second for the larger castings. Where we need a special close-grain iron we use the third mixture.

A Manufacturer of Milling Machines: We have never carried on any extensive experiments to learn the best mixtures of cast iron for our purposes. We use in the tables, knees, saddles and vises about 20 per cent of steel with a view to obtaining a close-grain casting, and increasing somewhat its strength. We use practically no cast iron for gears or small parts, these being made of steel, drop-forged in the case of larger parts, and also in the case of smaller parts when not adapted for manufacture from the bar. The subject of gray-iron castings is, we believe, one of the most annoying to be found in connection with the manufacture of machine tools. Customers are not satisfied to accept machines with defective castings even though the deficiency is of such a nature as to, in no wise, impair the life or efficiency of the machine. The ideal casting is, of course, one that is so close as not to show any grain when finished and at the same time, just as hard as it can be, and be worked into shape. The question of strength is probably not so important, as there is opportunity to use sufficient bulk to obtain strength. At any rate this is true of the parts that we make of cast iron, for, as stated above, all our gears, etc., are made from casehardened steel.

A Manufacturer of Heavy Lathes: With the heavier castings we are using a semi-steel mixture with about 20 per cent of steel. The analysis of this iron shows 1.60 to 1.70 silicon, 0.65 to 0.75 manganese, 0.40 phosphorus, 0.8 to 0.10 sulphur. While our carbons are not noted as a rule, we get a check on these every once in a while, showing the total carbons about 3.50 to 3.60. Our iron for smaller pieces runs from 1.80 to 1.90 in silicon, 0.40 to 0.50 in phosphorus, 0.65 to 0.70 manganese, 0.07 to 0.10 in sulphur. The total carbon shows up practically the same in both mixtures. Our test bars on the first mixture break at from 2800 to 3200 and on the latter mixtures at about 2600. This refers to 1 inch by 1 inch standard bars supported on 12-inch centers.

A Manufacturer of Grinding Machines: We use castings with various proportions of steel according to the size of the casting and the place where it is to be used, so that we have very bright lustrous surfaces.

Practice with Reference to Chilling Castings

There is a wide difference of opinion among machine tool manufacturers as to the desirability of chilling surfaces of castings. The writer asked some of the representative manufacturers of various classes of machine tools for their experience. The quotations state both sides of the case:

A Manufacturer of Milling Machines: We are not using any chills at this time, though we have experimented with these from time to time but have reached no satisfactory conclusion.

A Lathe Manufacturer: We have not used chills on any parts of our machines, which, we must concede, is from many points of view, not a very satisfactory admission to make.

A Manufacturer of Heavy Machine Tools: For quite a period, about nine or ten years ago, we chilled the ways on our lathes and also the rails on our boring mills. We found, however, after they had been out some time that there was considerable trouble owing to the chilled surfaces scratching. It was hard to find exactly the root of the trouble and we finally gave it up. The effect of the scratching of the chilled ways was a most peculiar one, and we sometimes observed on a machine, even before it had gone out, that some little particle of material had settled on the way and scratched it badly.

A Manufacturer of Grinding Machines: In regard to chilled iron, of course, you know that chilled iron means iron that cannot be filed, planed or scraped. At least any mechanic understands "chilled iron" to mean a surface that cannot be cut with tools. Now such a surface makes it impossible to get practical aligning ways on machine tools. It might just barely be possible to grind them accurately, but probably not practicable to do so. We use an iron with steel mixture, and vary the mixture according to the size of the casting, and we produce a casting as dense and as hard as we can possibly plane and scrape with any surety of getting perfect alignment, because imperfect bearing and imperfect alignment are just as bad as iron that is too soft.

Another Manufacturer of Grinding Machines: The main reason for chilling the different parts of our work is to increase the wearing durability and, at the same time, secure the advantage of refined metal and a clean surface. The parts chilled are the guides of the carriage and the surface of the table upon which the head and tailstocks are mounted. Our method of chilling is to place plates 5/8 inch thick in the mold; these give a depth of chill of about 1/2 inch and a degree of hardness to the point where the machining can be done readily. It would be natural to suppose that this chilling would produce or increase internal strains, but on our work, such conditions have not given any trouble.

Our work is not of such a nature that hammering upon it or peening is necessary; therefore, we are unable to state just what action would take place as the result of hammer blows and peening. The chilled surfaces are very much more durable than metal in the ordinary condition, and we believe by the chilling process, the durability of the surface upon which wear comes is increased at least from 300 to 400 per cent.

A Builder of Heavy Machine Tools: In 1888 we began the practice of solidifying cast-iron surfaces by introducing chill blocks in the molds, and we have continued the practice ever since. Answering your questions specifically, first, we have not discontinued the use of chilled surfaces because of any difficulty in oiling. We have never found that the fine grain of the chilled iron prevented the oil from sticking. There is no truth in the statement. We have not found any increase in internal strains due to the use of chills. On the contrary, when chills are properly placed they equalize the cooling of the heavy parts adjacent to lighter portions and reduce the internal stresses which would naturally result from the difference in time of cooling. If the chills are improperly used it would be possible, especially in thin castings, to cool the entire mass too rapidly and produce internal stresses. We have not found that the proper use of chills makes the iron more sensitive to a peening action; in fact, we have evidence to the contrary. The chilled surface we believe to be more durable. Gearing made in this way has outlasted several sets made in the old manner. The success or failure of this process depends upon the ability to produce, day in and day out, the kind of metal required, and, further, the intelligent designing of chills of iron molds so that a proper relation may always be observed between the size and shape of the casting and the thickness of the mold or chill block.

A Boring-Mill Manufacturer: We are chilling certain sur-

faces on our boring-mill spindles with good success, but have found no occasion for chilling any other surfaces. If we experienced difficulty due to undue wear on sliding surfaces, we would increase the area of the surfaces and supply better lubrication and protection from dirt rather than to try to chill the surfaces of these parts. The chills which we use on our spindles serve two purposes: First, by securing closer grained metal; second, by improving the quality of the wearing surfaces. We found that it was difficult to get good castings of these spindles until we used chills.

A Builder of Special Machine Tools: Concerning chills, we would say that to some extent we are now using these on the surfaces of beds and similar castings.

Chilled Lathe Beds

Analysis of Iron: In view of the considerable differences in opinions of the value of chilled surfaces and the idea held by some that it is impossible to chill an iron of high tensile strength without making it so hard that it cannot be machined, the practice of the Lodge & Shipley Machine Tool Co., with which the writer is connected, is here outlined.

Three average analyses are as follows:

Silicon	Sulphur	Phosphorus	Manganese	Tensile Strength
2.16	0.065	1.01	0.40	22,310
2.17	0.065	1.01	0.39	24,840
2.45	0.076	0.63	0.71	24,195

The first analysis is of a specimen taken in January, 1913, from the first iron run in a heat; the second, from the last iron of the same heat; the third, from the average iron of a heat in September, 1913. This iron is used for lathe beds of which the ways are chilled; it is also used for other cast-iron parts which do not require the high tensile strength of semi-steel. For parts, such as compound rest top slides and reverse plates, we use semi-steel. Parts subject to greater stress or to severe shock are made of steel.

A cross-sectional fracture through the finished ways and a portion of the side wall of a chilled bed for a 30-inch lathe, clearly shows that the iron, even far away from the chill in the side wall of the casting, is dense and of as close grain as other good cast iron; it also shows the much closer grain of the iron below the finished surface, as a result of the chill in closing up the iron and making it harder and more durable. In the 30-inch bed, the close iron produced by the chill extends to a depth of 1½ inch to 2 inches below the finished surface of the ways, thus proving that the chilled iron is not all removed in the planing.

Degree of Hardness

Scleroscope tests on chilled beds finish-planed but not scraped, gave as a result of eight different tests on four different beds, scleroscope readings of 40 to 42 with an average of 41. Similar tests on chilled beds which had been planed and then scraped gave a practically constant scleroscope reading of 42. Comparative scleroscope tests on a heavy section of unchilled cast iron which would give as nearly as possible conditions parallel to those just quoted gave readings ranging from 18 to 22, with an average of 20.

In addition to the advantage gained by the hardness, the chilled beds are, if anything, more uniform than the unchilled. The rough beds as received from the foundry are quite straight, so that the amount of metal removed all along the ways in planing is as nearly uniform as is practicable. Then, too, the scleroscope readings indicated a more nearly constant degree of hardness on the chilled beds than on the unchilled. Fewer castings are unsound than before chills were used.

Action of the Chill

The chilled surface is produced by a series of cast-iron chill plates, each about 6 inches long, placed end to end in the mold. The use of separate short plates eliminates much of the warping and twisting which would occur in a long chill plate. If a thick chill plate is used with a low-silicon iron, the surface of the casting is chilled so hard that it cannot be machined. The desired result is attained by regulating the thickness of the chill plate to suit the size of the casting for which it is used; then a low-silicon iron of high tensile strength can be poured successfully. The heavier the casting, the thicker the chill plate. The action in the mold is that when the molten iron strikes the cold plate it is chilled and hardened; then the heat in the mass of iron forming the body of the bed casting gradually warms the chilled surface and the chill plate, thus annealing the casting or "drawing the chill," just as when in tempering a chisel, the heat in the shank of the chisel "draws the temper" of the cutting edge to the proper point after the cutting edge has been hardened by quenching in water. This annealing of the chilled surface of the casting produces the desired form of hard, close-grained gray iron. The thickness of the chill plate used is such that the heat in the casting will anneal the surface sufficiently to permit planing, although at a greatly reduced cutting speed, and yet retain the benefits of the chill.

Value of Chilled Surfaces

The advantages of chilled wearing surfaces for machine tools are:

1. Much harder surfaces, which experience has proved are vastly more durable than similar unchilled surfaces.
2. A hard guiding surface with a relatively soft carriage, bringing the bulk of the wear on the carriage and thus maintaining the alignment of the guide.
3. A denser and much more closely grained surface of the casting, giving better appearance.
4. An exceptionally smooth finished surface, in which there are no pores where dirt and grit may become imbedded to cause rapid abrasion of the other bearing surface.

There are several ways of increasing the durability of working parts, such as by increasing the area of the bearing, by providing more complete lubrication, and by hardening the surfaces. All are successfully used. In general, each method may be used independently of the others. If the areas of the surfaces are as large as special conditions permit, and if the lubrication is thoroughly efficient, there would seem to be no objection to still further increasing the durability by the use of chills. Chilled surfaces are more advantageous on some machines and some parts than on others. In the case of a lathe the carriage will often be used for long periods of time on chuck work or on short jobs between centers which brings all of the wear on a comparatively short length of the bed just in front of the headstock; such uneven wear on the unchilled bed destroys the accuracy of the alignment for long work. Chilling the ways brings the wear principally upon the carriage, and even if the carriage is worn, the alignment at all points along the bed will remain relatively true.

Only one manufacturer of all who were kind enough to reply on this subject, had discontinued the use of chills; the others who are using chills do not report any trouble due to scratching. The objections to the use of chills, aside from the one instance quoted, have come from foundrymen who do not and have not used chills. Our own experience, based on the use of chilled ways on beds of all sizes of our lathes for more than two years, is that no internal stresses are created by the chilling; that the surface is not made more susceptible to a peening action; that the surface can be equally as well lubricated as before; that iron of high tensile strength is used; and that the increased hardness and closeness of grain of the chilled surface vastly increases the durability and permanency of alignment. We find no disadvantage except a somewhat increased cost.

Tensile Strengths of Various Irons

As the letters received from other machine tool manufacturers do not state tensile strengths, the following statements regarding the general practice of Cincinnati manufacturers are quoted:

A Professor of Mechanical Engineering and Testing: I believe the general Cincinnati machine tool practice for good castings runs from 22,000 to 24,000 pounds per square inch, tensile strength, but owing to the great variety I would not wish to commit myself to any particular figures.

A Cincinnati Chemist: After tabulating the results of my tests of the tensile strength of cast iron from various sources, I pick some at random to show the average run of machine tool iron in pounds per square inch in this locality: 22,962; 21,090; 24,522; 23,197; 23,260.

This will give an idea of what the general run is. Good machineable iron, where the grain does not have to be too close for machine tool work, should run from 20,000 to 26,000 pounds per square inch. Low tensile strength is due to too much silicon, sulphur, or phosphorus.

PRINCIPLES OF BAND-BRAKE DESIGN*

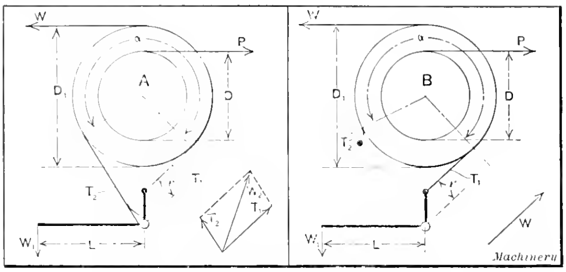
FORMULAS AND DATA WHICH SIMPLIFY THE CALCULATIONS INVOLVED

BY G. M. DAHL†

The purpose of this article is to deal very briefly with the fundamental principles of band-brake design. The brakes considered are classified under two general headings: 1, single-acting brakes, the most important feature of which is that they are good lowering brakes; 2, differential brakes, the most important feature of which is that they are good holding brakes but are liable to give a jerky lowering action, especially when the ratio $\frac{r}{r_1}$ is close to the locking ratio. Bearing in mind the features of these two classes of band-brakes, it will be evident that a single-acting brake should be used when a safe and steady lowering of the load is essential, but when the object is simply to hold a heavy load, a differential brake will be found most satisfactory. It must not be inferred from this statement that a single-acting brake cannot be made to hold a heavy load. From the formula,

$$\frac{L}{r} = \frac{FW}{W_1}$$

it will be easily seen that it is merely a question of making



Figs. 1 and 2. Single-acting Band-brakes; A, One End Loose on Shaft; B, One End Fastened

the ratio $\frac{L}{r}$ sufficiently large, and when this is done any kind of brake can be made to hold the required load. The ratio $\frac{L}{r}$ will, however, be limited by practical considerations in most cases of band-brake design.

Another important consideration is the bending stress on the drum-shaft that is produced by setting the brake. The bending stress on the brake-shaft is not of such importance because the brake-shaft can easily be supported by brackets on the bed plate of the hoist, thus reducing the bending moment to a minimum. In the case of the drum-shaft, however, this cannot be effected without considerably increasing the cost of the hoist and complicating its design. It is therefore essential to reduce the bending stress on the drum-shaft to a minimum. This result is obtained by increasing the arc of contact and the coefficient of friction, and also by locating the brake-shaft in such a way that the resultant bending stress produced by the brake acts in the opposite direction to the rope pull. Even though the location of the brake-shaft may be determined by the general design of the hoist, it is always well to remember that the location of the shaft within these fixed limits is a matter of importance.

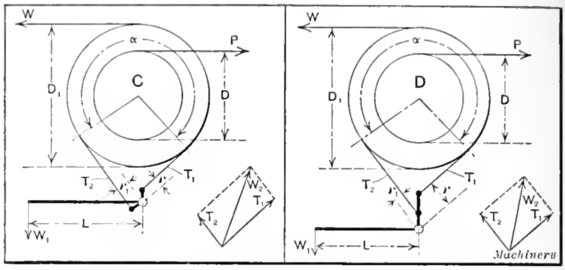


Fig. 3. Single-acting Band-brake C with Both Ends pulling.
Fig. 4. Differential Band-brake D

In order t ofacilitate calculations in the design of band-brakes, the following formulas are given:

$$F = \frac{W_1 \frac{L}{r}}{W} \qquad (1) \qquad\qquad W = \frac{W_1 \frac{L}{r}}{F} \qquad (2)$$

$$W_1 = \frac{FW}{\frac{L}{r}} \qquad (3) \qquad\qquad \frac{L}{r} = \frac{FW}{W_1} \qquad (4)$$

Examples illustrating the use of these formulas are given in subsequent paragraphs, which make the method of procedure quite clear. Figs. 1, 2 and 3 show different arrangements of single-acting band-brakes, while Fig. 4 illustrates the differential type of band-brake. The following explains the notation used in these illustrations:

P = rope pull in pounds = $\frac{WD_1}{D}$;

W = load on brake ring in pounds = $\frac{PD}{D_1}$;

D = diameter of rope circle in inches = $\frac{WD_1}{P}$;

TABLE I. VALUES OF CONSTANT FOR BAND BRAKE DESIGN

Arc of Contact, Deg.	C	f = 0.18				f = 0.30				f = 0.35				f = 0.57			
		N	T_2	T_1	A Sq. Ins.	N	T_2	T_1	A Sq. Ins.	N	T_2	T_1	A Sq. Ins.	N	T_2	T_1	A Sq. Ins.
220	1.667	2.00	2.000	1.000	0.000250	3.16	1.463	0.463	0.000183	3.83	1.352	0.352	0.000169	8.91	1.126	0.126	0.000141
230	1.746	2.06	1.943	0.943	0.000243	3.34	1.427	0.427	0.000178	4.08	1.325	0.325	0.000166	9.82	1.113	0.113	0.000139
240	1.820	2.12	1.893	0.893	0.000237	3.52	1.397	0.397	0.000174	4 34	1.299	0.299	0.000163	10.88	1.101	0.101	0.000138
250	1.894	2.19	1.840	0.840	0.000230	3.70	1.370	0.370	0.000171	4.60	1.278	0.278	0.000160	12.02	1.091	0.091	0.000136
260	1.970	2.26	1.794	0.794	0.000224	3.90	1.345	0.345	0.000168	4.89	1.257	0.257	0.000157	13.27	1.082	0.082	0.000135
270	2.046	2.33	1.752	0.752	0.000219	4.11	1.322	0.322	0.000166	5.21	1.238	0.238	0.000154	14.66	1.073	0.073	0.000134
280	2.124	2.41	1.709	0.709	0.000214	4.34	1.299	0.299	0.000163	5.54	1.220	0.220	0.000153	16.24	1.066	0.066	0.000133
290	2.200	2.49	1.67t	0.671	0.000209	4.57	1.280	0.280	0.000160	5.88	1.205	0.205	0.000151	17.94	1.059	0.059	0.000132
300	2.275	2.57	1.636	0.636	0.000204	4.81	1.262	0.262	0.000158	6.25	1.190	0.190	0.000149	19.78	1.054	0.054	0.000132
310	2.349	2.65	1.606	0.606	0.000201	5.07	1.246	0.246	0.000156	6.64	1.177	0.177	0.000147	21.88	1.048	0.048	0.000131
320	2.425	2.73	1.578	0.578	0.000197	5.34	1.230	0.230	0.000154	7.06	1.165	0.165	0.000146	24.18	1.043	0.043	0.000130
330	2.500	2.82	1.549	0.549	0.000194	5.63	1.216	0.216	0.000152	7.52	1.153	0.153	0.000144	26.70	1.039	0.039	0.000130
340	2.576	2.91	1.524	0.524	0.000190	5.93	1.203	0.203	0.000150	7.99	1.143	0.143	0.000143	29.50	1.035	0.035	0.000129

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* For further information on the subject of band brake design, see "Band and Block Brakes," by A. L. Campbell, published in MACHINERY, October, 1908; "Friction Brakes," by H. D. James, August, 1908; "Brakes," by C. F. Blake, August, September, October and November, 1906; and "Notes on Band Brake Design," by C. F. Blake, March, 1905.

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D_1 = diameter of brake ring in inches $= \dfrac{PD}{W}$;

r = distance from center of brake-shaft to slack side of brake-band in inches $= \dfrac{W_1 L}{FW}$;

r_1 = distance from center of brake-shaft to taut side of brake-band in inches;

L = length of brake-lever in inches $= \dfrac{FrW}{W_1}$;

F = force required at radius r to hold a load W of 1 pound on the brake ring;

$F = T_1$ for a nsigle-acting brake with one end pulling;

$F = T_1$ for a single-acting brake with one end pulling;

$F = T_1 - \dfrac{T_2}{\dfrac{r}{r_1}}$ for differential brakes;

T_1 = tension in slack end of band in pounds $= \dfrac{W}{N-1}$
$= T_2 - W$;

T_2 = tension in taut end of band in pounds $= \dfrac{WN}{N-1}$
$= W + T_1$;

W_2 = load on brake-shaft in pounds. This quantity is the resultant of T_1 and T_2 which is shown graphically in the illustration of the different styles of brakes.

$N = \dfrac{T_2}{T_1}$ = locking ratio of $\dfrac{r}{r_1}$. The ratio $\dfrac{r}{r_1}$ must be at least 1.5 N to prevent differential brakes from locking themselves. Log $N = Cf$. Values of the constant C for various arcs of contact and coefficients of friction are given in Table I.

f = coefficient of friction. For maple in contact with cast iron, the coefficient of friction $f = 0.18$; for a 75-degree V-brake with plain maple blocks, $f = 0.30$ = cosecant $\dfrac{75 \text{ degrees}}{2} \times f = 1.6427 \times 0.18 = 0.296$; for cork on cast iron $f = 0.35$; for a 75-degrees V-brake with cork inserts f 0.57.

A = minimum area of cross-section of wrought iron brake-band in square inches calculated for a fiber stress of 8000 pounds per square inch. This value of the fiber stress ought not to be exceeded for wrought-iron brake-bands.

The values of T_1 and T_2 and A are given in Table I for a load W of one pound on the brake ring. For any other load, the values given in the table are multiplied by that load. The force F required at a radius r to hold a load W of one pound on the brake ring is given in Tables II, III and IV, for different arcs of contact, coefficients of friction, and ratios $\dfrac{r}{r_1}$ for differential brakes. For any other arc of contact or ratios $\dfrac{r}{r_1}$, it will be accurate enough to interpolate between the values given in the table, although it is not strictly correct. It is important to observe at this point that it is not advisable to interpolate for coefficients of friction lying between the values given in the table.

In order to illustrate the use of the formulas and tables presented in this article, the following problems are worked out. These problems cover the different cases which may occur in band-brake design.

Example 1. To determine the most suitable style of brake to use for a given class of service. Consider a case in which the brake-ring load $W = 30{,}000$ pounds; the brake-lever load $W_1 = 150$ pounds; the ratio $\dfrac{L}{r} = 20$; and the arc of contact = 280 degrees. For these conditions:

$$F = \frac{W_1 \dfrac{L}{r}}{W} = \frac{150 \times 20}{30{,}000} = 0.10.$$

The only suitable brakes for this case are found in Tables

TABLE II. VALUES OF F FOR SINGLE-ACTING BAND BRAKES

Style of Brake	f	Arc of Contact in Degrees 220	230	240	250	260	270	280	290	300	310	320	330	340
Both ends pulling	0.18	3.000	2.886	2.786	2.680	2.588	2.504	2.418	2.342	2.272	2.212	2.156	2.098	2.048
	0.30	1.926	1.854	1.794	1.740	1.690	1.644	1.598	1.560	1.524	1.492	1.460	1.432	1.406
	0.35	1.704	1.650	1.598	1.556	1.514	1.476	1.440	1.410	1.380	1.351	1.330	1.306	1.286
	0.57	1.252	1.226	1.202	1.182	1.164	1.146	1.132	1.118	1.108	1.096	1.086	1.078	1.070
One end pulling	0.18	1.000	0.943	0.893	0.840	0.794	0.752	0.709	0.671	0.636	0.606	0.578	0.549	0.524
	0.30	0.463	0.427	0.397	0.370	0.345	0.322	0.299	0.280	0.262	0.246	0.230	0.216	0.203
	0.35	0.352	0.325	0.299	0.278	0.257	0.238	0.220	0.205	0.190	0.177	0.165	0.153	0.143
	0.57	0.126	0.113	0.101	0.091	0.082	0.073	0.066	0.059	0.054	0.048	0.043	0.039	0.035

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TABLE III. VALUES OF F FOR DIFFERENTIAL BAND BRAKES

$\frac{r}{r_1}$	f = 0.18: 2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.50
Arc of Contact, Deg.												
220	.200	.273	.333	.385	.429	.467	.500	.529	.556	.579	.600	.636
230	.165	.236	.295	.344	.387	.425	.457	.486	.511	.534	.554	.590
240	.135	.205	.262	.311	.352	.388	.419	.448	.473	.494	.514	.549
250	.104	.171	.227	.274	.315	.350	.381	.409	.432	.454	.473	.490
260	.076	.141	.196	.242	.281	.316	.346	.372	.395	.416	.435	.452
270	.051	.114	.164	.213	.251	.284	.313	.339	.362	.382	.401	.418
280	.023	.087	.139	.183	.221	.254	.282	.307	.330	.350	.368	.398
290	.001	.063	.114	.157	.194	.226	.253	.280	.300	.319	.337	.367
300	.....	.041	.091	.133	.179	.200	.228	.251	.273	.292	.309	.339
310	.....	.022	.071	.112	.147	.178	.205	.228	.249	.268	.285	.314
320	.....	.003	.051	.091	.126	.156	.182	.206	.226	.244	.261	.291
330	.....	.....	.033	.072	.106	.135	.161	.184	.201	.223	.239	.267
340	.....	.....	.015	.054	.088	.117	.142	.165	.184	.202	.218	.246

$\frac{r}{r_1}$	f = 0.30: 5.00	5.50	6.00	6.25	6.50	6.75	7.00	7.50	8.00	8.50	9.00	10.00
Arc of Contact, Deg.												
220	.170	.197	.219	.229	.238	.246	.254	.268	.280	.291	.300	.317
230	.142	.163	.189	.199	.208	.216	.223	.237	.249	.259	.268	.283
240	.117	.142	.163	.173	.181	.189	.196	.210	.222	.232	.241	.256
250	.096	.121	.142	.151	.159	.167	.174	.187	.199	.209	.218	.233
260	.077	.101	.121	.131	.139	.146	.153	.166	.178	.188	.197	.211
270	.058	.083	.102	.111	.119	.127	.134	.147	.158	.167	.176	.191
280	.040	.064	.084	.092	.100	.107	.114	.127	.137	.147	.156	.170
290	.025	.048	.068	.076	.084	.091	.098	.110	.121	.130	.139	.153
300	.011	.034	.053	.062	.069	.077	.083	.095	.106	.115	.124	.138
310	.....	.019	.038	.046	.054	.061	.068	.080	.090	.099	.108	.121
320	.....	.007	.026	.034	.042	.049	.055	.067	.077	.086	.094	.108
330	.....	.....	.012	.021	.028	.035	.041	.053	.063	.072	.080	.093
340	.....	.....	.....	.010	.018	.025	.031	.043	.053	.061	069	.083

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II, III and IV, for an arc of contact of 280 degrees, and $F = 0.10$. In Table II, for a single-acting V-brake with cork inserts and one end pulling, $f = 0.57$ and $F = 0.066$. This brake will hold the load with a load on the brake-lever:

$$W_1 = \frac{FW}{\frac{L}{r}} = \frac{0.066 \times 30{,}000}{20} = 99 \text{ pounds}$$

By making the load on the brake-lever $W_1 = 150$ pounds, the load can be held by proportioning the brake mechanism so that ratio $\frac{L}{r} = \frac{FW}{W_1} = \frac{0.066 \times 30{,}000}{150} = 13.2$. Referring to Table I, for an arc of contact of 280 degrees and a coefficient of friction $f = 0.57$, the value of A is found to be 0.000133. Multiplying this value by 30,000 for the case under consideration, the minimum cross-sectional area of the brake-band is found to be $0.000133 \times 30{,}000 = 3.99$ square inches. It is evident that a single-acting band-brake with both ends pulling cannot be used in this case because the minimum value of F for $f = 0.57$ is found to be 1.132, which is greater than the previously determined maximum value of 0.10.

Next consider the case of a differential brake in which $F = 0.10$; $f = 0.18$ and $\frac{r}{r_1} = 2.8$. The ratio $\frac{r}{r_1}$ is seen to be too close to the locking ratio 2.41 given in Table I, for it will be remembered that the value of this ratio for differential brakes must be at least 1.5 times the locking ratio in order to prevent the brake from locking itself. For a brake with $F = 0.10$, $f = 0.30$ and $\frac{r}{r_1} = 6.5$, the locking ratio given in Table I is found to be 4.34. This brake may be used, as the ratio $\frac{r}{r_1} = 6.5 = 1.5 \times 4.34$. The value of A in Table I is found to be 0.000163. Multiplying this value by 30,000 gives $0.000163 \times 30{,}000 = 4.89$ square inches, as the minimum cross-sectional area of the brake-band. For a differential brake with $F = 0.10$, $f = 0.35$ and $\frac{r}{r_1} = 11.0$, the locking ratio given in Table I is 5.54. This brake may be used, as the ratio $\frac{r}{r_1}$ is greater than 1.5 times the locking ratio. The value of A given in Table I is found to be 0.000153. Multiplying this coefficient by the load gives $0.000153 \times 30{,}000 = 4.59$ square inches as the minimum value of the cross-sectional area of the brake-band.

TABLE IV. VALUES OF F FOR DIFFERENTIAL BAND BRAKES

$\frac{r}{r_1}$ / Arc of Contact, Deg.	f = 0.35: 5	6	7	8	9	10	11	12	13	20
220	0.082	0.125	0.159	0.183	0.202	0.217	0.229	0.239	0.248	0.285
230	0.060	0.104	0.136	0.159	0.179	0.192	0.205	0.215	0.223	0.259
240	0.040	0.083	0.113	0.137	0.155	0.170	0.182	0.191	0.200	0.235
250	0.022	0.065	0.096	0.118	0.136	0.150	0.162	0.172	0.180	0.214
260	0.005	0.047	0.077	0.099	0.116	0.129	0.142	0.151	0.159	0.193
270	.....	0.029	0.059	0.081	0.098	0.111	0.123	0.132	0.140	0.173
280	.....	0.017	0.046	0.067	0.085	0.098	0.109	0.118	0.126	0.159
290	.....	0.004	0.033	0.054	0.071	0.084	0.095	0.104	0.112	0.145
300	.....	.....	0.021	0.042	0.059	0.072	0.083	0.092	0.099	0.131
310	.....	.....	0.010	0.031	0.049	0.060	0.071	0.080	0.087	0.120
320	.....	.....	.....	0.019	0.035	0.048	0.059	0.068	0.075	0.107
330	.....	.....	.....	0.009	0.024	0.038	0.048	0.057	0.064	0.095
340	.....	.....	.....	0.002	0.018	0.030	0.041	0.050	0.057	0.088

$\frac{r}{r_1}$ / Arc of Contact, Deg.	f = 0.57: 10	15	18	20	22	24	26	28	30	35	40	80
220	0.014	0.052	0.064	0.071	0.076	0.080	0.084	0.087	0.089	0.095	0.099	0.113
230	0.002	0.040	0.052	0.058	0.063	0.067	0.071	0.074	0 076	0.081	0.085	0.099
240	.....	0.028	0.040	0.046	0.051	0.055	0.059	0.062	0 064	0.070	0.074	0.087
250	....	0.017	0.029	0.035	0.040	0.045	0.048	0.052	0.054	0.059	0.063	0.076
260	.....	0.010	0.022	0.028	0.033	0.037	0.040	0.043	0.046	0.051	0.055	0.069
270	.....	0.002	0.014	0.020	0.025	0.029	0.033	0.036	0.038	0.043	0.047	0.061
280	.....	.....	0.006	0.012	0.017	0.021	0.024	0.027	0.030	0.035	0.038	0.052
290	.....	....	....	0 006	0.011	0 015	0.018	0.021	0.024	0.029	0.032	0.046
300	.....	.....	.....	0 001	0.006	0.010	0.013	0.016	0.019	0.024	0.027	0.040
310	.....	.....	.....	.....	....	0.004	0.008	0.011	0.013	0.018	0.022	0.035
320	.....	.....	....	.....	.....	.....	0.003	0.006	0.008	0.013	0.017	0.030
330	.....	.....	.....	.....	.....	.....	.....	0.002	0.004	0.009	0.013	0.026
340	.....	....	.....	....	.....	.....	.....	.....	0.001	0.005	0.009	0.022

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TABLE V. RESULTS OF VARYING ARC OF CONTACT AND COEFFICIENT OF FRICTION

For Arc of Contact of 220 Degrees				
f	0.18	0.30	0.35	0.57
T_1 in pounds	10,000	4630	3520	1260
T_2 in pounds	20,000	14,630	13,520	11,260
Bending force in pounds	28,200	18,300	16,400	12,150
For Arc of Contact of 320 Degrees				
T_1 in pounds	5780	2300	1650	430
T_2 in pounds	15,780	12,300	11,650	10,430
Bending force in pounds	11,900	10,700	10,500	9800

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TABLE VI. VALUES OF W_1 IN POUNDS FOR DIFFERENT ANGLES OF CONTACT AND COEFFICIENTS OF FRICTION

	Arc of Contact, Deg.	f = 0.18	f = 0.30	f = 0.35	f = 0.57
Single-acting brake with one end pulling	220	500	232	176	63
	320	289	115	83	21
Single-acting brake with both ends pulling	220	1500	963	852	626
	320	1078	730	665	539
Differential brake with the ratio $\frac{r}{r_1} = 1.5\,N$.	220	166	85	55	19
N = locking ratio	320	95	39	26	7

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Example 2. For a given brake, to determine the load that may be held on the brake ring with a given load on the lever. Consider the case of a single-acting V-brake with both ends pulling, arc of contact 260 degrees; $\frac{L}{r} = 25$; $W_1 = 100$ pounds; $f = 0.30$. Referring to Table II, the value of F is found to be 1.69. The load that can be held is:

$$W = \frac{W_1 \frac{L}{r}}{F} = \frac{100 \times 25}{1.69} = 1480 \text{ pounds}$$

The value of A in Table I is found to be 0.000168. Multiplying this value by the load gives $1480 \times 0.000168 = 0.249$ square inches as the minimum cross-sectional area of the brake-band.

Example 3. For a given brake, to determine the load required on the lever to hold a specified load on the brake ring. As an example, consider a single-acting brake with one end pulling; arc of contact 270 degrees; coefficient of friction $f = 0.35$; ratio $\frac{L}{r} = 20$; $W = 12{,}000$ pounds. Referring to Table II, we find $F = 0.238$.

$$W_1 = \frac{FW}{\frac{L}{r}} = \frac{0.238 \times 12{,}000}{20} = 143 \text{ pounds.}$$

The value of the coefficient A given in Table I is found to be 0.000154. Multi-

plying this value by the load gives $0.000154 \times 12{,}000 = 1.848$ square inches as the minimum cross-sectional area for the brake-band.

Example 4. For a given brake, to determine the value of the ratio $\frac{L}{r}$ that is necessary to hold a specified load on the brake ring with a given load on the brake-lever. Consider the case of a differential brake with the ratio $\frac{r}{r_1} = 5$; the coefficient of friction $f = 0.18$; the arc of contact = 290 degrees; the load on the brake ring $W = 15{,}000$ pounds. The load on the brake-lever $W_1 = 150$ pounds. Referring to Table III, we find $F = 0.337$. The ratio is then found to be:

$$\frac{L}{r} = \frac{FW}{W_1} = \frac{0.337 \times 15{,}000}{150} = 33.7$$

The coefficient A found in Table I is 0.000209. Multiplying this value by the load gives $0.000209 \times 15{,}000 = 3.135$ square inches, as the minimum value of the cross-sectional area for the brake-band.

In order to show the effect of changing the arc of contact and coefficient of friction, Tables V and VI have been prepared for two brakes with arcs of contact of 220 and 320 degrees, respectively, and coefficients of friction ranging from 0.18 to 0.57. The load on the brake ring W is 10,000 pounds and the ratio $\frac{L}{r}$ is 20. The values of T_1 and T_2 are obtained from Table I, the values of the coefficients obtained from this table being multiplied by 10,000 in order to secure the correct values for the case under consideration. The bending force on the brake-shaft produced by setting the brake is found by constructing a parallelogram of forces on T_1 and T_2 to some convenient scale. The resultant of this parallelogram is the required bending force.

The method of calculating the load required on the brake lever has already been illustrated by following through a problem. In Table VI values of the brake-lever load W_1 have been calculated for the two brakes referred to in the preceding paragraph, for arcs of contact of 220 and 320 degrees, respectively, and coefficients of friction f ranging from 0.18 to 0.57. It will be readily seen from these results that a single-acting brake with both ends pulling is a very poor holding brake. It will also be seen that for a single-acting brake with one end pulling, the load required on the brake lever varies from 500 to 21 pounds as the result of increasing the arc of contact from 220 to 320 degrees, and increasing the coefficient of friction from 0.18 to 0.57. Of course the figures in Tables V and VI give a somewhat exaggerated idea of the difference between good and poor examples of band-brake design, but they emphasize the point that it is possible to materially reduce the strains and increase the holding power of the brake by proportioning its members properly.

By way of conclusion, the following may be said to constitute the underlying principles of band-brake design. Make the arc of contact as large as possible; locate the brake-shaft where the bending stress in the drum-shaft produced by setting the brake is counteracted by the rope pull; and, if necessary, increase the coefficient of friction to give the required holding power.

CALCULATION OF STRESSES IN AUTOMOBILE FRONT AXLES

BY JOHN L. ALDEN*

Automobile front axles are made of steel or bronze forgings, steel castings, or steel tubing, although bronze is seldom used except for emergency or experimental purposes. Steel castings are frequently used for truck axles, but axles of this material are seldom found in pleasure cars to-day. Steel tubing was also one of the favorite materials of the earlier designers, and is still successfully used on many light- and medium-weight cars. It has the advantage of being readily obtainable in its finished form, needs little or no machining, and the only forgings required are those for the steering heads and spring seats. By far the greater number of pleasure cars in operation to-day carry drop-forged front axles, and thus far no other type has even threatened their supremacy. Both carbon and alloy steels are being used with success. Carbon steels of 0.25 to 0.30 per cent have an elastic limit of from 40,000 to 80,000 pounds per square inch when heat-treated according to the recommendation of the Society of Automobile Engineers. Steel of this character may be allowed a fiber stress of 10,000 pounds per square inch, but this value may be safely raised to 15,000 pounds per square inch if the specifications are rigidly adhered to and if great care is taken in the forging and heat-treatment. The elastic limit of 0.30 to 0.35 per cent carbon nickel steel lies between 65,000 and 160,000 pounds per square inch when the S. A. E. recommendations are followed. Chrome-nickel steel with 0.25 to 0.40 per cent carbon has an elastic limit ranging from 50,000 to 125,000 pounds per square inch for low chrome-nickel and from 65,000 to 200,000 pounds per square inch for high chrome-nickel steel. The elastic limit of 0.25 to 0.45 per cent carbon, chrome-vanadium steel may vary from 55,000 to 200,000 pounds per square inch. Any of these alloy steels are suitable for structural drop-forgings, and when used for axles, an average working stress of 15,000 pounds per square inch, with a limit of 20,000 for exceptionally favorable conditions, is allowable. The lower value is more suitable for cars for quantity production or for any case where the greatest care cannot be taken in manufacture, as under these circumstances, the elastic limit of the material will be found to be in the neighborhood of the lower figures given for the metal under consideration.

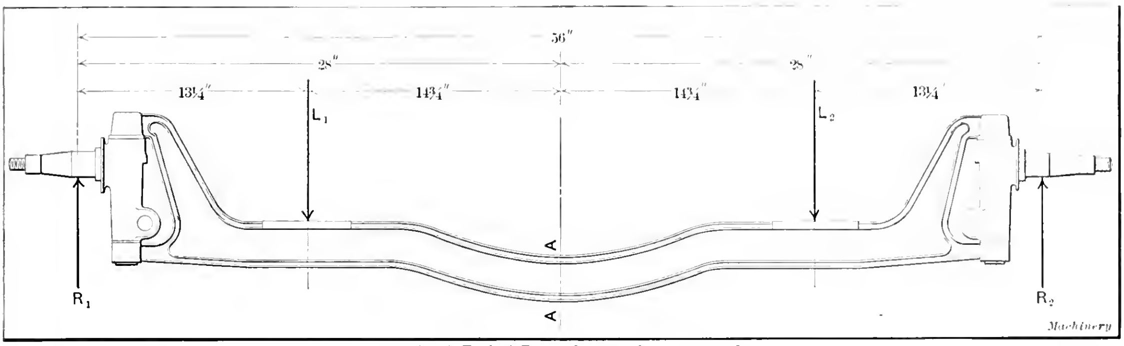

Fig. 1. A Typical Form of Automobile Front Axle

A typical front axle for a pleasure car is shown in Fig. 1. This is a drop-forging of an I-section similar to the one outlined in Fig. 2. The design shown is that of a well-known make equipped with Elliott type steering heads, and with the spring seats forged integral with the upper flange of the section. The I-shape is carried uniformly from spring seat to spring seat, as the bending moments due to the spring loads are equal at all points from L_1 to L_2. The top flange is flared from the width of the steering head bosses to the full width of the spring seat. When the car is in motion there are two sets of independent forces acting upon the axle—those caused by the weight of the car and those caused by the resistance of the road, due to striking obstacles, etc. The former are obviously vertical in direction, while the latter

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have both vertical and horizontal components. It is evident that the maximum horizontal force which the axle will be called upon to resist is indeterminate. The same is true of the vertical component of the collision force. The factors upon which this force depends are the velocity of the car, the size and shape of the obstruction, the depression of the tire due to impact, and the unsprung weight of the axle, wheels, etc. The determination of the horizontal resisting moment of the axle is, therefore, largely a matter of judgment and experience on the part of the designer. Any calculation of the vertical resisting moment must also be incomplete, since we have no means of determining the limiting value of the collision force. If we calculate our section to carry the static load of the vehicle, using the values for the allowable fiber stress previously given, we will be sure of a reasonable result, as the large factor of safety is expressly intended to cover the stresses which we are unable to estimate. Consequently, if we select a section whose proportions have proved satisfactory in actual service, we will not go far wrong in the relation between our horizontal and vertical resisting moments. The section shown in Fig. 2 is an average of a number of successful designs used on modern cars, covering a wide range of weight, speed and price. Therefore, if the section of Fig. 2 is selected and we calculate its dimensions, using the spring seat loads, we may expect to be reasonably close to modern practice. We will now assume the necessary data and carry through a typical example, in which we shall consider the axle as a simple beam, supported at the wheel centers and symmetrically loaded at the spring seats.

We will consider the case of a 3600-pound touring car which, when loaded with five passengers, will weigh about 4350 pounds. In general, about 0.4 of the weight of a pleasure car is borne on the front axle, one-half of this being carried by each front spring. Thus the front axle load of our hypothetical car is $0.4 \times 4350 = 1740$ pounds and the load at each spring seat is 870 pounds. As the weight of the axle itself rarely exceeds 80 or 85 pounds, we may safely neglect this item. The principal dimensions will be assumed to be as given in Fig. 1. The statement has already been made that the bending moment due to the static load is maximum and equal at all points from L_1 to L_2. Hence the critical section may be chosen anywhere between the spring seats. Then, taking our section at A–A, we have the maximum bending moment:

$M_a = 28 \times 870 - 14.75 \times 870 = 13.25 \times 870 = 11{,}528$ inch-pounds.

Using the formula for beams:

$$M = SZ$$

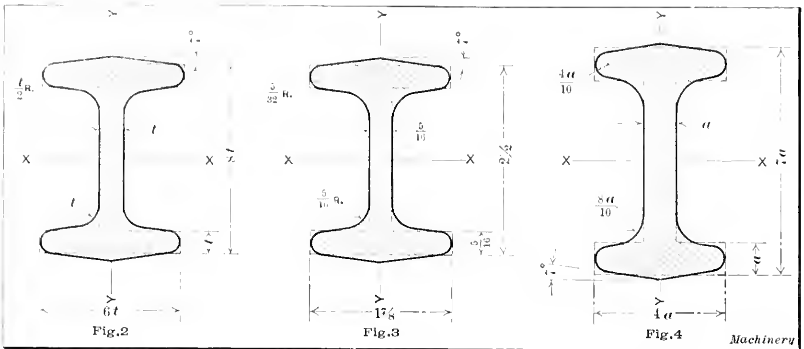
where M = maximum bending moment;

S = fiber stress due to the maximum bending moment;

Z = the section modulus.

We may solve for Z and the dimensions of the section, providing we assume a suitable fiber stress. Let us assign to S a value of 10,000 pounds per square inch. Then our flexure equation, when transposed, becomes:

$$Z = \frac{M}{S} = \frac{11{,}528}{10{,}000} = 1.15.$$



Figs. 2, 3 and 4. Two Forms of Sections used for Automobile Front Axles

Returning now to our average section, Fig. 2, it will be found much more simple and sufficiently accurate to base our calculations upon the equivalent section whose outline is shown dotted. The moment of inertia about the axis X–X is:

$$I_x = \frac{6\,t \times (8\,t)^3 - 2 \times 2.5\,t \times (6\,t)^3}{12} = 166\,t^4$$

$$Z_x = \frac{166\,t^4}{4\,t} = 41.5\,t^3$$

In the same manner:

$$I_y = \frac{2\,t \times (6\,t)^3 + 6\,t \times t^3}{12} = 36.5t^4$$

$$Z_y = \frac{36.5\,t^4}{3\,t} = 12.2t^3$$

$$\frac{Z_x}{Z_y} = \frac{41.5t^3}{12.2\,t^3} = 3.41$$

This signifies that the axle is 3.41 times as strong vertically as horizontally. The Z_x of our typical section is, according to the preceding calculations, $41.5\,t^3$; and the required value of Z_x of our axle is 1.15. Equating these, we have:

$$41.5\,t^3 = 1.15$$

$$t^3 = \frac{1.15}{41.5} = 0.0277.$$

$t = 0.3025$ inch or, to the nearest fraction, 5/16 inch.

From the value for t thus obtained all other dimensions for the section may be readily found. These are given in Fig. 3 for the case just discussed. By using these proportions, with the known section modulus, the cut-and-try methods commonly used are eliminated. It is evident that the calculations are thus much simplified.

Another section at one time in common use is shown in Fig. 4. The moments of inertia and section moduli are:

$$I_x = 83.1\,t^4; \qquad Z_x = 23.75\,t^3$$
$$I_y = 11.1\,t^4, \qquad Z_y = 5.56\,t^3$$
$$\frac{Z_x}{Z_y} = 4.27$$

This axle is, therefore, weaker in a horizontal plane than the one shown in Fig. 2. This would seem reasonable, as the horizontal force is due largely to shock and is proportional to the square of the velocity. Consequently, as the speed requirements increase, so should the horizontal resisting moment of the axle increase, which accounts for the gradual strengthening in this direction from year to year.

* * *

WOODEN SHOES MADE IN THE UNITED STATES

In this country beech is the favorite material for wooden shoes, the manufacture of which has reached considerable proportions in the United States according to the Department of Agriculture, which has just issued a bulletin on the use of the wood. These shoes, the department says, cost from sixty to seventy-five cents a pair and are good for two years. They are worn by those who have to work in cold or wet places, such as tanneries, breweries, and livery stables, and by workmen in steel mills and glass factories who must walk on hot grates or floors. Farmers, too, are classed among the users.

* * *

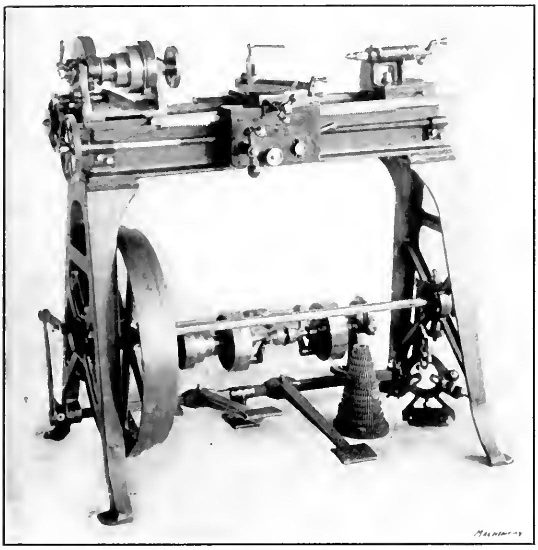
The melting points of some metals which fuse at very high temperatures are published by G. K. Burgess and R. G. Waltenberg in the *Journal of the Washington Academy of Science.* The melting points are as follows: Titanium, 1795 degrees C. (3263 degrees F.); vanadium, 1720 degrees C. (3128 degrees F.); chromium, 1520 degrees C. (2768 degrees F.); manganese, 1260 degrees C. (2300 degrees F.); iron, 1530 degrees C. (2786 degrees F.); cobalt, 1478 degrees C. (2692 degrees F.); nickel, 1452 degrees C. (2545 degrees F.)

A TRADE SCHOOL PRODUCT*

BY JAMES F. JOHNSON†

A commercial product of the State Trade Education Shop of Bridgeport, Conn., is shown in the accompanying illustration. The machine is a 9-inch screw-cutting lathe designed to cut from four to forty threads per inch. It is fitted with steady-rest, follow-rest, and attachments for taper turning, and has a compound rest graduated to 180 degrees. The carriage is fitted with a power cross-feed and a micrometer collar reading to thousandths. In case the countershaft drive is not desired, the lathe is made convertible so that foot power drive may be substituted, as the illustration indicates.

These lathes are constructed for the purpose of giving the apprentice definite training along just such lines as he will encounter when he has completed his trade school work, as he performs a variety of work involving many operations. The fact that it is a commercial product, requires a degree of accuracy that the apprentice would not find in other work. The delivery being promised at a certain date, keeps the boys on the alert, and with a careful system of time keeping and job cards, the apprentice is placed under the same conditions as exist in modern machine shops, while, at the same time, he is receiving definite instruction in his particular trade. To enable him to better understand the work and make him a more thorough mechanic, there is taught in connection with shop work, practical shop mechanics and shop mathematics.



Nine-inch Screw Cutting Lathe built by Apprentice Boys at State Trade Education Shop, Bridgeport, Conn.

The boy who cuts a lead-screw for a lathe has a mathematical understanding of screw threads, including the Acme thread and the square thread; the depth of the cut for this particular pitch as well as other pitches; the area of the section across the bottom of the screw, as well as problems relating to the time element in cutting the screw. In shop mechanics, the apprentice learns about gear combinations for cutting this particular pitch thread in the lead-screw; how speeds are effected by compounding gear trains; and similar problems.

The boys that cut the gears used on the lathe are taught in their shop mathematics the method of finding the diameter of the gear blanks for this particular pitch gear and for other gears; the required depth of cut for forming a tooth, and calculations concerning other problems in gearing. In mechanics the boys study subjects relating to the strength of gear teeth, speeds of gears, etc.

In the shop drawing class instruction is given in blueprint reading and the making of such drawings as are necessary to enable the boys to understand clearly the relation of the blueprints to shop practice. Instruction is also given in the making of working sketches such as the up-to-date mechanic is often called upon to make.

The lathe illustrated is a complete product of the boys of the trade school, each department contributing its part in making it a commercial success. The design for the lathe and the necessary tools, jigs and fixtures for its completion, were made in the drafting department. The drafting department was thus enabled to do real drafting and now takes much pride in reviewing the results of its work. Real live problems were furnished as, for example, the design of the proper gear train to cut the desired threads, the change necessary to cut the standard metric threads; the design of the headstock, the power cross-feed, together with the compound rest, and the apron mechanism.

The patterns were built by the boys in the patternmaking department, where the same shop conditions prevailed. The apprentice patternmaker worked from the drawings made by the apprentice draftsman and these furnished the necessary instruction for the patternmaking foreman. As we have no cupola, our castings were made outside. This gave our patterns a severe but very successful test. This fact together with the fact that the completed machine was a success, gave the boys considerable self-confidence and a realization of what was before them in the trade.

In the machine shop the apprentices handled the castings made from the patterns built by the apprentice patternmakers and machined them according to the drawings made by the drafting room apprentices. The work in the machine shop was so arranged that each apprentice was carried through a well organized scheme of machine shop practice, the boys securing a good systematic training. They quickly realized the importance of the job and an active and eager interest was always shown. As in all departments, the standard and accuracy of the work accepted was that of the successful machine shop.

After the apprentices assembled the lathes, they were all tested as to running qualities, feeds, thread cutting, and accuracy of turning—this last test showing a variation of 0.0005 inch on a test bar 20 inches long. The boys in the paint shop put on the final touches and the machines were crated by the carpenters and shipped to the customer. The value of this work in instructing the apprentice in his future trade can hardly be overestimated. He is put under shop conditions at work upon a product that is going to be of use to somebody and he is right "up against it," so to speak. He is able to see what will be expected of him later, and he gets an excellent opportunity to learn his trade under real trade atmosphere.

Since its organization, the policy of the school has been to instruct the apprentice in his trade by giving him real trade work, placing him directly under the care of men who are skilled tradesmen in the particular line he is following. In all departments we have been able to do this successfully. These courses in the trade school at Bridgeport are open to any boy between the ages of fourteen and sixteen, or to any boy who has completed the sixth grade at school. He must attend the shops forty-eight hundred hours and perform his work in an acceptable manner. In connection with his trade practice, he devotes about twelve hundred hours to receiving instruction in blueprint reading, practical shop drawings, shop mathematics and practical shop mechanics.

That the depleting ranks of the tradesmen must be filled is a certainty. That our tradesmen need training in their work can no longer be argued. That the American trades need a better class of skilled intelligent workmen is shown in the products of our European friends. If we as a nation are to be supreme in trade pursuits, we must educate our tradesmen and supply the trades with the best class of tradesmen possible. Our trade school is far-reaching. By means of our continuation school, part time school, and evening school, we are able to reach those who would not receive the benefit of the regular day trade course.

From an educational standpoint we are able to give the boy who would otherwise leave school at fourteen to sixteen, and either enter an occupation with no future for him or hang around and become a nuisance to his friends and himself, a chance to make good and amount to something.

* See "Woods Apprentice Industrial School," December, 1913.
† Superintendent State Trade Education Shop, Bridgeport, Conn.

LATTICE BAR SPACING TABLES

BY CHARLES B. GILBERT*

The accompanying tables for finding the pitch of rivet holes for lattice bars will be found useful both in the drafting-room and in the fabrication plant. The tables give spacing for 2 to 21 spaces inclusive, beginning with 6-inch pitch and advancing by eighths to 12-inch pitch.

The use of the tables is simple, of course. For example, what is the over-all distance center to center of 20 rivet holes in a straight line, the pitch being 6⅝ inches? Inasmuch as there are 20 rivets, there are 19 spaces. Referring to the table opposite 19 and underneath 6⅝, we find 10′ 5⅞″, the distance from center to center of the outside rivet holes.

No. of Spaces	Pitch 6″	6⅛″	6¼″	6⅜″	6½″	6⅝″	6¾″	6⅞″	7″	7⅛″	7¼″	7⅜″	7½″	7⅝″	7¾″	7⅞″	No. of Spaces
2	1′ 0″	1′ 0¼″	1′ 0½″	1′ 0¾″	1′ 1″	1′ 1¼″	1′ 1½″	1′ 1¾″	1′ 2″	1′ 2¼″	1′ 2½″	1′ 2¾″	1′ 3″	1′ 3¼″	1′ 3½″	1′ 3¾″	2
3	1′ 6″	1′ 6⅜″	1′ 6¾″	1′ 7⅛″	1′ 7½″	1′ 7⅞″	1′ 8¼″	1′ 8⅝″	1′ 9″	1′ 9⅜″	1′ 9¾″	1′ 10⅛″	1′ 10½″	1′ 10⅞″	1′ 11¼″	1′ 11⅝″	3
4	2′ 0″	2′ 0½″	2′ 1″	2′ 1½″	2′ 2″	2′ 2½″	2′ 3″	2′ 3½″	2′ 4″	2′ 4½″	2′ 5″	2′ 5½″	2′ 6″	2′ 6½″	2′ 7″	2′ 7½″	4
5	2′ 6″	2′ 6⅝″	2′ 7¼″	2′ 7⅞″	2′ 8½″	2′ 9⅛″	2′ 9¾″	2′ 10⅜″	2′ 11″	2′ 11⅝″	3′ 0¼″	3′ 0⅞″	3′ 1½″	3′ 2⅛″	3′ 2¾″	3′ 3⅜″	5
6	3′ 0″	3′ 0¾″	3′ 1½″	3′ 2¼″	3′ 3″	3′ 3¾″	3′ 4½″	3′ 5¼″	3′ 6″	3′ 6¾″	3′ 7½″	3′ 8¼″	3′ 9″	3′ 9¾″	3′ 10½″	3′ 11¼″	6
7	3′ 6″	3′ 6⅞″	3′ 7¾″	3′ 8⅝″	3′ 9½″	3′ 10⅜″	3′ 11¼″	4′ 0⅛″	4′ 1″	4′ 1⅞″	4′ 2¾″	4′ 3⅝″	4′ 4½″	4′ 5⅜″	4′ 6¼″	4′ 7⅛″	7
8	4′ 0″	4′ 1″	4′ 2″	4′ 3″	4′ 4″	4′ 5″	4′ 6″	4′ 7″	4′ 8″	4′ 9″	4′ 10″	4′ 11″	5′ 0″	5′ 1″	5′ 2″	5′ 3″	8
9	4′ 6″	4′ 7⅛″	4′ 8¼″	4′ 9⅜″	4′ 10½″	4′ 11⅝″	5′ 0¾″	5′ 1⅞″	5′ 3″	5′ 4⅛″	5′ 5¼″	5′ 6⅜″	5′ 7½″	5′ 8⅝″	5′ 9¾″	5′ 10⅞″	9
10	5′ 0″	5′ 1¼″	5′ 2½″	5′ 3¾″	5′ 5″	5′ 6¼″	5′ 7½″	5′ 8¾″	5′ 10″	5′ 11¼″	6′ 0½″	6′ 1¾″	6′ 3″	6′ 4¼″	6′ 5½″	6′ 6¾″	10
11	5′ 6″	5′ 7⅜″	5′ 8¾″	5′ 10⅛″	5′ 11½″	6′ 0⅞″	6′ 2¼″	6′ 3⅝″	6′ 5″	6′ 6⅜″	6′ 7¾″	6′ 9⅛″	6′ 10½″	6′ 11⅞″	7′ 1¼″	7′ 2⅝″	11
12	6′ 0″	6′ 1½″	6′ 3″	6′ 4½″	6′ 6″	6′ 7½″	6′ 9″	6′ 10½″	7′ 0″	7′ 1½″	7′ 3″	7′ 4½″	7′ 6″	7′ 7½″	7′ 9″	7′ 10½″	12
13	6′ 6″	6′ 7⅝″	6′ 9¼″	6′ 10⅞″	7′ 0½″	7′ 2⅛″	7′ 3¾″	7′ 5⅜″	7′ 7″	7′ 8⅝″	7′ 10¼″	7′ 11⅞″	8′ 1½″	8′ 3⅛″	8′ 4¾″	8′ 6⅜″	13
14	7′ 0″	7′ 1¾″	7′ 3½″	7′ 5¼″	7′ 7″	7′ 8¾″	7′ 10½″	8′ 0¼″	8′ 2″	8′ 3¾″	8′ 5½″	8′ 7¼″	8′ 9″	8′ 10¾″	9′ 0½″	9′ 2¼″	14
15	7′ 6″	7′ 7⅞″	7′ 9¾″	7′ 11⅝″	8′ 1½″	8′ 3⅜″	8′ 5¼″	8′ 7⅛″	8′ 9″	8′ 10⅞″	9′ 0¾″	9′ 2⅝″	9′ 4½″	9′ 6⅜″	9′ 8¼″	9′ 10⅛″	15
16	8′ 0″	8′ 2″	8′ 4″	8′ 6″	8′ 8″	8′ 10″	9′ 0″	9′ 2″	9′ 4″	9′ 6″	9′ 8″	9′ 10″	10′ 0″	10′ 2″	10′ 4″	10′ 6″	16
17	8′ 6″	8′ 8⅛″	8′ 10¼″	9′ 0⅜″	9′ 2½″	9′ 4⅝″	9′ 6¾″	9′ 8⅞″	9′ 11″	10′ 1⅛″	10′ 3¼″	10′ 5⅜″	10′ 7½″	10′ 9⅝″	10′ 11¾″	11′ 1⅞″	17
18	9′ 0″	9′ 2¼″	9′ 4½″	9′ 6¾″	9′ 9″	9′ 11¼″	10′ 1½″	10′ 3¾″	10′ 6″	10′ 8¼″	10′ 10½″	11′ 0¾″	11′ 3″	11′ 5¼″	11′ 7½″	11′ 9¾″	18
19	9′ 6″	9′ 8⅜″	9′ 10¾″	10′ 1⅛″	10′ 3½″	10′ 5⅞″	10′ 8¼″	10′ 10⅝″	11′ 1″	11′ 3⅜″	11′ 5¾″	11′ 8⅛″	11′ 10½″	12′ 0⅞″	12′ 3¼″	12′ 5⅝″	19
20	10′ 0″	10′ 2½″	10′ 5″	10′ 7½″	10′ 10″	11′ 0½″	11′ 3″	11′ 5½″	11′ 8″	11′ 10½″	12′ 1″	12′ 3½″	12′ 6″	12′ 8½″	12′ 11″	13′ 1½″	20
21	10′ 6″	10′ 8⅝″	10′ 11¼″	11′ 1⅞″	11′ 4½″	11′ 7⅛″	11′ 9¾″	12′ 0⅜″	12′ 3″	12′ 5⅝″	12′ 8¼″	12′ 10⅞″	13′ 1½″	13′ 4⅛″	13′ 6¾″	13′ 9⅜″	21

Machinery

No. of Spaces	Pitch 8″	8⅛″	8¼″	8⅜″	8½″	8⅝″	8¾″	8⅞″	9″	9⅛″	9¼″	9⅜″	9½″	9⅝″	9¾″	9⅞″	No. of Spaces
2	1′ 4″	1′ 4¼″	1′ 4½″	1′ 4¾″	1′ 5″	1′ 5¼″	1′ 5½″	1′ 5¾″	1′ 6″	1′ 6¼″	1′ 6½″	1′ 6¾″	1′ 7″	1′ 7¼″	1′ 7½″	1′ 7¾″	2
3	2′ 0″	2′ 0⅜″	2′ 0¾″	2′ 1⅛″	2′ 1½″	2′ 1⅞″	2′ 2¼″	2′ 2⅝″	2′ 3″	2′ 3⅜″	2′ 3¾″	2′ 4⅛″	2′ 4½″	2′ 4⅞″	2′ 5¼″	2′ 5⅝″	3
4	2′ 8″	2′ 8½″	2′ 9″	2′ 9½″	2′ 10″	2′ 10½″	2′ 11″	2′ 11½″	3′ 0″	3′ 0½″	3′ 1″	3′ 1½″	3′ 2″	3′ 2½″	3′ 3″	3′ 3½″	4
5	3′ 4″	3′ 4⅝″	3′ 5¼″	3′ 5⅞″	3′ 6½″	3′ 7⅛″	3′ 7¾″	3′ 8⅜″	3′ 9″	3′ 9⅝″	3′ 10¼″	3′ 10⅞″	3′ 11½″	4′ 0⅛″	4′ 0¾″	4′ 1⅜″	5
6	4′ 0″	4′ 0¾″	4′ 1½″	4′ 2¼″	4′ 3″	4′ 3¾″	4′ 4½″	4′ 5¼″	4′ 6″	4′ 6¾″	4′ 7½″	4′ 8¼″	4′ 9″	4′ 9¾″	4′ 10½″	4′ 11¼″	6
7	4′ 8″	4′ 8⅞″	4′ 9¾″	4′ 10⅝″	4′ 11½″	5′ 0⅜″	5′ 1¼″	5′ 2⅛″	5′ 3″	5′ 3⅞″	5′ 4¾″	5′ 5⅝″	5′ 6½″	5′ 7⅜″	5′ 8¼″	5′ 9⅛″	7
8	5′ 4″	5′ 5″	5′ 6″	5′ 7″	5′ 8″	5′ 9″	5′ 10″	5′ 11″	6′ 0″	6′ 1″	6′ 2″	6′ 3″	6′ 4″	6′ 5″	6′ 6″	6′ 7″	8
9	6′ 0″	6′ 1⅛″	6′ 2¼″	6′ 3⅜″	6′ 4½″	6′ 5⅝″	6′ 6¾″	6′ 7⅞″	6′ 9″	6′ 10⅛″	6′ 11¼″	7′ 0⅜″	7′ 1½″	7′ 2⅝″	7′ 3¾″	7′ 4⅞″	9
10	6′ 8″	6′ 9¼″	6′ 10½″	6′ 11¾″	7′ 1″	7′ 2¼″	7′ 3½″	7′ 4¾″	7′ 6″	7′ 7¼″	7′ 8½″	7′ 9¾″	7′ 11″	8′ 0¼″	8′ 1½″	8′ 2¾″	10
11	7′ 4″	7′ 5⅜″	7′ 6¾″	7′ 8⅛″	7′ 9½″	7′ 10⅞″	8′ 0¼″	8′ 1⅝″	8′ 3″	8′ 4⅜″	8′ 5¾″	8′ 7⅛″	8′ 8½″	8′ 9⅞″	8′ 11¼″	9′ 0⅝″	11
12	8′ 0″	8′ 1½″	8′ 3″	8′ 4½″	8′ 6″	8′ 7½″	8′ 9″	8′ 10½″	9′ 0″	9′ 1½″	9′ 3″	9′ 4½″	9′ 6″	9′ 7½″	9′ 9″	9′ 10½″	12
13	8′ 8″	8′ 9⅝″	8′ 11¼″	9′ 0⅞″	9′ 2½″	9′ 4⅛″	9′ 5¾″	9′ 7⅜″	9′ 9″	9′ 10⅝″	10′ 0¼″	10′ 1⅞″	10′ 3½″	10′ 5⅛″	10′ 6¾″	10′ 8⅜″	13
14	9′ 4″	9′ 5¾″	9′ 7½″	9′ 9¼″	9′ 11″	10′ 0¾″	10′ 2½″	10′ 4¼″	10′ 6″	10′ 7¾″	10′ 9½″	10′ 11¼″	11′ 1″	11′ 2¾″	11′ 4½″	11′ 6¼″	14
15	10′ 0″	10′ 1⅞″	10′ 3¾″	10′ 5⅝″	10′ 7½″	10′ 9⅜″	10′ 11¼″	11′ 1⅛″	11′ 3″	11′ 4⅞″	11′ 6¾″	11′ 8⅝″	11′ 10½″	12′ 0⅜″	12′ 2¼″	12′ 4⅛″	15
16	10′ 8″	10′ 10″	11′ 0″	11′ 2″	11′ 4″	11′ 6″	11′ 8″	11′ 10″	12′ 0″	12′ 2″	12′ 4″	12′ 6″	12′ 8″	12′ 10″	13′ 0″	13′ 2″	16
17	11′ 4″	11′ 6⅛″	11′ 8¼″	11′ 10⅜″	12′ 0½″	12′ 2⅝″	12′ 4¾″	12′ 6⅞″	12′ 9″	12′ 11⅛″	13′ 1¼″	13′ 3⅜″	13′ 5½″	13′ 7⅝″	13′ 9¾″	13′ 11⅞″	17
18	12′ 0″	12′ 2¼″	12′ 4½″	12′ 6¾″	12′ 9″	12′ 11¼″	13′ 1½″	13′ 3¾″	13′ 6″	13′ 8¼″	13′ 10½″	14′ 0¾″	14′ 3″	14′ 5¼″	14′ 7½″	14′ 9¾″	18
19	12′ 8″	12′ 10⅜″	13′ 0¾″	13′ 3⅛″	13′ 5½″	13′ 7⅞″	13′ 10¼″	14′ 0⅝″	14′ 3″	14′ 5⅜″	14′ 7¾″	14′ 10⅛″	15′ 0½″	15′ 2⅞″	15′ 5¼″	15′ 7⅝″	19
20	13′ 4″	13′ 6½″	13′ 9″	13′ 11½″	14′ 2″	14′ 4½″	14′ 7″	14′ 9½″	15′ 0″	15′ 2½″	15′ 5″	15′ 7½″	15′ 10″	16′ 0½″	16′ 3″	16′ 5½″	20
21	14′ 0″	14′ 2⅝″	14′ 5¼″	14′ 7⅞″	14′ 10½″	15′ 1⅛″	15′ 3¾″	15′ 6⅜″	15′ 9″	15′ 11⅝″	16′ 2¼″	16′ 4⅞″	16′ 7½″	16′ 10⅛″	17′ 0¾″	17′ 3⅜″	21

Machinery

No. of Spaces	Pitch 10″	10⅛″	10¼″	10⅜″	10½″	10⅝″	10¾″	10⅞″	11″	11⅛″	11¼″	11⅜″	11½″	11⅝″	11¾″	11⅞″	12″	No. of Spaces
2	1′ 8″	1′ 8¼″	1′ 8½″	1′ 8¾″	1′ 9″	1′ 9¼″	1′ 9½″	1′ 9¾″	1′ 10″	1′ 10¼″	1′ 10½″	1′ 10¾″	1′ 11″	1′ 11¼″	1′ 11½″	1′ 11¾″	2′ 0″	2
3	2′ 6″	2′ 6⅜″	2′ 6¾″	2′ 7⅛″	2′ 7½″	2′ 7⅞″	2′ 8¼″	2′ 8⅝″	2′ 9″	2′ 9⅜″	2′ 9¾″	2′ 10⅛″	2′ 10½″	2′ 10⅞″	2′ 11¼″	2′ 11⅝″	3′ 0″	3
4	3′ 4″	3′ 4½″	3′ 5″	3′ 5½″	3′ 6″	3′ 6½″	3′ 7″	3′ 7½″	3′ 8″	3′ 8½″	3′ 9″	3′ 9½″	3′ 10″	3′ 10½″	3′ 11″	3′ 11½″	4′ 0″	4
5	4′ 2″	4′ 2⅝″	4′ 3¼″	4′ 3⅞″	4′ 4½″	4′ 5⅛″	4′ 5¾″	4′ 6⅜″	4′ 7″	4′ 7⅝″	4′ 8¼″	4′ 8⅞″	4′ 9½″	4′ 10⅛″	4′ 10¾″	4′ 11⅜″	5′ 0″	5
6	5′ 0″	5′ 0¾″	5′ 1½″	5′ 2¼″	5′ 3″	5′ 3¾″	5′ 4½″	5′ 5¼″	5′ 6″	5′ 6¾″	5′ 7½″	5′ 8¼″	5′ 9″	5′ 9¾″	5′ 10½″	5′ 11¼″	6′ 0″	6
7	5′ 10″	5′ 10⅞″	5′ 11¾″	6′ 0⅝″	6′ 1½″	6′ 2⅜″	6′ 3¼″	6′ 4⅛″	6′ 5″	6′ 5⅞″	6′ 6¾″	6′ 7⅝″	6′ 8½″	6′ 9⅜″	6′ 10¼″	6′ 11⅛″	7′ 0″	7
8	6′ 8″	6′ 9″	6′ 10″	6′ 11″	7′ 0″	7′ 1″	7′ 2″	7′ 3″	7′ 4″	7′ 5″	7′ 6″	7′ 7″	7′ 8″	7′ 9″	7′ 10″	7′ 11″	8′ 0″	8
9	7′ 6″	7′ 7⅛″	7′ 8¼″	7′ 9⅜″	7′ 10½″	7′ 11⅝″	8′ 0¾″	8′ 1⅞″	8′ 3″	8′ 4⅛″	8′ 5¼″	8′ 6⅜″	8′ 7½″	8′ 8⅝″	8′ 9¾″	8′ 10⅞″	9′ 0″	9
10	8′ 4″	8′ 5¼″	8′ 6½″	8′ 7¾″	8′ 9″	8′ 10¼″	8′ 11½″	9′ 0¾″	9′ 2″	9′ 3¼″	9′ 4½″	9′ 5¾″	9′ 7″	9′ 8¼″	9′ 9½″	9′ 10¾″	10′ 0″	10
11	9′ 2″	9′ 3⅜″	9′ 4¾″	9′ 6⅛″	9′ 7½″	9′ 8⅞″	9′ 10¼″	9′ 11⅝″	10′ 1″	10′ 2⅜″	10′ 3¾″	10′ 5⅛″	10′ 6½″	10′ 7⅞″	10′ 9¼″	10′ 10⅝″	11′ 0″	11
12	10′ 0″	10′ 1½″	10′ 3″	10′ 4½″	10′ 6″	10′ 7½″	10′ 9″	10′ 10½″	11′ 0″	11′ 1½″	11′ 3″	11′ 4½″	11′ 6″	11′ 7½″	11′ 9″	11′ 10½″	12′ 0″	12
13	10′ 10″	10′ 11⅝″	11′ 1¼″	11′ 2⅞″	11′ 4½″	11′ 6⅛″	11′ 7¾″	11′ 9⅜″	11′ 11″	12′ 0⅝″	12′ 2¼″	12′ 3⅞″	12′ 5½″	12′ 7⅛″	12′ 8¾″	12′ 10⅜″	13′ 0″	13
14	11′ 8″	11′ 9¾″	11′ 11½″	12′ 1¼″	12′ 3″	12′ 4¾″	12′ 6½″	12′ 8¼″	12′ 10″	12′ 11¾″	13′ 1½″	13′ 3¼″	13′ 5″	13′ 6¾″	13′ 8½″	13′ 10¼″	14′ 0″	14
15	12′ 6″	12′ 7⅞″	12′ 9¾″	12′ 11⅝″	13′ 1½″	13′ 3⅜″	13′ 5¼″	13′ 7⅛″	13′ 9″	13′ 10⅞″	14′ 0¾″	14′ 2⅝″	14′ 4½″	14′ 6⅜″	14′ 8¼″	14′ 10⅛″	15′ 0″	15
16	13′ 4″	13′ 6″	13′ 8″	13′ 10″	14′ 0″	14′ 2″	14′ 4″	14′ 6″	14′ 8″	14′ 10″	15′ 0″	15′ 2″	15′ 4″	15′ 6″	15′ 8″	15′ 10″	16′ 0″	16
17	14′ 2″	14′ 4⅛″	14′ 6¼″	14′ 8⅜″	14′ 10½″	15′ 0⅝″	15′ 2¾″	15′ 4⅞″	15′ 7″	15′ 9⅛″	15′ 11¼″	16′ 1⅜″	16′ 3½″	16′ 5⅝″	16′ 7¾″	16′ 9⅞″	17′ 0″	17
18	15′ 0″	15′ 2¼″	15′ 4½″	15′ 6¾″	15′ 9″	15′ 11¼″	16′ 1½″	16′ 3¾″	16′ 6″	16′ 8¼″	16′ 10½″	17′ 0¾″	17′ 3″	17′ 5¼″	17′ 7½″	17′ 9¾″	18′ 0″	18
19	15′ 10″	16′ 0⅜″	16′ 2¾″	16′ 5⅛″	16′ 7½″	16′ 9⅞″	17′ 0¼″	17′ 2⅝″	17′ 5″	17′ 7⅜″	17′ 9¾″	18′ 0⅛″	18′ 2½″	18′ 4⅞″	18′ 7¼″	18′ 9⅝″	19′ 0″	19
20	16′ 8″	16′ 10½″	17′ 1″	17′ 3½″	17′ 6″	17′ 8½″	17′ 11″	18′ 1½″	18′ 4″	18′ 6½″	18′ 9″	18′ 11½″	19′ 2″	19′ 4½″	19′ 7″	19′ 9½″	20′ 0″	20
21	17′ 6″	17′ 8⅝″	17′ 11¼″	18′ 1⅞″	18′ 4½″	18′ 7⅛″	18′ 9¾″	19′ 0⅜″	19′ 3″	19′ 5⅝″	19′ 8¼″	19′ 10⅞″	20′ 1½″	20′ 4⅛″	20′ 6¾″	20′ 9⅜″	21′ 0″	21

Machinery

* Address: 122 Louden St., Philadelphia, Pa.

MAKING HIGH-EFFICIENCY WORM-GEARING*

METHODS EMPLOYED BY THE CLEVELAND WORM & GEAR CO

BY DOUGLAS T. HAMILTON†

In an endeavor to secure quiet running and efficient rear axle drives for automobiles, various types of gearing have been employed, bevel and worm gearing being the two types most generally used. Bevel gearing has been used with considerable success, and when properly made and aligned shows a high efficiency with comparative quietness in action. When bevel gears begin to wear, however, backlash is introduced, tending to produce "clatter" and the familiar humming sound emitted from a transmission case. Dis-alignment of the gearing reduces the efficiency and also produces noise. Within the last few years worm-gearing has been receiving considerable attention on the part of automobile manufacturers for the following reasons: it is possible to produce this type of drive, with the proper equipment, more cheaply than the best bevel

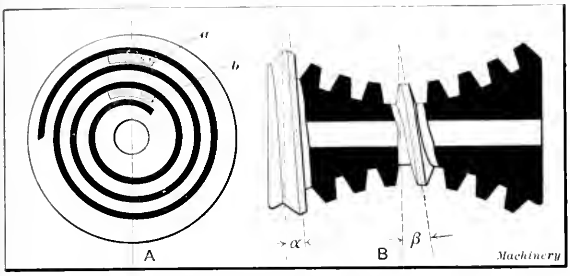


Fig. 1. Diagram illustrating an Objectionable Point in the Contact of the Globoid or Hindley Type of Worm

gearing; it is much more quiet in action; has a longer life; and if properly made, has a higher efficiency and smoother action.

Different Types of Worm-gearing

Generally speaking, there are three distinct types of worm-gearing that have been applied to rear axle drives. The first is the common type of worm drive produced by the ordinary gear hobbing machine method, which generally shows a comparatively low efficiency. The second type is globoid gearing, more commonly called Hindley or hour-glass type of worm-gearing. This shows a very high efficiency, but owing to the refinement necessary in its manufacture and alignment, as will be described later, has not given the satisfactory service that its design would indicate. The third type, and the one on which this article is based, is not so well known as

Fig. 2. Cutting a Straight Worm-wheel by Means of the Tapered Hob Method

the other two, but judging from various experiments and tests that have been made gives a high efficiency and long life combined with quiet running and smooth action. It is known as the "straight worm" type of drive, this name serving to differentiate it from the Hindley type in which the

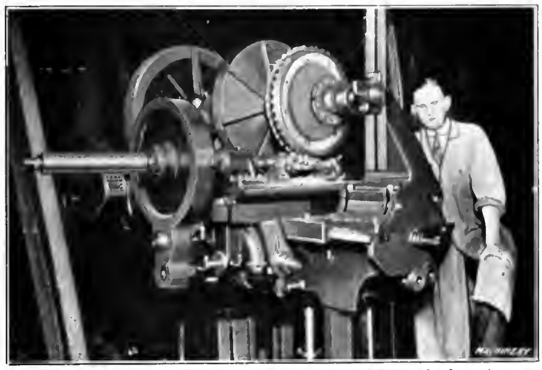


Fig. 3. Machine used for cutting Straight Worm-wheels using Tapered Hobs

worm is curved to conform with the circumference of the worm-wheel.

Globoid or Hindley Worm-gearing

The purpose in designing globoid or Hindley worm-gearing is to enlarge the surfaces in contact so as to reduce wear, and obtain relatively small dimensions—pitch of teeth, etc. While, theoretically speaking, the conditions obtained in this

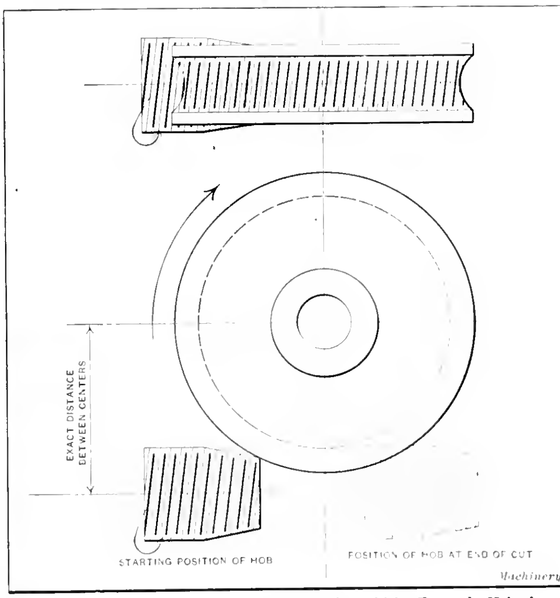


Fig. 4. Diagram illustrating Manner in which Tapered Hob is presented to Worm-wheel Blank

type of gearing would seem almost perfect, there are, in practice, serious objections to its use where dis-alignment of the gearing occurs. To illustrate one weak point in this type of gearing Fig. 1 is presented, in which the ordinary type of scroll used in lathe chucks serves as a means of illustration and comparison. In Position 1 one tooth of the jaw *a* is put into the outer part of the scroll, and in Position 2, the tooth *b* of the jaw is put in the inner part of the scroll. It will be observed that, in theory, the tooth of the jaw has contact only on one vertical line. Now on an ordinary screw the pitch angle depends on the lead and on the pitch diameter, and the angle of inclination of the threads is uniform from end to end. Such is not the case in the Hindley worm where the diameter increases with the length, or in other words, enlarges on each side of a vertical line drawn through the

* For additional information on the making and application of worm-gearing for various purposes, see the following articles previously published in MACHINERY, "Making Hindley Worm Gearing at the Brooklyn Navy Yard," November, 1912; "Efficiency of Worm-Gearing for Automobile Transmissions," September, 1912; "Worm and Helical Gears as Applied to Rear Axle Drives," September, 1912 (engineering edition); "Cutting Hindley Worm-Gearing on the Schuchardt & Schutte Gear-Hobbing Machine," July, 1911; "Table for Calculating the Outside Diameter of Worm-Wheels," April, 1911; "Worm-Gearing Employed for Freight Elevators," December, 1910; "Allowable Load and Efficiency of Worm Gearing," September, 1910; and other articles there referred to.

†Associate Editor of MACHINERY.

axis of the worm-wheel and the center of the worm.

At B in Fig. 1 it will be seen that the angle β of the screw line in the middle portion of the globoid worm is greater than the angle α at the outside. This means that the conditions of contact are similar to those in the lathe scroll as shown at A in Fig. 1. Further, the difference in the theoretical peripheral velocity of the worm would have a tendency to retard the advance of the worm-wheel. From these and other well-known points in gearing, it is evident that the conditions for contact are not so favorable as they are sometimes supposed. In practice, it is not a simple matter in all cases to get the center or hollow of the worm exactly in conformity with the center of the worm-wheel. This, however, is one of the conditions necessary in the alignment of Hindley worm-gearing if good results are to be expected. Hindley worm-gearing shows a very high efficiency when new and when set up in proper alignment, but just as soon as the least wear begins to take place, the efficiency immediately drops. This subject has been admirably treated in an

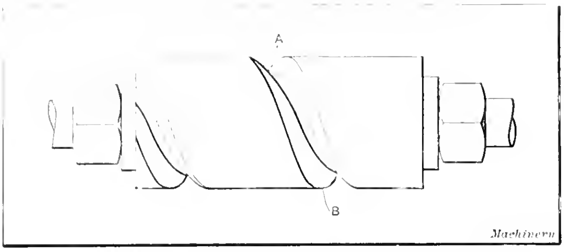


Fig. 5. Diagram illustrating Reverse Curve that is produced on Worm-wheel Teeth by hobbing with a Tapered Hob fed longitudinally and at Right Angles to the Axis of the Worm-wheel Blank

article entitled "The Hindley Worm Gear," by John Edgar, which appeared in the December, 1908, number of MACHINERY, engineering edition.

Straight Worm Type of Worm-gearing

The worm-gearing to be described in the following is known as the "straight worm" type, as previously mentioned. In the straight worm type the difficulties in alignment common to globoid gearing are eliminated, because the center portion of the worm does not have to bear any direct relation to the center of the worm-wheel. The only requirement is that the center distances of the worm and worm-wheel must be exact if perfect action and high efficiency are to result. In the method to be described, this important point is carefully provided for and is comparatively easy of attainment. Fig. 2 shows a close view of the machine used for cutting the straight type of worm-wheel. By this method a taper worm hob *A* held on the arbor *B* is used. The arbor is supported in bearing shoes *C* which are retained in blocks fastened to the table of the machine. The hob is set by means of a

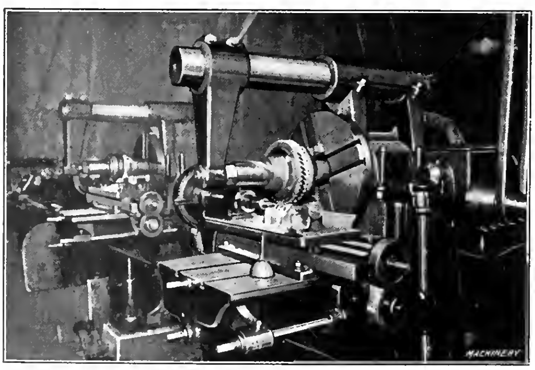


Fig. 6. Two Special Hobbing Machines at work on Worm-wheels for Electric Automobile Rear Axle Drives

vernier and scale at the exact center distance in relation to the worm-wheel blank, and as shown in Fig. 3 is very rigidly supported. The worm hob and work are rotated in the correct relation to each other, and at the same time the hob is fed in a longitudinal direction as indicated in Fig. 4, past the axis of the worm-wheel.

Ordinary and Taper Hob Method of Hobbing Worm-wheels Compared

By applying the hob to the work in the method just described, a theoretically correct and accurate worm-gear is produced, which cannot be excelled where high pitch angles or wide wheel faces—wide in relation to the worm—are concerned. By such a method of production the area of contact between the worm and worm-wheel is as large as possible,

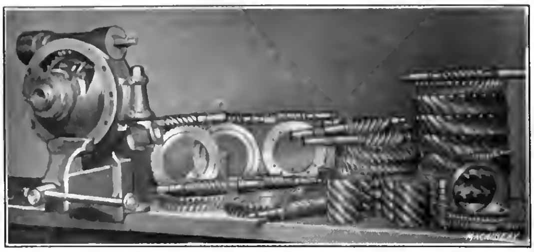


Fig. 7. Group of Straight Worm and Worm-wheels used for Rear Axle Automobile Drives

and provided that a good combination of materials is used, *viz.*, a high grade of phosphor-bronze for the worm-wheel and a good grade of casehardening steel for the worm, this type of gearing shows no appreciable wear under the heaviest loads after having run for a practically unlimited time. In cutting the worm-wheel in this manner, the reversible curve *AB*, Fig. 5, is actually obtained in the worm-wheel tooth. This curve conforms to the path followed by a tooth of the worm in rotating, and in practice is considered to give a surface contact which is impossible to obtain by hobbing worm-wheels in the old way.

The method ordinarily used in hobbing worm-wheels is to gear up the mechanism driving the hob with that actuating

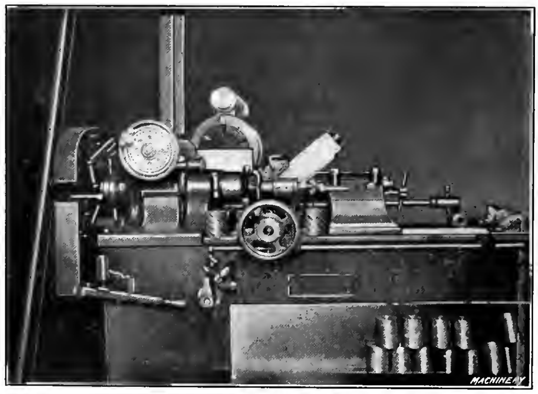


Fig. 8. Thread Milling Machine used for cutting Worms and Tapered Hobs

the dividing wheel which controls the indexing or rotation of the worm-wheel, and to feed the hob axially into the worm-wheel, both hob and blank being rotated at the same time. This action is continued until the hob has been fed in to the correct depth. Now in analyzing this method of cutting the worm-wheel, it will be seen that by presenting the hob in this manner it does not produce a tooth of a theoretically correct shape, for the simple reason that the hob cuts away certain portions of the tooth that are necessary to give a perfect contact with the worm. This is due to the constant changing of the theoretical helix angle of the hob while being fed in axially. Instead, therefore, of producing a worm-wheel tooth that has a reverse curve corresponding with the path through which the face of the worm tooth travels in rotating, this method removes a certain amount of the surface of the worm-wheel tooth that should come in contact with the worm, and in theory the line of contact between a worm-wheel (cut in this manner) and the worm is only on the center. The worm-wheel teeth are relieved toward each end and do not contact at all with the teeth of the worm, these portions of the worm-wheel teeth being removed by the hob in forming them. It will therefore be seen that this method never produces a correct tooth form, and its failings are especially

noticeable as soon as the pitch angle or width of the worm-wheel face becomes somewhat great, resulting in the mutilation of the teeth.

Cutting Straight Worm-wheels

Fig. 3 shows one of the machines employed by the Cleveland Worm & Gear Co., Cleveland, Ohio, for cutting "straight worm-wheels." The hob arbor and the work arbor on this machine both have a positive drive, which is governed by a series of change gears to obtain the required ratio between the worm-wheel and hob. The hob *A*, see Fig. 2, is fed longitudinally and automatically under the blank at the correct speed by means of another series of change gears, located at the left-hand end of the worm-shaft, which drives the work arbor through the dividing wheel. The table of this machine cannot be swiveled one way or the other from a position at right angles to the axis of the work arbor, thus avoiding trouble which has often occurred in the making of worm-gearing by not having the hob cut the worm-wheel at an angle of exactly 90 degrees with the hob axis. When the worm-wheel teeth have not been cut at the correct angle great friction is introduced between the worm and the worm-wheel, especially when the worm is forced to fit in the housing provided for it, which naturally would be machined exactly at an angle of 90 degrees. This machine also has power feeds in all directions and could be used for cutting the Hindley type of worm-gearing if so desired.

In Fig. 6 are shown two smaller type machines at work on worm-wheels for electric pleasure cars, which is one of the

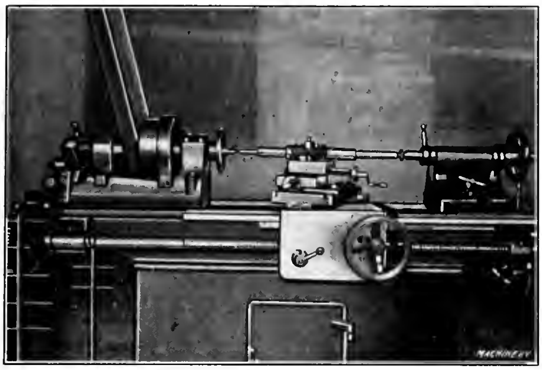


Fig. 9. A Special Type of Lathe used for backing-off or relieving Tapered Hobs

prominent uses being made of this type of worm-wheel. One peculiar feature which is noticeable in cutting a worm-wheel by the tapered hob method illustrated in Fig. 2 is that the hob, in starting to cut on the small end, produces a series of steps on the outside faces of the worm-wheel teeth, and as it feeds in further, the steps are produced on the other side of the teeth. Then as the cutter passes the center all marks are removed, producing a particularly smooth surface and correctly shaped teeth. The two positions of the hob before and after cutting the worm-wheel are indicated in Fig. 4. The hob is fed past the axis of the worm-wheel until the last tooth of the hob passes out of contact with the worm-wheel teeth; this action produces the reverse curve previously referred to. The chief advantages claimed for this worm-wheel is that it has a perfect surface bearing (this, theoretically, would be only a line bearing, but with the aid of the oil film becomes in practice a surface bearing) with the worm teeth for its entire arc of contact. It is also cut theoretically correct, which cannot be said of the ordinary method of worm-wheel hobbing.

A very high degree of accuracy can be obtained by this method of hobbing worm-wheels, owing to the fact that the full size of the hob does not come into play until the finishing cut is reached, so that the teeth of the hob tend to preserve their shape indefinitely. Another point, previously mentioned, that tends to produce accuracy is the fact that the distance between the work arbor and the hob spindle is at all times fixed at exactly the distance between the axis of the worm-wheel and the worm in the finished gearing. This is a refinement of greater importance than is usually realized, and one that is not always looked out for in hobbing operations in which the cutter spindle is fed in toward the work.

Efficiency of Straight Worm-gearing

In order to prove that worm-wheels cut by this method would work out as satisfactorily in practice as theoretical considerations indicated, a number of tests were made by a prominent concern manufacturing pleasure electric cars. In these tests it was found that the efficiency was very high, averaging from 90 to 98 per cent. Continual running ap-

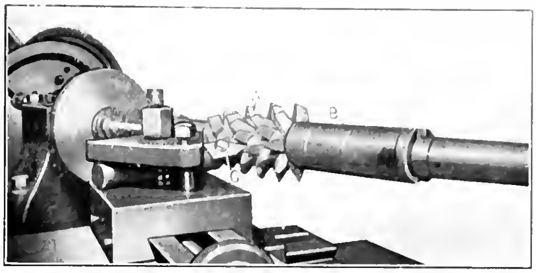


Fig. 10. Close View of Machine shown in Fig. 9 illustrating Method of applying Cutting Tool to Tapered Hob

peared to have but very little effect on the efficiency, and the wear was almost negligible. The way in which the worm and worm-wheels are mounted before being placed in the testing machine is indicated in Fig. 7, where a completed rear axle unit is shown held in an ordinary bench vise. Both worm and worm-wheel shafts run in ball bearings and are held in place so that the center distances of the worm and worm-wheel cannot change due to wear; the only effect that wear has on this type of gearing is to increase the backlash between the worm and worm-wheel teeth. It was also found in these tests that, as far as noise was concerned, the ball bearings did not run anywhere nearly as quietly as the worm and worm-wheel did, which would indicate that from this point of view the conditions met with in this type of gearing are almost ideal. This type of worm-gearing has also proved highly satisfactory for reduction gearing in connection with electric motors. A particularly good example which illustrates the adaptability of this type of gearing to large reductions was a reduction gear having a ratio of 903 to 2 that showed an efficiency of 80 per cent when transmitting 10 horsepower under tests covering a considerable period of time.

Cutting a Straight Worm

The Cleveland Worm & Gear Co. uses a thread milling machine of the type shown in Fig. 8 for cutting straight worms. By means of this machine worm milling becomes quite a sim-

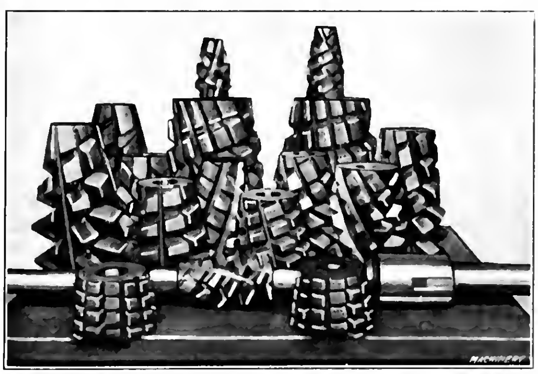


Fig. 11. Group of Tapered Hobs—One necessary for Every Pitch, Pitch Diameter and Variation in Number of Starts on Worm

ple matter, and the machines are so simple in operation that intelligent workmen can easily handle them and turn out good work cheaply and satisfactorily. The cutter head is accurately graduated and can be swiveled either way to the correct angle of the thread. The headstock spindle is hollow, allowing work to pass completely through it, and the cross-slide is provided with an automatic stop. The machine is also stopped automatically, at the end of a thread, thus insuring regularity of length when cutting multiple pitch

worms. There is, of course, as is evident in all milled spiral flutes, a tendency to leave the face of the worm thread cut somewhat concave. In order, therefore, to produce the best results, this company finds it advisable to rough out the worm on the thread milling machine illustrated, and leave a grinding allowance of 0.010 inch on each face of the thread. The worm, after hardening, is then ground by a special machine which corrects this concavity of the worm tooth and also removes any distortion which is likely to occur in hardening.

Making Tapered Hobs

The tapered hobs used for cutting the straight type of worm-wheels are roughed out in the thread milling machine shown in Fig. 8, and are then fluted in the milling machine; before hardening they are backed off in the special backing-off or relieving lathe shown in Fig. 9. This is a patented machine which has been constructed for making gear-cutters of every description as well as side relieved cutters with straight or spiral grooves, right- or left-handed; and if necessary it could be used as an ordinary engine lathe. The longitudinal feed of the carriage is actuated through change gears shown to the left of the machine, and a lead-screw in connection with the usual split nut.

The relieving mechanism works in either direction and can be easily reversed or released; it is actuated by means of a shaft running longitudinally inside of the bed of the machine and by gearing at the right-hand end of the machine. By means of easily interchangeable cams the clearance angles for each special tooth are obtained. The hob *A* to be relieved is held on a special arbor *B*, see Fig. 10, which in actual operation (it is not properly set up in the illustration) is held in the headstock spindle by a screw, and on the other end is supported in a taper bushing held in the tailstock spindle. By means of this method of retaining the arbor, deviation of the work during the relieving operation is impossible as the arbor withstands all pressure from the backing-off tooth *C*. By means of a system of change gears actuated by a lead-screw, a worm-drive and a differential gear, relieving can be obtained to any given length of left- or right-hand spiral. By this arrangement it is also possible to relieve, in addition to the ordinary plain and machine relieved cutters, taps and hobs with any given lead or number of spiral grooves. Provision for relieving spirally fluted hobs is secured by means of the change gears at the right-hand end of the machine. The spacing, of course, is accomplished with cams held on the screw running longitudinally inside of the machine bed. The hob thus relieved is accurate as to shape of tooth, and it is then hardened. In the event of any distortion from hardening, the hob is ground in the special worm-grinding machine previously mentioned.

Fig. 11 shows a group of tapered hobs of various pitches and sizes. For cutting straight worm gearing it is necessary to make a hob for every different pitch, pitch diameter and number of starts on the worm. In making a separate worm hob for each pitch and pitch diameter, the theoretically correctly shaped tooth on the worm-wheel is obtained. The reverse curve previously mentioned is also secured and the action of the worm-wheel teeth with the worm closely approximates ideal conditions. While the making of a hob for each pitch, pitch diameter and number of starts on the worm incurs considerable expense, it is evident that if a perfect working worm and worm-wheel is desired, the expense incident to the making of the hob is of minor consideration.

* * *

The Lackawanna R. R. has recently made tests to determine the practicability of communicating with moving trains by wireless telegraphy. The experiments thus far conducted indicate great possibilities. The Lackawanna has wireless stations at Scranton, Pa., and Binghamton, N. Y. The distance between these two stations is sixty-five miles, and it was found possible to maintain communication with a train running at the rate of fifty-five miles per hour, from one station to the other. The train was equipped with four quadrangular aerials mounted on the roofs of four adjacent cars. The heights of these aerials was limited to eighteen inches to avoid interference with tunnels and bridges. The regular Marconi system is employed except that power is supplied by a special motor-generator set driven from the train lighting dynamo. In the test referred to, when the train had proceeded to a point too far away for the low aerials on the cars to force signals back to the first station direct, the signals were delivered to the station ahead and relayed back to the starting point. At no time during the tests was the train out of communication with both stations.

* * *

FIRST INTERNATIONAL EXPOSITION OF SAFETY AND SANITATION

The First International Exposition of Safety and Sanitation was held in the Grand Central Palace, New York City, December 11-20. Among the large American industries exhibiting the advance that has been made in accident prevention and life-saving methods, appliances and devices were the Pennsylvania, New York Central, Southern Pacific, Baltimore & Ohio and Chicago & North Western railroads, the New York Edison Co., the New York Telephone Co., the National Cash Register Co., the Welin Marine Equipment Co., and the United States Steel Corporation.

The Pennsylvania R. R., which was awarded a gold medal by the American Museum of Safety last year for advance in safety, and which has a remarkable safety organization consisting of thirty safety committees, presided over by a central safety committee, had arranged an interesting exhibit based on practical experience. Men from the various shops demonstrated how they revive a comrade who has been shocked by coming in contact with a third rail.

The New York Central R. R. reproduced at the exposition the safety car which travels over all of the New York Central lines and in which lectures and practical demonstrations in safety work are given. This missionary car for safety was a feature of the exhibit. Other railroads showed progress in safety signaling systems, methods of inspection and rules regarding yard practice for employes.

The New York Edison Co. exhibited the many safety devices in use at the Waterside power stations, where half a million horsepower in electrical energy is generated, and in the various sub-stations throughout New York City. By means of these safety devices the Edison Co. has practically eliminated danger in the careful handling of electricity.

The Welin Marine Equipment Co. showed the progress made in saving life at sea. Their exhibit included davits, rafts, life boats and various kinds of life preservers. The New York Telephone Co., which maintains rest rooms, lunch rooms, and roof gardens for its operators, and which is particularly active in caring for the health and comfort of its thousands of employes, had an interesting exhibit. The United States Steel Corporation showed in a graphic manner how the workers in a hazardous industry are being protected.

In connection with the field hospital exhibited by the United States Army, a detail of fifty soldiers was sent to the exposition from Fort Totten on certain days, and these men went through physical drills and exercises which are especially designed a correct certain physical faults and ailments.

Among the exhibitors of safety devices designed for protecting workers in shops and factories were the following:

Allen Mfg. Co., Hartford, Conn. Safety set-screws.

Bass Bros., 82 Walker St., New York City. Safety guards for woodworking machinery.

Benjamin Electric Mfg. Co., 114 Liberty St., New York. Safety guard for punch presses.

Brown & Sharpe Mfg. Co., Providence, R. I. Charts and photographs of safety appliances.

Corbin Cabinet Lock Co., New Britain, Conn. Safety guard for punch presses.

Max H. Fischer, 41 Park Row, New York City. Hollow set-screws. Safety guards for presses.

L. F. Grammes & Sons, Allentown, Pa. Safety guards for woodworking machinery.

Julius King Optical Co., 12 Maiden Lane, New York City. Safety glasses for protecting the eyes of workmen.

Neverslip Safety Clamp Co., 141 Broadway, New York City. "Neverslip" clamps for handling boiler plates.

Norton Co., Worcester, Mass. Safety and sanitary appliances used in connection with grinding wheels.

T. A. Wilson & Co., Inc., Reading, Pa. Eye protectors for foundry, iron and steel workmen, etc.

Zeh & Hahnemann, Newark, N. J. Safety trip for punch presses.

H. & A. Lock Co., Brooklyn, N. Y. Safety guard for power presses.

PROGRESS OF THE SAFETY MOVEMENT*

A REVIEW OF WORK DONE TO PREVENT ACCIDENTS AND TO PROMOTE HEALTH IN THE INDUSTRIES

BY MANCIUS S. HUTTON†

It has been estimated by conservative competent experts that 35,000 workmen are killed and 2,000,000 injured, and that there are 3,000,000 cases of sickness due to occupational diseases among the industrial workers in this country each year. It is known that between 50 and 60 per cent of this economic and social waste is preventable by proper means. It is in those states which have passed workmen's compensation laws that there is the greatest progress in the promotion of safety and sanitation. At the end of the year 1913 the following twenty-two states have passed such laws:

Arizona;	Michigan;	Oregon;
California;	Minnesota;	Rhode Island;
Connecticut;	Nebraska;	Texas;
Illinois;	Nevada;	West Virginia;
Iowa;	New Hampshire;	Washington;
Kansas;	New Jersey;	Wisconsin.
Maryland;	New York;	
Massachusetts;	Ohio;	

The laws in these different states are not alike, some being more drastic than others. Some apply to all workers, others apply only to those working in hazardous enterprises which are specified. All these state laws are elective, as explained later, with the exception of Arizona, California and Ohio, which are compulsory. In the elective states the employer has the choice of voluntarily accepting the provisions of the act or of working under the common law; in the compulsory states he has no such choice. In order to make the law attractive to the employer, all the states which have already passed workmen's compensation laws and some that have not done so as yet, have changed or stricken from the statute books the old common liability law defenses called the "fellow servant" rule and the "assumption of risk" doctrine. By the fellow servant rule is meant "that the injury was caused by the negligence of another employe engaged in the same employment" and by the assumption of risk doctrine is meant "that the employe assumed the hazard of the occupation." In the past the employer has, in 75 per cent of the cases, by using either or both of these defenses, defeated any suit which the injured employe might institute in court to recover damages due to an injury. In addition, the amount of compensation for any injury has been definitely specified. In Maryland, Massachusetts, Ohio, Oregon, Texas, West Virginia and Washington, the employer is required to insure his men against casualty with a state insurance board or in one of the insurance companies which the state allows to receive such insurance. The employer pays the premiums. In ten states "Industrial Accident Boards" or commissions have been created to administer these laws.

The United States government has already passed laws which compensate for injuries and death for about a quarter of its 400,000 civilian employes. There will be presented to congress during this session a compensation bill which will take care of all these civilians. This bill, which will be introduced by Senator Kern of Indiana, provides for compensation for sickness or death due to occupational diseases as well as accidents. During 1914 there will probably be one state, at least, which will pass a compensation law, and two other states which will change their present laws. Besides providing for adequate and prompt compensation for accidents to industrial workers without the necessity of going to court, fifteen states have taken steps to study the question of occupational sickness among wage workers in the different trades, by requiring physicians to report to a state board or department cases of certain occupational diseases which they may be treating. In the near future these and other states will incorporate occupational diseases as well as accidents in their compensation laws. It has been found on investigation that lead-poisoning lurks in 150 different trades.

In the twenty-two states previously mentioned, laws have been passed which have increased and bettered the state inspection department, given the inspectors more power, increased the punishment imposed for violations of the laws besides requiring certain definite protection to be given to the workers in several of the trades. Where the state has an accident board or commission, the law-makers have delegated the prevention end to such board or commission by means of executive orders instead of enacting individual laws.

Active work in the prevention of mine accidents has advanced since the formation of the Bureau of Mines of the Department of the Interior in 1910. There are about three thousand miners killed every year, of which only fifteen per cent are killed in the large mine disasters which get into the daily papers. About seventy-five per cent of the miners in this country are ignorant foreigners. The investigations which the bureau has carried on during the last four years, have been helpful both to the owners and miners. These investigations have been published by the government and can be obtained free upon request. The bureau has taught miners and mine officials how to carry on rescue work in gaseous mines, how to fight mine fires, and how to give first-aid to injured workers. The government has in operation, at the present time, six mine-safety stations and seven mine-safety railway cars, both fully equipped as regards breathing apparatus, fire-fighting apparatus and materials for first-aid to the injured. These are presided over by a mining engineer who has under him a corps of highly trained miners. Up to the present 7734 miners have been instructed in the carrying on of rescue work with the use of breathing apparatus, in the fighting of mine fires, and the giving of first-aid. Safety lectures have been delivered to 71,500 persons by employes of the bureau. Once a year rescue and first-aid teams from various mines compete for different prizes which are offered by several of the mine companies.

For the last twenty-four years the Interstate Commerce Commission has been collecting statistics of accidents from the railroads doing interstate business. These statistics show that during that period 188,037 persons have been killed and 1,395,618 injured. These persons can be divided into three classes: First, the employes of the railroads; second, passengers; third, "other persons," including trespassers on the tracks. The "other persons" are by far the most numerous being about 62 per cent of the whole number of those killed. Of this 62 per cent, about 85 per cent can be classified as trespassers. The reports of the commission show that a large majority of these trespassers were killed and injured at other points on the track than at the highway crossings. The eliminating of grade crossings, the stationing of gate and flag-men at the crossings, has and will in the future, lessen the number of accidents at these points. One of the greatest problems which the railroads and commissions will have to face will be the question of reducing these trespasser accidents. It is the collisions and derailments in which passengers are killed or injured which get into the front pages of the newspapers but it is a fact that the number of injuries and deaths of passengers is small compared to the number of passengers carried. This is said guardedly since there is still fresh in the memory of almost everyone the terrible disasters which have occurred on one of the eastern roads this last year.

The employes of a railroad can be divided into three classes: First, those who work in the shops and roundhouses; second, those who work in connection with the operation of trains, such as yard and switchmen; third, those who operate the trains, which include the engineer, conductor, firemen and brakeman. The men in the first class are like those in any industrial factory and can be protected some-

* For articles on safety activities previously published in MACHINERY, see "American Museum of Safety Award," February, 1913, and "Museums of Safety and Their Activities," September, 1912, and articles there referred to.

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what by means of safety devices and can be helped by working in well lighted, well ventilated buildings, which are not overcrowded so that the aisles and passage-ways can be kept clear. There are not many known safeguards which can be used for the second and third classes of employes. These men must run no risks, be quick of action, have a clear vision and brain, and be sure that they are safe before doing anything. In 1910 there was started a "safety-first" movement among the railroads. At the end of this year there will be sixty-seven railroads having a total mileage of over 183,596, which have organized this movement among their employes. Not a week passes but other railroads are taking up this movement, until within a few years, all the railroads will have joined it. This is nothing more than a practical movement to interest and cooperate with the railroad employes so that they will always think and act "safety first." This is accomplished by various means, among which are workmen's safety committees, talks by railroad officials, illustrated lectures on safety and other methods. The men have appreciated what the companies are doing for them, and they are trying to live up to what is required of them, thereby "boosting safety." The railroads which are active in this movement have been able to show a surprisingly large reduction in the number of accidents. Some of these roads have fitted up cars with traveling exhibits of safeguards. They also carry lantern slides of safety devices and methods of protection. Each car is in charge of one of the road's safety engineers, who goes with the car to the different shops, roundhouses and yard terminals of the road, where he lectures to the men and shows them models of the different safety devices which the company uses.

The statistics given in the foregoing only refer to railroads doing interstate business. The street and interurban railroads, besides the intrastate steam railroads, come under the jurisdiction of the state public service or railroad commission, if such has been created by the legislature of the state. The greatest number of accidents which occur on the street railroads are in the getting on and off of moving cars. The prevention of this class of accidents is in the education of the passengers not to be in a hurry, but to wait till the car stops before proceeding to get on or off. The running or stepping in front of moving cars is always a source of great danger. A large number of these latter accidents happen to thoughtless school children. It might be mentioned that the accidents which have happened since the advent of the motor vehicle and motor truck have been increasing instead of decreasing. State and local ordinances have attempted to decrease speeding and reckless driving by chauffeurs. While these are not industrial accidents, everyone is vitally interested in preventing them as far as possible.

Ever since the *Titanic* disaster of April 15, 1912, when 1517 persons were lost at sea, the United States government and the ship-owners have been trying to prevent a repetition of this calamity. As a result, ships which ply on the navigable rivers and lakes and those leaving ports of this country for foreign destinations, which carry more than 50 persons (crew and passengers), must be equipped with a wireless system having a day or night radius of 100 miles at least. This equipment must be so arranged that it can be independent of the engine room supply of electricity. They are also required to have at least two operators so that one will be on duty all the time. The ships must have enough life boats and rafts to accommodate all the passengers and crew. The life boats, rafts and life preservers are regularly inspected to see that they are in sea-worthy condition. Lifeboat and fire-drills by the crew are supposed to take place at regular intervals. Traveling by water to-day is far safer than it was four or five years ago. While it is a fact that some of the worst marine disasters have happened by collisions or by having the vessel tossed against a shore and knocked to pieces by the wind and waves, yet it is also true that the burnings of ships at sea, or in port, have been more numerous. The burning of the S. S. *Volturno* in the summer of 1913 is only one instance in a long line of such disasters. Even with all the latest apparatus for detecting and extinguishing fires, it sometimes happens that the fire gets beyond control. One of the greatest safeguards of the age, as regards protection at sea, has been the use of wireless telegraph in calling for help from other vessels. In December 1913 there was held in London, England, an "International Conference on Safety at Sea," having representatives from twelve different nations. This conference will make a report as regards its findings.

In 1911 the fire in the Triangle Shirt Waist Co.'s loft occurred in New York, and another disastrous fire in Newark, N. J. The next year there was another large fire in a loft building in Binghamton, N. Y. In each of these fires there was a terrible loss of life among the young women workers in the shops. As the result of investigations conducted after these fires, several of the states have changed existing laws and have enacted others to protect the workers in factories and lofts from such disastrous fires. It would take too long to tell what has been done in the line of fire prevention, but mention will be made of the increased number of, and larger fire escapes built of firmer materials, of fire drills conducted in different shops, of more adequate fire fighting apparatus to extinguish a blaze in its incipiency, of buildings constructed of fire-resisting materials and of other methods by which the fire insurance companies and the owners of factories are improving conditions.

All the work of the government commissions, bureaus, state boards, employers and other officials in accident prevention, hygiene, and sanitation, would count for very little if it did not have the active cooperation of the workers themselves. There are several reasons why the safety movement has taken such big steps within the last year or two. One of these has been the awakening of the employers to the fact that they are their "brothers' keepers" and therefore it is their moral and rightful duty to take every means in their power to keep their workers in health and as free as possible from accident. Second, the employe realizes now that it is his duty to become a partner with his employer in carrying out any safety suggestions that will be helpful to both of them. Again both the employer and his workmen know that they owe it to society at large to decrease the number of accidents and cases of sickness.

Among the agencies which are helping the progress of the safety movement are the museums of safety, one of which is now located in New York at 29 West 39th St. Another will be started with the beginning of this year, in San Francisco, Cal., and still a third will be located in Chicago, Ill., in the near future. Other museums are being considered by several of the state boards and by the national government. These museums are stationary and can be seen only by those who are within a traveling distance of these cities or who may be sojourning in them. The lecture work which members of these museums can give need not be confined to these cities. In fact, during the last three years illustrated lectures have been delivered by officials of the American Museum of Safety before audiences of superintendents, foremen and workers of several large industrial plants and railroads. They have also given the same lectures before meetings of chambers of commerce, factory inspectors, organizations of employers, and others of a similar nature. This last year, safety talks have been given by the New York museum to 449,120 children of the schools of Greater New York.

Some of the railroads and large industrial concerns have printed safety talks which they have sent to the school authorities in the cities in which they are located, for distribution among the school children. Lecture work has been given by officials of the National Association of Manufacturers at the different industrial centers during the last few years. This association is proposing to widen its scope of lectures this coming year by fitting up a train which will carry the lecture officials. One car of this train will be arranged so that it can become a moving picture theater, and another car will carry models and samples of various safety devices. One of the railroads already has a train of this nature for its own use and others are considering doing the same thing. Several of the state boards are doing lecture work among the manufacturers of their states. This edu-

cational lecture work has been a great help to all concerned and one of the leading factors that has brought the safety movement to its present state of development.

Another agency which is helping the movement is the cooperation of the technical journals in the publishing of editorials and articles by leaders of the movement, on questions relating to safety, sanitation and hygiene. The *Railroad Record* publishes once a month an issue devoted wholly to safety and safety engineering, and has each month a section given over to questions regarding safety. Several of the insurance companies which carry liability insurance have been actively promoting the safety movement among their insured. It is not unnatural that new organizations whose members consist of those whose interest centers about this movement, should come into existence as the work progresses. Among such organizations might be mentioned the American Mine Safety Association, and the American Railway Safety Association. In Milwaukee, Wis., from September 30 to October 5, 1913, there was held the "First Cooperative Safety Congress" under the auspices of the association of the Iron and Steel Electrical Engineers. At the end of this congress there was formed a National Council of Industrial Safety to serve as a committee for organizing future congresses. In New York there was held, from December 11 to 20, 1913, the "First International Exhibition of Safety and Sanitation" under the auspices of the American Museum of Safety.

It has not been possible in as short an article as this, to give more than a general outline of the progress in the safety movement since its beginning. No mention has been made of other lines of progress in labor which have helped this movement nor has mention been made of what has been done by the legislatures and the employers in hygiene and sanitation. The safety movement has now become a permanent one in this country and it will progress faster here than it did abroad, since America has their experience to draw from.

* * *

THE "PAPERED" PRESSES

A story is told of a manufacturer who bought some small presses from a concern that built machinery spasmodically—that is, when it had orders to fill. The presses were delivered, and after a time they were taken down for readjustment. The fitting was found to be hardly satisfactory even to a good-natured man. This man was good natured, but being slightly given to sarcasm, he penned the following letter:

John Blank, Esq.:

I have taken down the presses you sold me and am now ready to put them together. Will you please send me some copies of the *Billtown Bugle?* I don't find any paper around here of the same thickness. Shall need three copies to go around.

Yours truly,
Samuel Dash

TEST GAGES FOR AUTOMOBILE CYLINDERS

BY E. H. PRATT*

In the production of automobile cylinders there is always considerable discussion regarding the cylinder bore being square with the flange, and various devices and gages have been designed to test the squareness, which depends upon several conditions: First, the cylinder boring machine must be of very rigid construction; send, the jig for holding the cylinder must be strong and accurate; third, the boring tools must be kept sharp and have the proper clearance; fourth, the cores that form the cylinder barrels must be set true. The cores are the principal cause of the trouble and it seems almost impossible for the foundry to overcome the difficulty. When the cored hole is considerably out of true, the cutters will have more stock to remove from one side of the hole than the other, and, if the spindle of the boring mill is not perfectly adjusted, there will be a certain amount of play or spring that will allow the cutter to follow the core. The error arising from this cause is likely to be in any direction, and, after the finishing cut is taken, it is necessary to test the bore to determine how much it is out of square.

The test gages shown in the accompanying illustrations represent the ideas of various engineers and inspectors. Some of them have proved to be very accurate but not economical, owing to their excessive first cost, whereas others are accurate, cost little, and therefore are practical. The gage illustrated in Fig. 1 has previously been shown in MACHINERY's columns, but is reproduced to make the set complete. The flange *A* of this gage is placed on the cylinder flange, and the bar *B* which slides in bearings *C* is then moved vertically, thus causing the "anvil points" *D* to pass down the sides of the cylinder wall. Any variation is indicated by the relation of pointer *E* to the graduation marks seen at the upper end of the gage. This gage was very successful, but can only be used on one size cylinder, which is a decided disadvantage in a job-shop where cylinders of several diameters are being made.

The gage shown in Fig. 2 is used to test the variation in thickness between the cylinder bores. It was not very successful, inasmuch as both bores could be out of square with the flange while the thickness between them was uniform. The construction of this gage is clearly shown by the illustration. A gage which proved very satisfactory for testing bores for taper is shown in Fig. 3. Attached to one end of the body *A* there is a movable block *B* normally held out by springs *C*. The indicator arm *D* is pivoted at *E* and is connected with the movable block as shown. The frame is graduated on the upper end and is also formed for a handle with which to operate the gage.

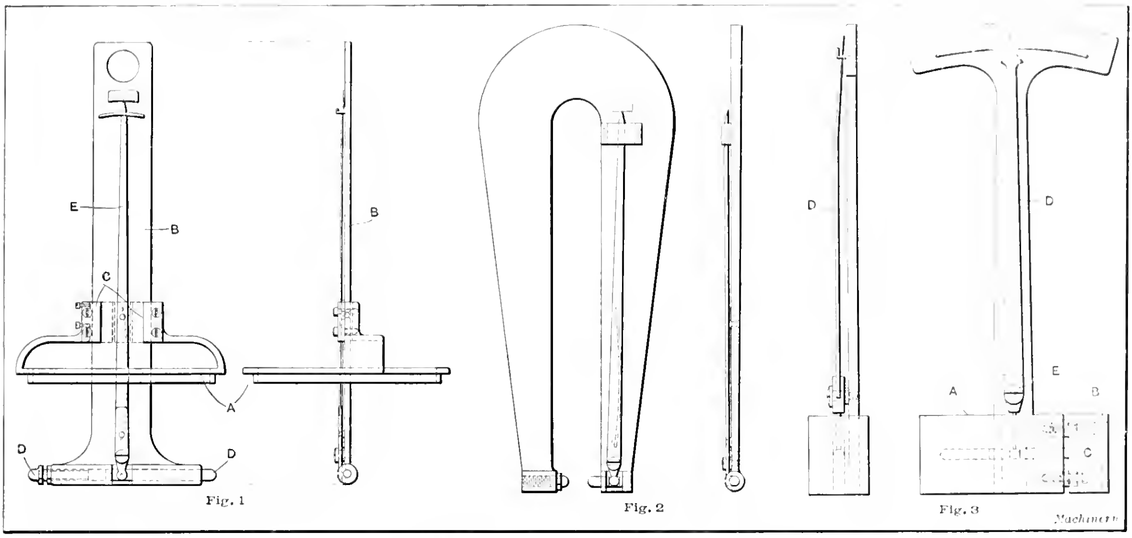

Fig. 1. Gage for testing Squareness between Cylinder Flange and Bore. Fig. 2. Gage for testing Parallelism of Wall between Adjacent Bores. Fig. 3. Gage which shows whether Bore is Cylindrical or Tapering

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The gage shown in Fig. 4 is very elaborate and is an extensive improvement over the type shown in Fig. 1. It was designed for use on cylinders varying from 4 to 5 inches in diameter, and gave fairly accurate results, but its use under ordinary circumstances would be prohibitive owing to high cost and complicated construction. The body *A* is made in two pieces to allow machining a dovetailed bearing for the gage slide; the latter has a gib for adjustment and a knurled knob at the top (see plan view) by which the slide is operated vertically. When anvil *C* is in contact with the cylinder wall, any variation in the squareness or size of the bore is shown by pointer *D*, which, through the lever *E*, multiplies the variation twenty-five times. The set-screws *G* are used to adjust the gage for different cylinder diameters. The spring *F* keeps anvil *C* in contact with the cylinder bore. The gage is located on the cylinder by means of two stationary pins *H* and the adjustable pin *J*, which is fastened to rod *K*. The latter is controlled by a spring lever *L* as shown in the plan view. To insure the gage being square with the cylinder flange, pins *M* and knife-edge plate *N* are so located that they will give sufficient bearing on the cylinder, but dirt and chips are not likely to get under the gage and throw it out of alignment, because of the small bearing surfaces.

The gage illustrated in Fig. 5 is simple and effective for a given size cylinder. The cylindrical cast-iron body *A* (see also plan view) is made to fit the cylinder bore and is attached to a seamless tube *B* which acts as a pilot for the knife-gage *C*.

The body *A* is placed into the cylinder bore with pilot *B* extending upward, and square *C* is moved down until it comes in contact with the cylinder flange; tissue paper or steel "feelers" are then used to determine the error between the bore and flange. Square *C* is provided with clamp-screws to take up the wear on tube *B*.

The final result of much experimenting is represented by

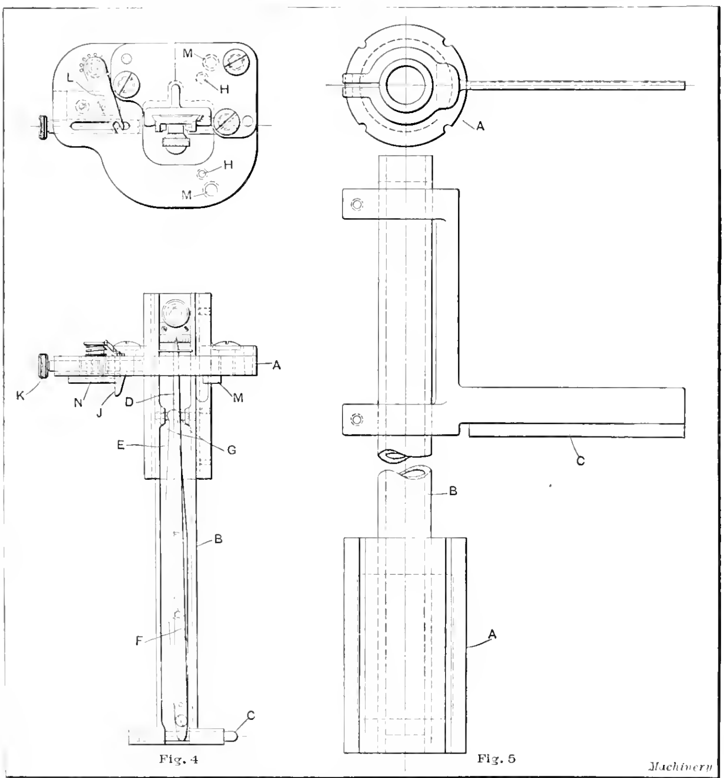

Fig. 4. Expensive and Complicated Type of Gage. Fig. 5. Simple Form of Gage for testing Squareness of Bore

the gage shown in Fig. 6. This gage can be used in various size cylinders, without changes or adjustments, and is simple, cheap and accurate. There are only four principal parts, *viz.*, the base *A*, lever support *B*, and lever pivot *C*, and the indicating lever *D*. The body of this gage is made in two parts to facilitate machining. The indicating lever support is fastened to the body with cap-screws and dowel pins, and extends into the cylinder, so that the center of the lever pivot is somewhat below the face of the flange, as shown. By placing the

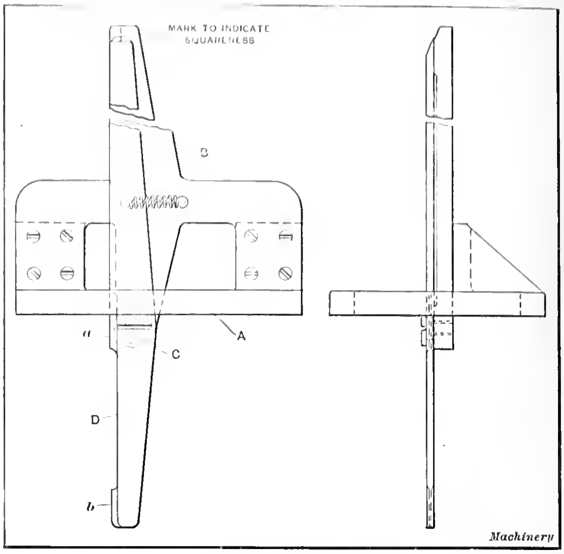

Fig. 6. Simple Design of Gage applicable to Any Size of Cylinder for testing Squareness of Bore

gage on the cylinder flange and bringing the knife-edges *a* and *b* of the lever into contact with the cylinder wall, any variation is shown by the mark at the upper end of the gage. The center of pivot *C* is placed below the face of the cylinder flange, so that when the indicating arm is moved against one side of the cylinder bore, the thrust will be taken directly by this pivot; as the lower end of the lever is held against the cylinder wall by a spring above the pivot, contact is insured at both points. This gage has solved the problem of testing cylinder bores, and it is in daily use in a factory where thousands of cylinders are produced every month.

* * *

WATERPROOFING CONCRETE

The College of Engineering of the University of Wisconsin is conducting a series of tests on the permeability of concrete. The object of the tests is to find a simple means of making concrete water-tight. The work shows that there is considerable difference in the imperviousness of concrete when the sand is dry and when the sand is wet before mixing. Good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed, but when the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. Experiments showed that mixtures consisting of 1 part cement, 1½ part Janesville sand of the "torpedo" grade and 3 parts Janesville gravel, when mixed to a wet consistency, are impervious to water under a pressure of 40 pounds per square inch. Mixtures as lean as 1 part of cement to 6 parts of gravel (graded mixture) have been made impervious by using care in proportioning the amount of water.

* * *

More than 800,000 horsepower has been developed from streams on national forests under government regulation. This is the output under conditions of lowest stream-flow.

MILLING FIXTURE FOR ANGULAR WORK

BY L. J.

The fixture which it is the purpose of this article to describe was designed for milling the sides of the block shown in Fig. 1. Three operations are involved; the parallel sides *A* are milled by means of the straddle cutters and the two sides *B* and *C* are then milled in two subsequent operations. These three operations are all performed without requiring more than one setting of the work. The block is cut off from bar stock, and drilled and counterbored to receive two fillister head screws which hold it in place on the machine of which it forms a part. These holes are also utilized for holding the block in position on the fixture.

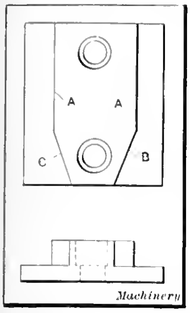

Fig. 1. Piece to have Sides A, B and C milled

Fig. 2 shows plan and sectional views of the milling fixture which consists of an upper plate *A* which is pivoted on the stud *B*. This stud is mounted in the cross-slide *C* which runs on the base *D*. The plate *A* is provided with two tapped steel bushings which are a forced fit in holes drilled and counterbored for the purpose. These bushings receive the two screws which secure the work in position on the fixture, their purpose being to prevent the rapid wear of the threads which would take place if they were tapped directly into the cast iron. Fig. 2 shows the fixture set in position for milling the parallel sides *A* of the work. Referring to the illustration it will be seen that there are two tapered pins *E* and *F* which are used for locating the work in the required position. For milling the parallel sides of the work, the pin *F* is inserted in the hole *N* to locate the cross-slide *C* in the required position. Similarly the pin *E* is located in the central hole to locate the swivel plate *A*. These pins are merely used to locate the fixture, the bolts *G* and *H* being provided to secure it in the required position. Fig. 3 shows an end sectional view of the fixture set in the same position as in Fig. 2, and by referring to this illustration a better idea of the operation of the fixture will be obtained.

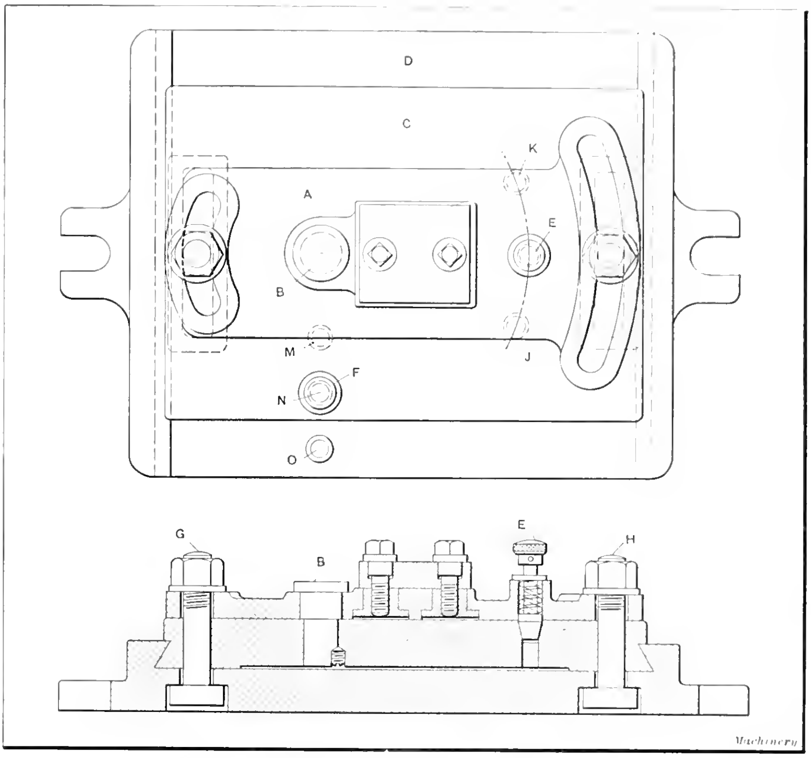

Fig. 2. Plan and Sectional Views of the Milling Attachment

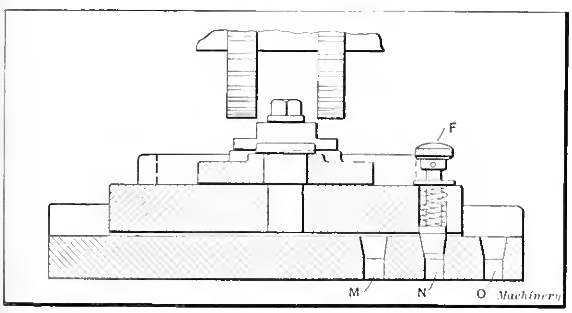

Fig. 3. Attachment set for milling Sides A of the Work

Fig. 4 shows an end sectional view of the fixture set for milling the angular side *C* of the work. For this purpose the pin *E* is inserted in the hole *J* and pin *F* in the hole *O*. This sets the swivel plate *A* at the required angle and also locates the cross-slide *C* at the required distance off center to enable the work to be milled by the outer edge of the cutter, as shown in Fig. 4. After this operation has been completed the swivel plate *A* is swung over to enable the pin *E* to enter the hole *K*. Similarly the cross-slide *C* is moved so that the pin *F* will enter the hole *M*. This brings the work in position to enable the angular side *B* to be milled by the outer edge of the other cutter on the arbor.

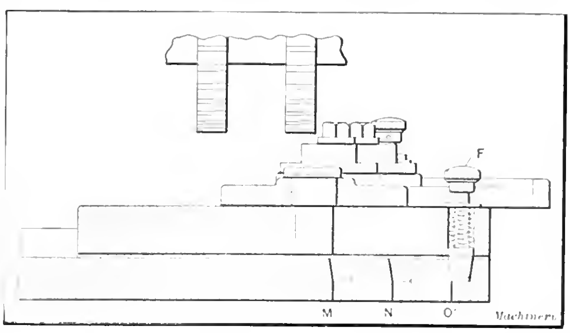

Fig. 4. Attachment set for milling Side C

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LARGE HYDRO-ELECTRIC POWER DEVELOPMENT

The Chattanooga & Tennessee River Power Co.'s hydro-electric development at Hale's Bar on the Tennessee River near Chattanooga was formally opened and dedicated November 13. This is the largest hydro-electric power development in the South and one of the four greatest in this country, ranking with those at Keokuk and Niagara Falls. The power dam and lock were designed and constructed under the supervision of the U. S. Government Engineers at a cost of $9,000,000 and seven years was required to complete them. The length of the dam is 1200 feet and the lock is the highest single lift in the world, the height of the down stream gates being 58 feet. The lock, inside, is 60 by 310 feet and the power house 356 feet long; 65,000 H. P. will be generated.

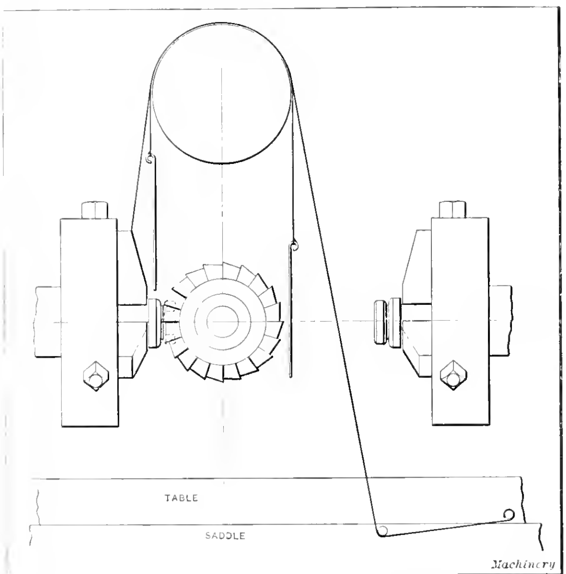
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A PROBLEM IN "HEXING"

In the How and Why section of the October number of MACHINERY H. L. B. asked for information concerning a good and cheap method of forming hexagons on machine steel pieces. A multiple jig for milling hexagons on six pieces simultaneously was illustrated and described in MACHINERY some time ago. Aside from the expense of making a jig of this nature, the time required for loading the jig, indexing and removing the finished work is so high, as compared with the actual time required for milling, that the output is not as great as might be expected. The following method requires no special tools or equipment, aside from the guards which protect the operator's hands while setting up the work in the chucks, and if a milling machine is used which has a feed reverse in the table, a close approach to continuous milling is obtained.

The two chucks shown in the illustration are mounted on plain index heads, and a pair of 3½- or 4-inch straddle milling cutters are set up on the arbor of the machine. The guard plates and cords for protecting the operator's hands while setting up work are shown more with the idea of suggesting what is necessary in this way than with the view of presenting a final solution of this part of the problem. Some more rigid device would be desirable, the only essential feature being that the plates should be moved into place and withdrawn alternately, in order to have the plate interposed between the milling cutters and the chuck in which a fresh blank is to be placed. The heads should be set as close together as possible, just sufficient room being allowed to provide for inserting the blanks and removing finished pieces. For the work that H. L. B. refers to, a 2½- or 3-inch movement of the table ought to be ample. It will be evident that the cutters will be working on the piece held in one of the chucks while the other piece is being indexed or while a finished part is being removed and replaced with a fresh blank.

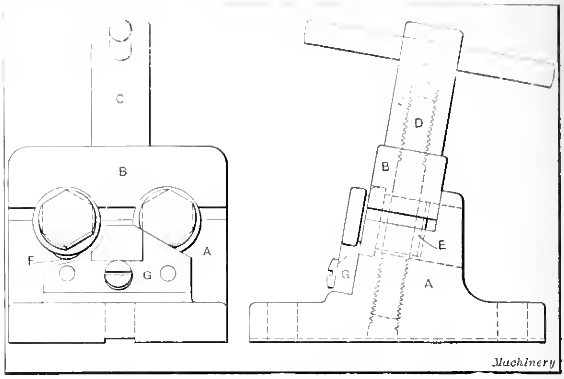


Method of hexing Work where Two Single Chucks are used

Philadelphia, Pa. C. W. PITMAN

The writer believes that H. L. B. would find the use of two milling fixtures of the type shown in the accompanying illustration to constitute a satisfactory solution of his problem in hexing. Referring to the illustration, it will be seen that the fixture consists of a body *A* in which two pieces of work are held by the clamping cap *B*. The method by which this cap is tightened through a nut *C*, that is turned on the stud *D* by means of a handle, will be evident from the illustration. A coiled spring *E* is provided to lift the cap off the work when the nut is released. The holes in which the two pieces of work rest are bored all the way through and counterbored to receive the large diameter of the work; the shoulder at the bottom of the counterbore serves as a stop and the thrust of the cut is carried by it. It will be seen that the two holes are grooved as shown at *F* in order to afford a better grip on the work.

The locating plate *G* is removed while performing the first operation, although it need only be removed from one of the fixtures. As the work comes from this fixture, the pieces are set up in the other fixture to have the second operation performed on them. When a sufficient number of pieces has accumulated, the locating plate *G* is replaced and both fixtures are used for performing the third operation, which finishes the work.



Method of hexing Four Pieces of Work held in Two Opposed Chucks

Two pairs of straddle milling cutters of about 3½ inches diameter by about ⅜ inch face are used. The inner pair of cutters works in the slot in the plate *G* while the outer pair works at either edge of the plate. The cutters are narrow enough to clear the screw which holds the plate *G* in position on the fixture, and their diameter is such that it is just possible to mill the "hex" without interfering with the flange on the work. The object of inclining the fixture is to provide greater convenience of operation which includes ease of cleaning, more room between the clamping handle and the overhanging arm of the milling machine and a better view of the work.

The fixtures are bolted to the table so that they face each other at either side of the spindle. They are located as close to the spindle as it is possible to have them and still provide room to safely remove the machined plugs and insert fresh blanks while the cutters are operating on the work in the opposite fixture. The power feed of the table is tripped by the regular feed-stops which are applied when the cutters have finished their work on the "hex." At this point the cutter will be within about 1/32 inch of the flange on the work, but although there is little room to spare, it is entirely practicable to operate a machine that is in good condition in this way. When one side of the milling cutters becomes dull, they can be reversed on the arbor, thus increasing the length of time that they can be used between grindings.

Watervliet, N. Y. MARTIN H. BALL

In reply to H. L. B.'s problem in hexing presented in the How and Why section of the October number of MACHINERY, I offer the following solution. The method has the distinction of being cheap when the possible output is considered, and may also be of value in suggesting a still better method. The fixture used for this purpose is shown in Fig. 1, where it will

be seen to consist essentially of two plates *A* and *B*. The upper plate is drilled to receive thirty-six studs, upon each of which a piece of work can be mounted. The base is provided with four lugs *C* by which it can be bolted to the table of the milling machine, and the upper plate is held down by means of three bolts *D* fitting in lugs on the upper and lower plates.

Each row of pieces is milled by straddle cutters and after two sides of the hexagon have been finished in this way, the work is indexed through 60 degrees by means of the taper pin *E* which fits into either of six holes in the base of the fixture. Three holes would really suffice for this purpose, but six are used in order to distribute as far as possible any wear which would develop. It will also be noticed from the illustration that there are cored recesses *F* under the holes in the base of the fixture which provide for the use of a drift to force out the index pin. A projection *G* on the plate *A* extends into an opening in the base *B* in order to hold the two plates in alignment while they are being indexed.

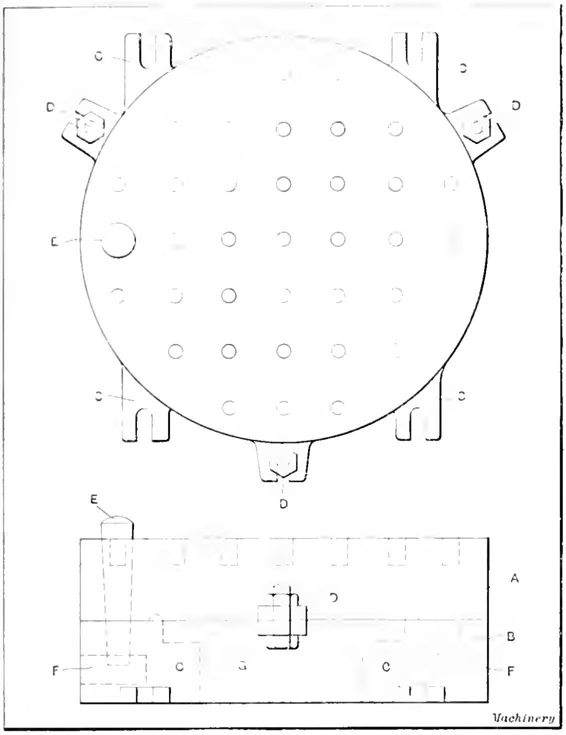


Fig. 1. Design of Multiple Fixture for milling Hexagons

Several methods may be used for holding the work in position on the fixture. One of the simplest devices for this purpose consists of the use of studs over which the work is slipped and held by a nut and washer. A convenient form of stud for this purpose is shown in detail at *B* in Fig. 2. The nut on this stud is made of such a size that the work will slip over it. It will be seen that the washer has a slot milled in it so that it may be slipped into place without requiring the nut to be screwed all the way off the stud. This greatly facilitates the rapidity with which the work may be set up or removed. The studs should be hardened and ground to increase their durability, and it is a good plan to use a bushing in the counterbore of the work, in order to provide for having it held snugly on the stud. Another good method of holding the work in place is by means of split bushings of the form shown at *A* in Fig. 2. These bushings are an accurate fit in the bore of the work and extend into reamed holes in the face of the fixture. When the work has been set up on these bushings, taper pins are driven in, which expand the bushings and hold the work securely in place. If this method is used, the upper plate *A* would be considerably thicker and provided with cored recesses to permit drift pins to be used for ejecting the taper pins.

A similar arrangement of simpler design could be made by mounting five studs in a bar to provide for milling five pieces simultaneously. A bar with the work mounted on it would be placed in the milling machine vise and the work milled by means of straddle cutters. After taking the first cut, the vise—which must have a graduated base—is swung through 60 degrees, after which the second cut is taken. The vise is then swung back through 120 degrees to locate the work ready for taking the third cut, which completes the operation. This method has nothing to recommend it but the reduction in the initial cost of the fixture.

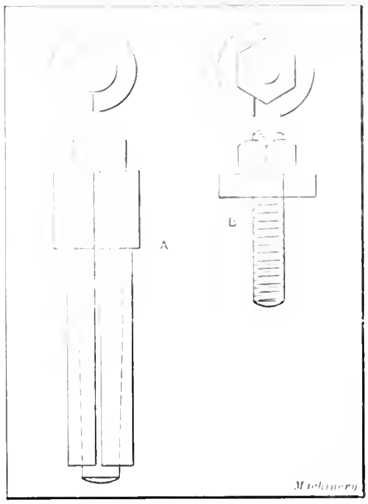


Fig. 2. Details of Two Methods of holding Work

Stillwater, Minn. R. C. MacLachlan

Some time ago the writer saw a hydraulic press rigged up for making semi-steel gears, and it appears that the same idea might be used to advantage in solving H. L. B.'s problem in hexing, which was presented in the October number of Machinery. The writer has not had any experience with this particular class of work, but a wide experience in toolmaking leads him to believe that it would be entirely practicable. The design for a die for handling this operation was taken up in exactly the same way that any other new operation coming into the shop would be handled, the idea being to turn out the work with the least possible expense for tools and labor.

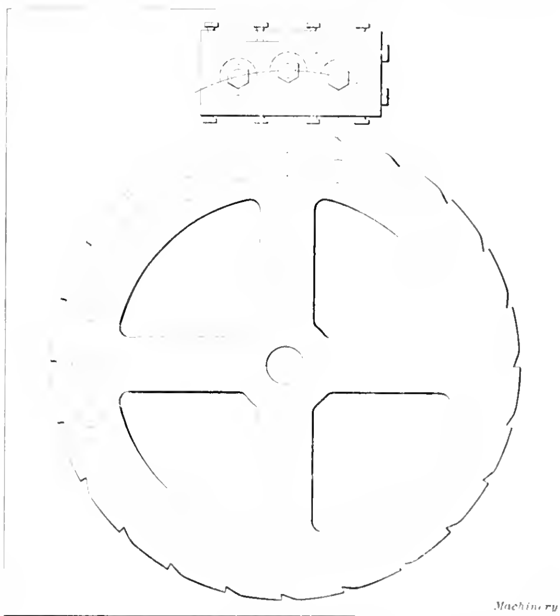


Fig. 1. Method of producing Hexagonal Heads in a Power Press

The preliminary work in producing these pieces would be an ordinary screw machine job, the order of operations being to form the piece, drill the small hole, counterbore and then cut off. After the pieces had been produced in this way, they would be transferred to a punch press equipped with dial feed and a die of the kind shown in Fig. 1. A detailed view of this die is illustrated in Fig. 2, from which its construction will

be better understood. Referring to this illustration, it will be seen that there are three openings in the die laid out on a circle of the same radius as that of the circle on which the work is set up on the dial of the punch press.

From the dimensions given by R. L. B., it appears that there is about 5/64 inch of metal to be removed from the sides of the "hex." To get a good finish, it would be desirable to take this cut in three steps: first roughing cut, 1/32 inch; second roughing cut, 1/32 inch; finishing cut, 1/64 inch. The three dies are graduated in sizes to take these three cuts. The dial is indexed by means of the usual ratchet mechanism so that the work is advanced from die to die between strokes. In this way one piece of work will be finished at each stroke of the press after the first two strokes have been made. It would be entirely practicable to rig up some form of ejecting mechanism which would knock the finished pieces of work out of the dial. With such an arrangement the operator would merely have to sit in front of the press and mount blanks in the holes which had been left vacant by the removal of the finished pieces of work.

Referring to Fig. 2, it will be seen that the three dies are equipped with pilots which assist in holding the die in the desired alignment. It will also be seen that each die is provided with a stripper which is backed up by a stiff spiral spring that ejects the scrap from the die after each stroke. The stripper also serves to hold the work in place in the index wheel. In producing "hexes" in this way, it would doubtless be a good plan to have two dies to fit into the punch-holder. With such an arrangement one die could be sent to the tool-room to be sharpened and the other set up in position so that

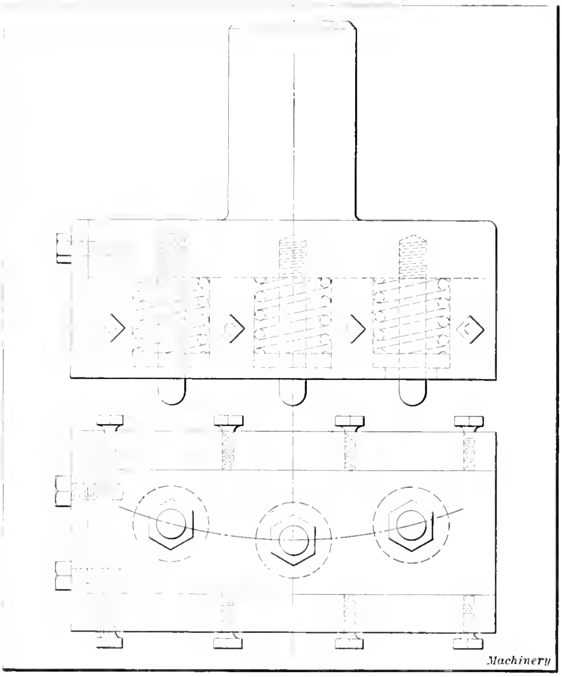


Fig. 2. Design of the Hexing Die

no loss of time would result. The end stop on the holder facilitates bringing the die blank into the desired alignment with the least possible loss of time.

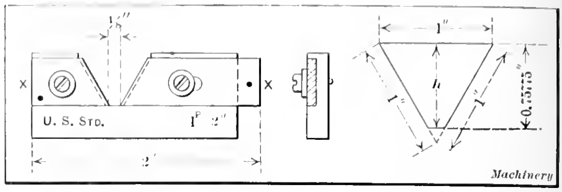
Beloit, Wis. O. F. Philler

[Suggestions for methods of handling this operation were also received from James R. Allan, Chicago, Ill.; Walter Butz, Pearl River, N. Y.; W. J. Kittle, Pearl River, N. Y.; P. S. Souders, Rockford, Ill.; E. Wanamaker, West Haven, Conn., and O. A. Webster, Readville, Mass.—Editor]

U. S. STANDARD THREAD TOOL GAGE

As most mechanics know, the U. S. standard thread has a 60 degree included angle and a flat at the top and bottom equalling 1/8 of the pitch. This means that the depth of a U. S. standard thread of a given pitch is equal to 3/4 the depth of an ordinary V thread of the same pitch. It will be evident from the preceding that a thread of 1-inch pitch has a 1/8-inch flat at the top and bottom, and this is taken as the basis in constructing the present gage.

The decimal equivalent of 1/8 is 0.125. Suppose it is attempted to divide this number by 8 in order to obtain the flat on a U. S. standard thread tool with eight threads to the inch. The length of the flats in this case will be found to be 0.015625 inch, but it would be very difficult to make an accurate gage for a thread tool of this size. This difficulty has been entirely avoided by using a thread of 1 inch pitch for the basis in making the gage. Referring to the illus-



U. S. Standard Thread Tool Gage and Templet used for setting

tration, it will be seen that the gage consists of a body which has one jaw secured to it by a screw and pin. The other jaw is secured by a screw which passes through a slot in the jaw, so that this jaw may be adjusted longitudinally to adapt the gage for different pitches. The jaws run in a slot machined in the body of the gage so that they are kept in the desired alignment, and the end of the tool is brought up against the body. The gage is set for different pitches by measuring the distance between the outside ends of the jaws with a micrometer.

In order to obtain the proper location of the angular sides of the two jaws when they are together for a one-pitch V-thread or open for a U. S. standard thread tool of the same size, a templet was made of the form shown at the right-hand side of the illustration. This templet was first made an accurate equilateral triangle with sides 1 inch long, and one point was then cut off to make the height h exactly 0.75775 inch. The jaws were then adjusted so that they fitted against this templet with one of the sharp points in position, which corresponded to the setting for an ordinary V-thread, and with the cut-off point in position when the setting is that for a U. S. standard one-pitch thread tool. When set for a one-pitch V-thread, the distance between the ends of the jaws, as obtained with the micrometer, is 1.875 inch; and for a one-pitch U. S. standard thread, 2 inches.

A convenient method of setting the gage is to open it a small amount more than is required and then partially tighten the screw which holds the movable jaw. The micrometer is then put over the ends of the gage and screwed up to the required dimension, carrying the movable jaw with it. After the setting has been obtained in this way, the binding screw which holds the movable jaw is tightened up. It will be evident from this description that the gage is easily set by any man who knows how to use a micrometer.

Springfield, Mass. Francis W. Clough

SETTING DIAMONDS

I have read with much interest the short articles which have been published in Machinery relating to methods of setting diamonds. After trying nearly all of these, I decided that setting the diamond in a piece of copper and forging the metal tight around the stone was the most satisfactory for average shop conditions. We use a large number of small diamonds for scoring glass tumblers before they are put into the heat to be cracked off. These diamonds require careful setting as they must make a clean accurate mark.

I would be interested to hear from readers of Machinery what they have found to be the best method of selecting a diamond. This, to my mind, is of more importance than the method of setting. My own practice has been to look at the stones carefully under a magnifying glass and choose those that are the closest grained and of a glossy black appearance.

Some black diamonds are just like pieces of coke—full of small pores. I once set one of these stones that cost $60 and it ground away like graphite. What I would like to know is whether the color has anything to do with the quality of the stone because in all of the different diamonds that I have looked at, the color varied from a deep black down to a dark gray. By way of conclusion, I would say that I have not yet met an agent who would guarantee a diamond.

Bridgewater, Pa. J. TOWLER

ON CLEANING MACHINES

Some time ago I read about a technical school workshop in which the machines were all finished in white enamel. I should like to know if the boys keep these machines clean, or if the cleaning is done by a special attendant. So far as my experience goes, it is about as difficult to teach a boy to clean a machine tool and leave it in passable order at the close of a lesson as it is to teach him anything else.

Finally it began to dawn on me that I was expecting too much from the boys. I saw girls being put through an elaborate course of training, requiring many months, a large part of which consisted in teaching them to keep a house, its furniture and utensils clean. They were drilled in the washing of dishes, pots, pans and tables, day after day, until in place of the gawky little slatterns who entered school a year before, you were dazzled with the trim smart capable young persons who would strike terror into the heart of any ruffian who dared to enter a house without first leaving his boots on the mat outside.

Evidently, the boys needed more elaborate drilling in the cleaning and general order of machines and tools, even though it shortened the time available for their regular work. Such training is most important, however, as a machine which is kept clean and tidy gives less trouble and lasts longer than one which is neglected. A good illustration of this was afforded me a number of years ago, when I was sent to repair a small steam engine which was continually breaking down. I found it located in a dark and dirty shed, smothered in old grease and soot. I gave the attendant a few scrapers and started him on the job of cleaning it while I dismantled the defective parts. After a few hours' work, he announced that it was clean. I directed his attention to parts on which he had not reached the original coat of paint, and he started again. This process was repeated several times during the period the engine was under repair. At last he began to take notice of things himself, and, to my gratification, suggested cleaning and whitewashing the shed and giving the engine a coat of paint. This was done and I left him in charge of an engine which he had cleaned and painted and polished, and of which he was proud. That engine gave no more trouble until it was superseded by a more powerful one some years later.

Christchurch, New Zealand. JOHN PEDDIE

LUBRICANT FOR WORM-GEARS

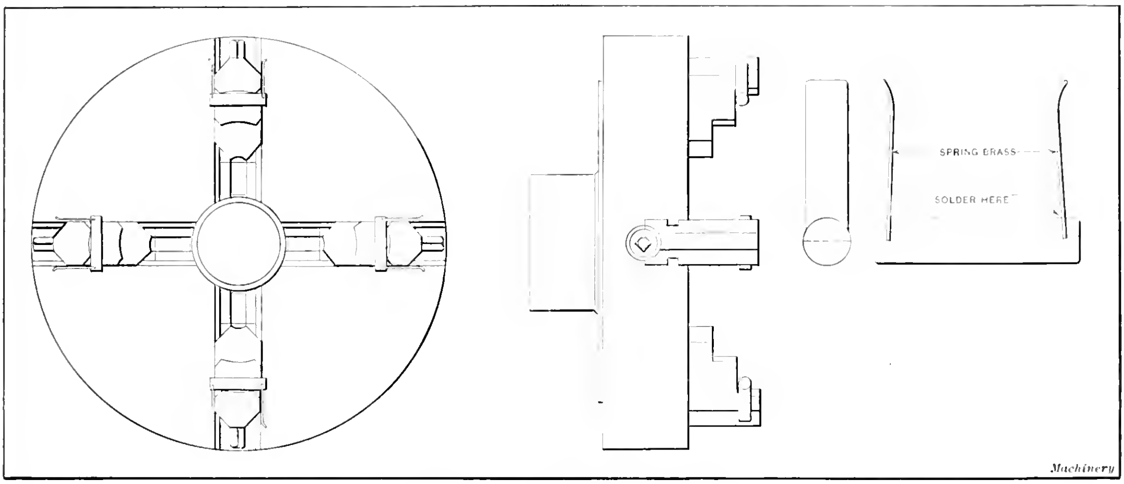
No doubt many readers of MACHINERY have had trouble with worm-gears even in cases where the gears ran in oil. In the majority of installations, the worms are cut from steel while the worm-wheels are of cast iron. The writer has had a lot of experience with worm-geared elevator hoists and gives below a very satisfactory formula for a lubricant which is composed of the following ingredients: Cylinder oil, 2 gallons; common flour, 1 pound; common salt, ½ pound.

It will be found that the flour will make the oil heavy enough to stick while the salt will so glaze the worm and gear that they will run smoothly without any tendency to "score." In extreme cases, where the worm-gear runs hot, owing to continuous and fast running and to friction, it is sometimes advisable to add to the above ½ pound of graphite. The lubricating and cooling properties of graphite are too well known to require discussion. Anyone who has had trouble with worm-gearing will find this lubricant well worth trying.

Decatur, Ind. HARRY FRITZINGER

LATHE JAW DISTANCE PIECES

Machinists, and especially toolmakers, frequently have occasion to set up a job with the work set out from the faces of the lathe jaws. Distance pieces are commonly used for this purpose and various methods are resorted to in order to hold them in place. The accompanying illustration shows the type of distance pieces that I have used for a number of years. They are made from pieces of round drill rod 5/16 inch in diameter and about ¼ inch longer than the width of the chuck jaws. A slot is sawed half way through the drill rod at each end and flat strips of brass are soldered into these slots. The brass pieces are bent to the form shown in the illustration, so that they grip the chuck jaws firmly enough to hold the distance pieces in place.



Convenient Form of Lathe Jaw Distance Pieces

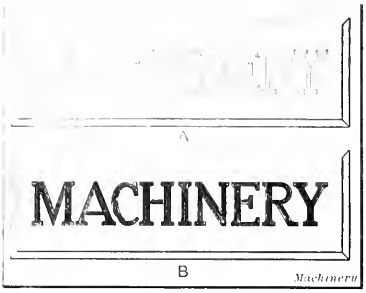
Delphos, Ohio. A. J. BRICKNER

IMPROVED METHOD OF MARKING MACHINE PARTS AND TOOLS

The method of marking machine parts, referred to in this article, is for producing brass letters, numbers, designs, etc., on steel, iron and brass. In addition, this method is very effective for making name-plates, such as are used on front doors of apartment houses and hotels. The desired result may be obtained in various ways, a few of which are given in the following:

The first step is to see that the part to be marked has a true surface, free from rust and dents. The name, or number, is stamped on the work by means of steel letters, or a steel stamp as indicated at *A* in the illustration. The only precaution necessary to take in stamping the letters or num-

bers, is to have them as deep as possible and all of the same depth. A coating of molten brass is next distributed over the entire surface of the work by the common process of brazing, plenty of flux being used. The work is then allowed to cool, after which it is ground on a grinding machine, or by other means, in order to remove the surplus brass from the surface. This operation leaves the brass only in the letters or numbers that have been previously stamped on the work. After the surface is polished in the usual manner, the letters present a very pleasing appearance. The view *B* illustrates the plate after grinding. If it is desirable to give the letters a bronze appearance, the work, after polishing, should be immersed for a few seconds in a solution of equal parts of nitric and hydrochloric acids.



(A) Stamped Name-plate
(B) Stamped Name-plate with Brazed Brass Letters

Another method is to first outline with a pencil, the name or design, on the surface of the steel or iron to be marked. The outline is then gone over carefully with a center punch, the punch marks being made as close together as possible without touching, and about one-sixteenth inch deep. After the work is brazed and polished, as previously explained, the letters have the appearance of being formed of inserted brass plugs.

Still another method is to etch the name or design on the steel, by means of a suitable acid, after which the foregoing procedure is followed. It is necessary with this method, to boil the work for a few minutes, in soda water, before brazing, to remove any trace of the acid from the letters or design.

To stamp brass with "steel" letters, the same method may be employed, with the exception that solder is used to fill up the letters. Any common soldering acid or paste may be used as a flux for this purpose.

The methods given in this article, may, of course, be changed somewhat to suit requirements, and many new methods substituted; the work will be found very attractive, and *"out of the ordinary."*

East Orange, N. J. GEORGE GARRISON

AUTOMOBILE REAR AXLE DESIGN

I have just finished reading the article entitled "Automobile Rear Axle Design" that appeared in the September number of MACHINERY and have several criticisms to offer. The equations that appear immediately above Fig. 4 should read:

$$TI = Q\,r\,\mu$$

and for one wheel

$$\frac{TI}{2} = \frac{Q\,r\,\mu}{2}$$

Some designers make a great mistake in assuming that if one wheel is locked by the greater frictional resistance of the road or by getting wedged in a narrow rut, the other wheel takes the full torque TI. Such is not the case. When one wheel is completely locked, the differential mechanism causes the other wheel to rotate at twice its ordinary speed, and hence the torque drops to $\frac{TI}{2}$.

In the equation below Fig. 5, the coefficient ½ should be inside the parentheses, as it does not refer to the tension of the driving chain. But the quantities $\frac{Q\,r\,\mu}{2}$ and the tension of the driving chain cannot be added together, as they are different quantities, the first being a moment expressed in inch-pounds and the second a force expressed in pounds. If anything, this expression should be:

$$M_2 = A_2\left(\frac{Q\,\mu}{2} + \text{tension of driving chain.}\right)$$

The $\frac{Q\,\mu\,A_2}{2}$ is all right but the tension of the driving chain should be multiplied by a lever arm A_3, which is the distance from the center line of the chain to the center line of the radius rod, as shown in Fig. 2. Then

$$M_2 = \frac{Q\,r\,\mu\,A_2}{2}$$

$$M_3 = \text{tension of driving chain} \times A_3$$

The resultant bending moment M of the axle is then given by the following:

$$M = \sqrt{(M_2 + M_3)^2 + M_1^2}$$

Further on in the article the expression occurs:

$$\text{Torque of ball} = \frac{43{,}200}{60} = 720 \text{ pounds.}$$

The term "pressure" should be used in place of "torque." If the quantity was a torque, the result would be expressed in inch-pounds.

I do not agree with the way in which the force F on the housing pin is figured. As shown in Fig. 5, the torque rod, the housing torque boss, and the torque rod pin form the familiar type of hinge construction. As such, the pin is subject to a shearing stress in the planes of the joint, which are found to be 7.5 inches apart by scaling the drawing. Regarded in this light, the magnitude of the shearing force will be:

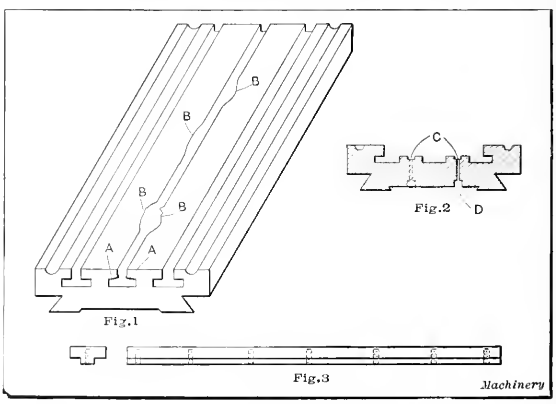
$$F = \frac{720 \times 56\tfrac{3}{8}}{7.5} = 5400 \text{ pounds.}$$

Mr. Najder does not state whether he regards the stress as a bending or a shearing stress, but as he uses the distance of 10.75 inches between the centers of the bearings supporting the pin, it appears that he is figuring for bending. As a matter of fact, there can be no bending action on the housing pin, as it invariably forms a press fit in the torque rod and a nice sliding fit in the housing torque boss, which is generally lined with an accurately reamed bronze bushing. If Mr. Najder had a shearing force in mind, the illustration is wrong; and if the illustration is right, he must have based his analysis upon the assumption that the pin was subjected to a bending stress.

Flint, Mich. M. TERRY

REPAIRING A MILLING MACHINE TABLE

The milling machine table shown in Fig. 1 has been broken at *A* and *B* through the use of common bolts for clamping the work in position. Tables are frequently damaged in this



Figs. 1 to 3. Method of repairing a Broken Milling Machine Table

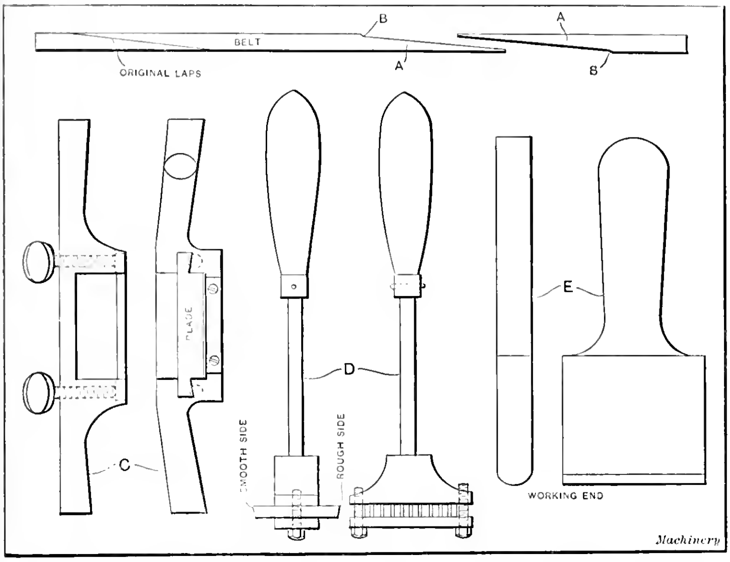
way when the remainder of the machine is in good condition; hence a method of making a satisfactory repair is of considerable value. The method which I developed for this purpose may be briefly described as follows: The two bars which form the T-slots were planed off, after which two

grooves were planed as shown at *C* in the sectional view, Fig. 2. Two bars shown in Fig. 3 were next planed up with extensions to fit into the grooves *C* in the table. When this work had been done, the table was turned over and the bars put in place under it, after which seven holes *D* were drilled and tapped in each bar to provide for holding the bars in place by countersunk screws. Hexagon cap-screws were used for this purpose. With the bars secured to the table in this way, a very satisfactory repair was made

New York City. MAX HIMOFF

PREPARING AND CEMENTING BELTS

The cementing of endless belts—either new ones or old ones that have parted in service—is not as well understood as it might be by the average mechanic. With the view of explaining the method of procedure in cementing belts for the benefit of men employed in shops where there is no regular repair man, the following article has been written. In order to prepare an old belt that is greasy, the first step is to clean is thoroughly by soaking in benzine for about fifteen minutes. The belt is then laid out flat on a board or bench to allow it to dry. The ends that are to be joined should be further cleaned by placing blotting paper over and under them and then applying a hot iron to soften the grease so that it will be absorbed by the blotting paper. It is, of course, understood that a clean new belt does not require this treatment.



Method of forming Belt Laps and Tools used for the Forming and Cementing Operations

In the case of a new belt, the belt should be fastened to a board or bench and the ends beveled as shown at *A*, the tools *C* and *D* being used for this purpose. The tool *C* is employed to rough down the ends to shape and the smooth side of *D* is used to scrape the end of the lap to produce the shoulder *B*. The rough side of the tool is then brought into action to rough the surfaces to be joined so that they will take the cement. In beveling the ends of the belt, care should be taken to see that the finished lap will run in the same direction as the original lap in the belt, the length of the lap being determined from the length of the original lap of the old belt.

A good cement for joining the ends of a belt is cheapest, as a cheap cement is dear at any price. A good cement can be made from the following formula: Peter Cooper's white glue, 1 pound; powdered white lead, 1 ounce.

This glue is heated in a double boiler and thoroughly stirred until it forms a thick paste. Before using, the paste is thinned down the required amount with grain alcohol until a thin paste is formed. This paste is applied hot. After joining the ends of the belt, the joint is rubbed with the end of the wooden spatula *E*, taking care to apply pressure over the entire lap. Two small pieces of board can be clamped or nailed over the joint, after which the belt is placed in a warm, dry corner away from drafts. The joint should be allowed twenty-four hours to set before it is used.

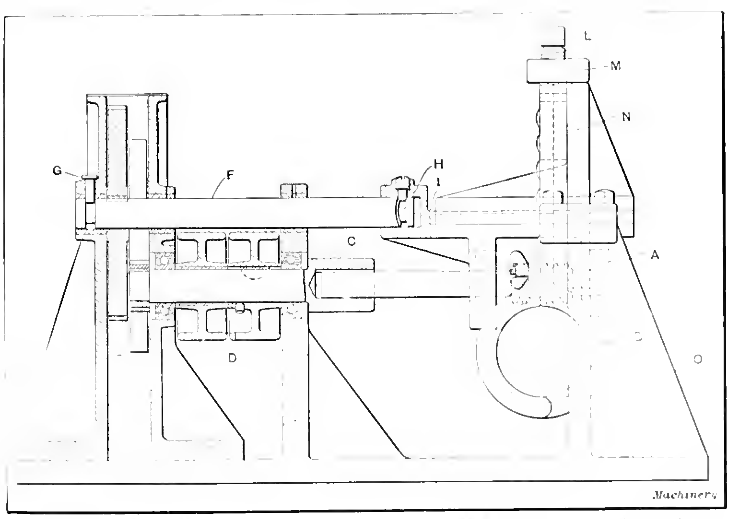
New Britain, Conn. W. C. BETZ

WORM AND WORM-WHEEL LAPPING FIXTURE

There is no part of an automobile that requires more careful attention than the steering gears. It is essential for these gears to be designed to meet the requirements of the particular car on which they are to be used, and to keep the cost of production within certain limits. There are several types of steering gears that may be used, among which may be mentioned the worm and segment, the bevel gear and bevel segment and bevel gears. The most universally used type is the worm and worm-wheel.

In manufacturing these gears the best grade of high-carbon machine steel, nickel steel, chrome-nickel or chrome-vanadium steel is used. These steels all forge well and are easily machined. They are always carbonized and hardened to give the greatest strength and wearing qualities. It is during this hardening process that strains are set up which cause the steel to warp. No matter how accurately the parts may have been machined, they will be distorted by the heat-treatment to such an extent that many cannot be used. It was to overcome this distortion that the fixture shown in the accompanying illustration was designed. By grinding or lapping the worm and worm-wheel together, it was found that the uneven spots which caused the steering wheel to turn harder in one position than another were removed, and the wheel would then turn smoothly and easily.

After a worm and worm-wheel have been used on a car for some time, it is necessary to adjust the worm and wheel to take up end motion. Therefore it is essential for more than one thread on the worm to be lapped to the wheel. It is for performing this lapping operation that the present fixture was designed. For this purpose the worm is placed



Fixture for lapping a Worm and Worm-wheel to insure having them run smoothly together

in the fixture at A and the wheel at B. The end of the worm-shaft is fitted to the driving shaft C; this driving shaft carries tight and loose pulleys D and a small gear which engages the train of gears E that operate the shaft F. The gears E run in an oil bath formed by means of the upright members of the fixture. The pin G fits in a groove at the left-hand end of the shaft F and prevents it from moving in an endwise direction, while a cam H is cut at the opposite end of the shaft F; this cam operates the slide I in which the worm is mounted. By means of this cam the worm receives an oscillating motion which laps enough of the thread to allow adjustment between the worm and wheel.

The worm-wheel is also clamped in an adjustable slide which is provided to allow various sized worm-wheels to be lapped in the fixture. Gibs provide an ample bearing for this slide, which is operated by the screw L which runs in the plate M. The casting N supports the gibs and forms the dovetailed bearing for the slide I. The base casting of the fixture is shown at O.

In using this fixture the worm is driven at about fifty revolutions per minute, and the gear reduction is such that the worm is removed longitudinally at about one-quarter the rate at which it revolves. This ratio allows the thread of the worm to engage each tooth of the worm-wheel, and the use of emery and oil for lapping gives a very smooth surface that insures even running between the worm and wheel.

Springfield, Mass. E. H. Pratt

REPAIRING AN AUTOMOBILE CYLINDER

The shop in which the writer is employed recently made rather an unusual repair on an automobile cylinder, and a description of this repair will, perhaps, interest readers of Machinery. The reason trouble was taken to repair the cylinder was because considerable time would have elapsed before a new one could have been obtained from the manufacturer; also, to make a new cylinder in a local shop would have meant a large expense in the preparation of patterns.

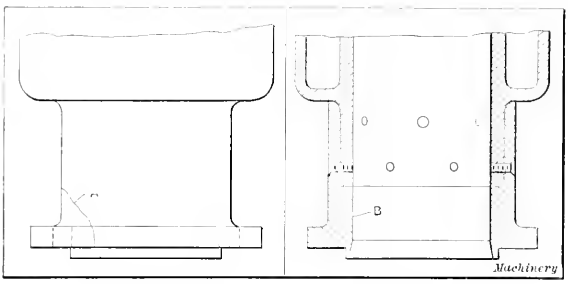


Fig. 1. The Broken Cylinder Fig. 2. Repaired Cylinder

The cylinder was broken through the bottom flange as the result of being bolted down unevenly to the crank-case. The position of the break may be seen at A in Fig. 1. In making the repair, the cylinder was first placed in a lathe, and the flange parted off at the break, as shown in Fig. 2. The outside diameter of the cylinder was next turned right up to the water-jacket, a light cut being taken to leave the wall as thick as possible. The casting B was then made and machined to go over the outside of the cylinder, and to fit up underneath the water-jacket. This casting was secured in place by means of eight manganese-bronze set-screws staggered around it. The reason the set-screws were made of manganese-bronze was because this material expands at practically the same rate as cast iron when it becomes heated, and so, although the set-screws penetrate to the inside of the cylinder, they will not score the piston. The holes for the set-screws were drilled and tapped into both the casting and the cylinder, and then countersunk. The set-screws were screwed home and the ends riveted over.

Before the original cylinder was touched the necessary dimensions were taken to make sure of the repaired cylinder having the same compression as the original. Up to the present time, the cylinder has not given any trouble.

Christchurch, New Zealand. J. H. Clarke

A GROOVING TOOL

If one stops to study the problem that was presented when it was desired to machine the casting shown in Fig. 1 on an automatic turret lathe, it will be seen that a grooving tool will be needed which must not only be strong but very compact and accurate. Fig. 2 shows the design finally adopted, which has proved very satisfactory, both as to automatic action, strength and accuracy. Although rigid enough as it is, a pilot, of course, would add to its rigidity.

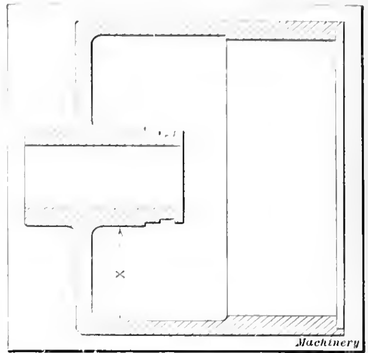


Fig. 1. Work for which Grooving Tool was made

The bar A is offset as shown at B, point C being the center of the lathe chuck and point D the fulcrum point of the tool-holder E, which is a steel casting bored to hold the tool F. This tool is set and held in the proper relation as regards its cutting edge by clamps G and nut H. It will be noticed that the tool F is so shaped that it will allow of much and inexpensive grinding, forestalling any possible objection to such an expensive cutting tool. The tool-holder E is free to move on the bar A up to a certain limit, and when this limit is reached, pin J will come into contact with screw K. It is necessary to adjust this screw very accurately, for upon it, more than upon the travel of the lathe carriage, depends the accuracy of this tool; it takes the backlash out of the cam, so to speak.

The lathe carriage, of course, also has an adjusting screw L which engages the surface of the plate M as the carriage moves inward and brings the tool-holder around, thus feeding the cutting tool into the work the required amount. The pull-back arrangement consists of a spring N, pin O, bracket P and adjusting screw Q. When we consider that this tool, from which so much is expected as regards rigidity and automatic performance, needs but 1½ inch working space at X, as shown in Fig. 1, it will be apparent that it is of excellent design.

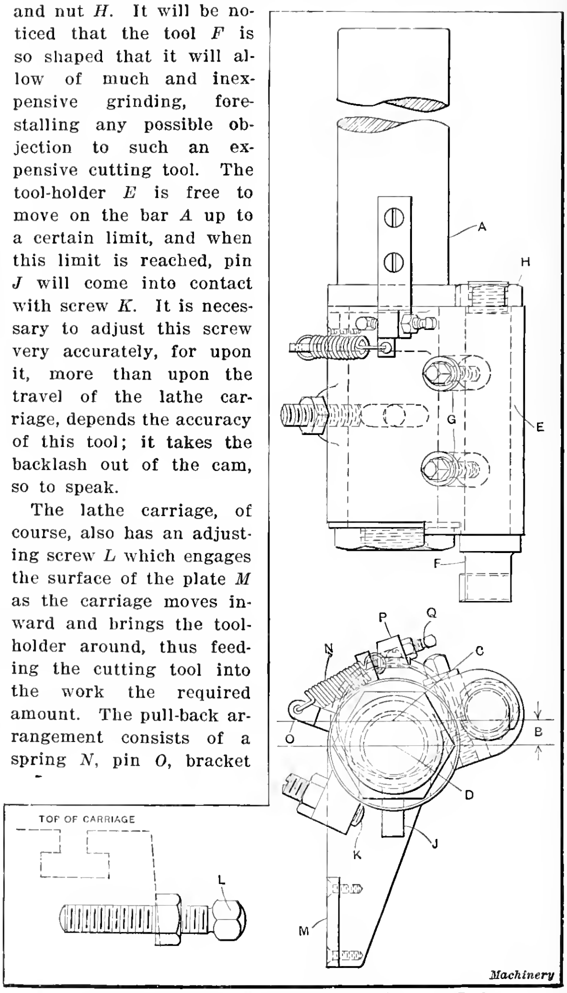


Fig. 2. Grooving Tool for use on Automatic Turret Lathe

Richard Russell

"RELIEF OF TAPS"

In the December number of MACHINERY on page 263 (engineering edition) in the article, "Relief of Taps," is a misstatement of fact which we believe you should correct.

The form of relief shown in Fig. 13 is not new. We began making taps with that form of relief in March, 1885,

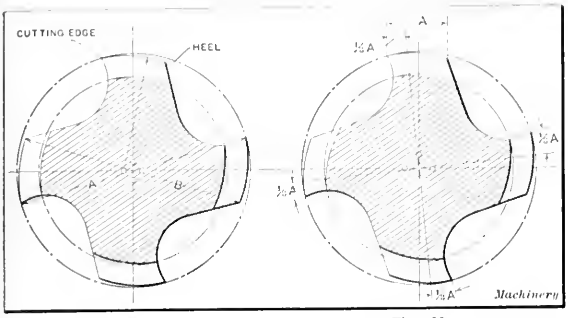


Fig. 1 Fig. 13

and have continued the practice ever since, calling the tap "machine relieved." One-third of the width of the land is concentric, that is, the top, angle and bottom of the thread follow the curve of the hole. The remaining two-thirds of the land is relieved on the top, angle and bottom of the threads.

Thousands of users of "Lightning machine relieved" taps will recognize the error into which your editorial department has fallen.

Greenfield, Mass. WILEY & RUSSELL MFG. CO.

[We are glad to publish this letter from the Wiley & Russell Mfg. Co., which is something of a revelation. The letter will remove the impression existing, we believe, not only among tap users but among tap makers that "Lightning" machine relieved taps are made with full eccentric relief, the relief beginning at the cutting edges of the teeth as shown in Fig. 1. We think that many users of "Lightning" taps are not aware of the fact that one-third the land is concentric and the remaining two-thirds eccentric, as shown in Fig. 13. The editorial department was never taken into the confidence of the company as regards the exact shape of thread relief used and was as much in the dark as to the details as the average tap user.—EDITOR.]

"RELIEF OF TAPS"

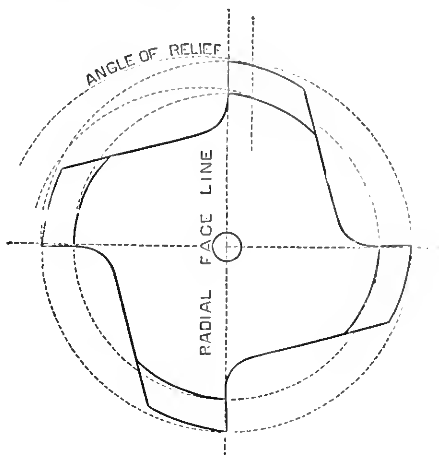
I have read with great interest the article in December MACHINERY entitled "Relief of Taps," and wish to endorse heartily the conclusion reached therein that the type of relief shown in Fig. 13 is the most practical and satisfactory form discussed. The article contains one error, however. The Pratt & Whitney Co. is wrong in its belief that it is the originator of this particular type of relief, when adopting it five or six years ago. I can testify, from personal knowledge, that this identical type of relief was used on the tap product of the Wiley & Russell Mfg. Co. during the whole time I was connected with them—a period of about eighteen years—prior to the retirement of the Russells from that company upon its reorganization about two years ago. I believe they still use it.

The accompanying cut and text are from a catalogue of the Wiley & Russell Mfg. Co. published about eight years ago, and will be found to describe accurately the same type of relief as shown in Fig. 13 of MACHINERY's article. This catalogue clipping, while not giving the exact width of the concentric land, shows in the cut that the full diameter of the tap is maintained for approximately one-third of the land, and this, indeed, was our practice.

In that catalogue of eight years ago was first printed the description of our tap relief, but I have in my possession a Wiley & Russell catalogue of thirty years ago, which contains this phrase: "Our taps are all machine relieved on the most correct principle." This refers to the same type of relief as that we are now discussing, and was printed at about the time we began applying this relief by machinery during the process of threading. Even earlier than that, probably for a period of about five years, we had been applying this same relief to our taps by hand with a "three-square" file. While I cannot get from the records the exact date when this type of relief was first used upon the Wiley & Russell tap product, it is safe to assume from the above that it was at least thirty-five years ago.

The long experience of the management of our new organization, the Russell Mfg. Co., has so strongly convinced us

Lightning Machine Relieved Taps



The above diagram shows our Machine Relief, exaggerated to show the principle.

Every tooth, both top and bottom of thread, is relieved like a milling cutter This reduces friction and binding to a minimum, and produces a free, clean cut.

In this form of relief, the true size of the tap is maintained the full length of the flute; ample stock being left behind the cutting edge, so that it may be reground for sharpening many times without destroying the size.

This relief might also be termed a "parallel" relief, as the full threads are of the same diameter throughout and absolutely parallel from end to end.

The life of these taps is much longer than that of taps relieved by the common method, which have the true size only in the first few teeth at the point, the relief being gained by gradually reducing the size toward the shank. It will readily be seen that the size of taps, relieved in this way, is lost as soon as the teeth at the point wear down; and these teeth wear the fastest, because they do all the cutting.

Our relief is applied in process by special machinery, which insures absolute uniformity.

☞Index on pages 4 to 6

Reproduction of Page from Wiley & Russell Mfg. Co.'s Catalogue published about Eight Years ago

of the superiority of this type of tap relief over all others that we will use it upon our product as soon as it is ready for the market.

Greenfield, Mass. CHARLES C. RUSSELL

RECHARGING PERMANENT MAGNETS

In the How and Why department of MACHINERY for December I note that A. B. has trouble in retaining magnetism in permanent magnets of magnetos. In the first place, the steel should be very hard, as this is an important feature of permanent magnets. As the magnetic flux is strong when the current is on, the current evidently flows in the proper direction; the trouble is elsewhere. I have magnetized permanent magnets with success by tapping them with a hammer while in the magnetic field. The sharp hammer blows seem to help the magnets take up the flux. The hammer should be of brass or other non-magnetic metal to prevent it from sticking to the magnetized steel. After the magnets are energized, they should be subjected to as few shocks or blows as possible, as this tends to weaken them.

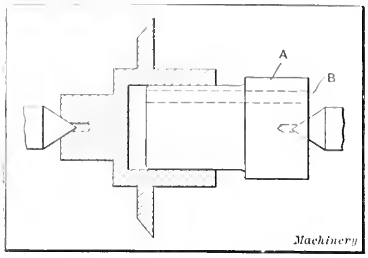
Youngstown, Ohio E. D GAGNIER

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

REMOVING A PLUG FROM A FINISHED PIECE

It sometimes happens that a finished piece with a regular center at one end and a central bore at the other must be held between centers on a lathe. Such a piece is shown in the accompanying illustration, where it will be seen that an auxiliary plug A has been driven into the bore to provide a bearing for one of the lathe centers. If it is necessary for this auxiliary plug to be a tight fit in the bore, it may be difficult to get the plug out again without spoiling the finish on the work. An easy way of doing this is to drill a small hole *B* of such a size that a piece of drill rod will be a slip fit in it. After filling the bore with oil, the piece of drill rod is inserted in the hole and then struck on the end with a hammer. This action is equivalent to that of a hydraulic ram and causes the plug to slip out of the bore in the work.

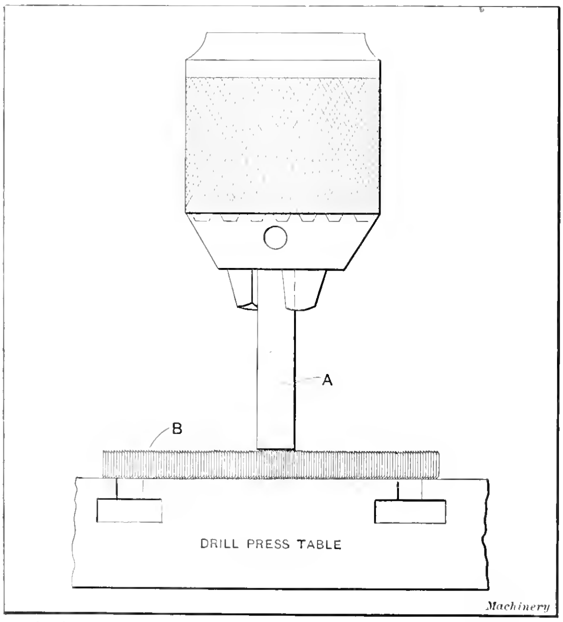


Method of removing a Plug from a Finished Piece

Detroit, Mich. HERMANN MUELLER

FACING STOCK IN A DRILL PRESS

The accompanying illustration shows a useful "kink" for facing off and finding the center of stock that can be chucked in a drill press. The stock to be faced is shown at *A*, which illustrates a piece of round stock held in the drill chuck and being fed against a flat file *B*. A few revolutions will be sufficient to locate the center of the stock. In facing pieces by this method, a bastard file can be used for roughing, after which the finish is produced with a smooth file.

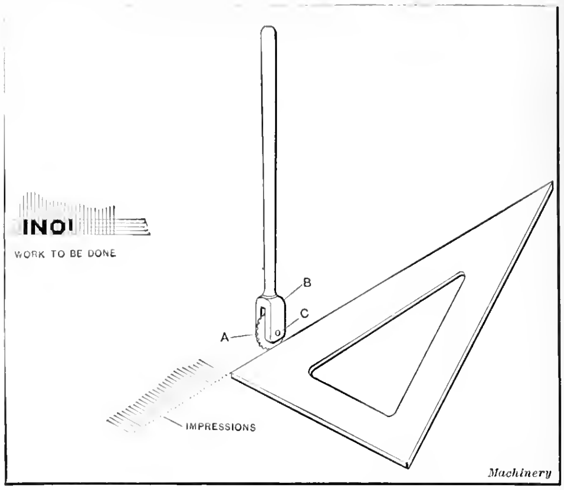


Rapid Method of facing and centering Stock held in a Drill Chuck

Corbin, Ky. J. A. JESSON

A HANDY DRAFTSMAN'S INSTRUMENT

It was necessary for a lot of neat block lettering to be made for titles of standardization sheets, etc. To do this well, accurate spacing is required. Such spacing, if done by the ordinary method of pricking it off from a scale, is very tedious as well as expensive, and it would pay any draftsman to make the simple little tool here shown. To do so, sharpen the teeth of a wheel from an old clockwork to the desired point and mount it in a handle *B* with a pin *C*. The wheel *A*, if run along a triangle, will impress dots with speed and accuracy. It will also be of aid in cross-sectioning.

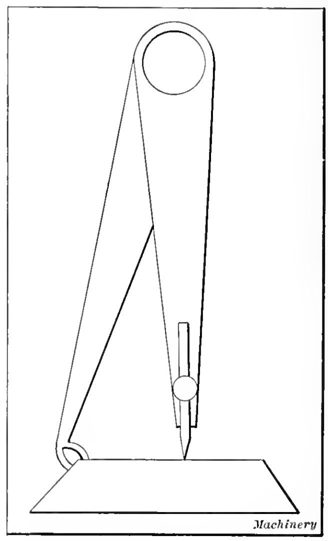


Instrument for laying off Spaces for Block Letters or Section Lines

East Lynn, Mass. R. F. POHLE

SPECIAL HERMAPHRODITE CALIPERS

The writer recently had to lay out some pieces with beveled sides and found that he could not use an ordinary pair of hermaphrodite calipers with only one hook on the leg. For this job, a special pair of hermaphrodite calipers, illustrated herewith, was designed. The illustration will be self-explanatory to any mechanic, but it may be mentioned that the size of the double hook is exaggerated in order to show it more clearly. There are probably many mechanics who have felt the need of such a tool from time to time. For the particular job for which these calipers were made, it would have been difficult to scribe a straight line for even a short distance with a tool of the ordinary design, as it would require a very steady hand to keep the calipers running on the beveled side of the work. The double hook did away with this difficulty entirely so that the laying out was a very simple matter.



Special Hermaphrodite Calipers for use on Beveled Work

Philadelphia, Pa. FRED HENKE

* * *

Don't forget that a drill with a short shank can be removed from the spindle, if a short piece of drill rod is dropped on the end of the shank through the spindle broach so the drift can strike it.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

MAKING TEMPLETS AND TOOLS FOR INVOLUTE GEAR CUTTERS

A. J. T.—I would like to see an article published in MACHINERY describing the process of generating or forming a templet and the tools for planing and backing off a one diameter pitch B. & S. involute gear tooth cutter. What I would like to know is how the templet is made so that it will be exactly alike on both sides and theoretically correct as to the radii of the curves and over-all dimensions; the kind of steel used and the process of making the tools and fly-cutters if any are used.

A.—The data on tooth shapes are regarded as a private matter by the manufacturers of so-called involute gear cutters. The method of making templet and formed cutters, however, is more or less common knowledge among first-class toolmakers. An article on the subject would be welcomed by the editorial department.

DRAW-BAR PULL OF TRACTORS—DRAFT OF PLOWS

B. E. M.—1. What percentage of the power of an internal combustion motor tractor is available at the draw-bar when working on soft soil? 2. What is the draft per unit of a gang plow?

A.—1. The draw-bar pull of tractors varies widely. The design of the driving wheels and the efficiency of the driving gear as well as the character of the ground on which the tractor is working must be taken into account. An average of the draw-bar pull of farm tractors working on soft soils probably would lie somewhere between 15 and 35 per cent of the power developed by the engine according to the experience of one tractor builder. Conditions may be so adverse, however, that the tractor is barely able to pull itself, when the pulling power, of course, will be practically nil. The design of the tractor wheels is an important consideration. The following data were furnished by C. H. Melvin of Deere & Co., Moline, Ill.: One tractor weighing 8000 pounds, with driving wheels $5\frac{1}{2}$ feet diameter by 14 inches face, driven by a 40 horsepower, four-cylinder engine, developed 3000 pounds draw-bar pull under normal favorable traction conditions. Another tractor weighing 12,000 pounds and having four driving wheels 5 feet diameter by 12 inches face developed a draw-bar pull of 2950 pounds under exactly the same conditions. Apparently there is no rational basis as yet for fixing standard draw-bar pulls of different types of tractors.

2. The draft of plows varies greatly in different soils, as is indicated in the following table compiled from tests made of the draft of a single unit, 14-inch plow.

Corn stubble, 7 inches deep	300 to 350 pounds
Wheat stubble, 7 inches deep	350 to 400 "
Clover sod, 7 inches deep	350 to 450 "
Blue grass, 7 inches deep	500 to 600 "
June grass, 7 inches deep	500 to 600 "
Breaking prairie sod $3\frac{1}{2}$ to $4\frac{1}{2}$	700 to 800 "

A turf and stubble plow working under normal conditions to an average depth of 6 inches will require a draw-bar pull of 425 pounds, and the same plow will vary in draft in various conditions of soil from 250 pounds in light soils to 650 pounds under hard plowing conditions, and even more. In fact, 1050 to 1250 pounds pull is required in the black waxy Texas lands. M. Rumely Co., La Porte, Ind., states that under ordinary conditions the draft of a plow per square inch of cross-section in old ground is from 4 to 6 pounds; $2\frac{1}{2}$ to 3 pounds in sandy ground and as high as 15 to 20 pounds in virgin gumbo sod. This company states that the draw-bar horsepower of a tractor ranges from 25 to 65 per cent of the indicated horsepower. Further information on the subject can be obtained from a book entitled "Power and the Plow."

TAPER TURNING WITH COMBINED FEEDS

A. S.—When taper turning is done with a vertical boring mill, by using the horizontal and vertical feeds in combination, how is the angular position of the tool-head determined? Suppose the surface is to be turned to an angle of 84 degrees (as shown in the illustration Fig. 1) and the tool feeds 8 inches in a horizontal direction while it feeds 5 inches vertically. How much should the tool bar incline from the vertical?

A.—The method of determining the vertical position of a boring mill tool-head when turning tapers by using both feeds in combination, is as follows: If the horizontal feeding move-

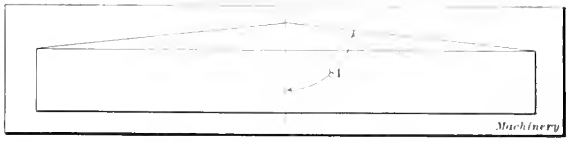


Fig. 1. Conical Shape to be turned

ment H (Fig. 2) is 8 inches and the vertical feeding movement V is 5 inches, obviously the surface will be turned to angle c, provided the head is vertical, but if inclined to some angle x, angle c will be diminished, and if the tool-bar is set over the right amount, the conical surface can be turned to an angle a equal to 6 degrees, thus giving an 84-degree angle as measured from the axis.

The first step in determining the angle x is to find angle b. The sine of angle $b = \frac{\sin a \times H}{V}$ in which H represents the rate of horizontal feed and V the vertical feed.

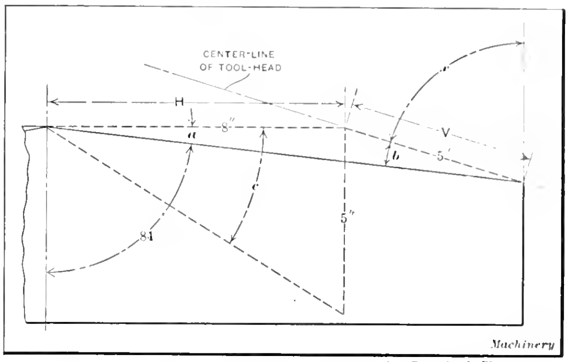


Fig. 2. Combination of Feeds that generate the Required Shape

The value of angle b is next found by referring to a table of sines. We now have angles b and a and by subtracting the sum of these angles from 90 degrees, the required angle x is obtained. To illustrate, the sine of 6 degrees or angle a, is 0.1045; hence $\sin b = \frac{0.1045 \times 8}{5} = 0.1672$.

By referring to a table of sines, we find that the angle corresponding to 0.1672 is 9 degrees 38 minutes, approximately; then angle $x = 90° - (6° + 9° 38') = 74° 22'$.

If the required angle a is greater than angle c, which is obtained when the tool-bar is in a vertical position, it would then be necessary to swing the lower end of the bar to the left, rather than to the right of a vertical plane.

* * *

The Ronay process for briquetting brass, bronze, aluminum and other metal chips, without the use of a binding material, was developed in Germany and is now protected in this country by U. S. patents. The process subjects every part of the material to heavy hydraulic pressure, so great that a comparatively solid briquette is produced. In order to produce the greatest possible solidity, it is necessary that the air be thoroughly expelled. The air cannot be expelled if the pressure is exerted in the mold from one direction only. It is necessary to exert pressure on the briquettes from the sides also. Briquettes produced by this process, in which all air is expelled, melt in the furnace with little or no more waste than pigs of new metal. The pressure employed approximates 30,000 pounds per square inch.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The annual meeting of the American Society of Mechanical Engineers was held in New York City, December 2-5, the Engineering Bldg. being the headquarters. The papers presented covered a wide range of subjects, giving the program a scope and interest hardly before exceeded. They comprised boilers and their operation, cement, enameling, fire protection, gas measurement, gas power engineering, lineshaft bearings, machine tools, management, properties of steam, rope drive, steel railway cars, textiles with reference to mill engineering, and vacuum cleaning.

The president, Dr. W. F. M. Goss, read his presidential address, "Efficiency in Technical Education a Factor in the Development of Professional Ideals," Tuesday evening, after which a reception was given to the members and their friends. On Wednesday evening the Grashof medal, presented by the Verein deutscher Ingenieure to George Westinghouse, was conferred. Mr. Westinghouse was unable to be present because of illness, and the medal was transferred to the keeping of James Hartness the new president. An address illustrated by lantern views on Leonardo da Vinci, engineer and artist, was made Wednesday evening by John W. Lieb, Jr. The customary reunion took the form of a German dinner given Thursday evening. This dinner reproduced one of the menus served to the visiting engineers in Germany last summer. The dinner was held at the Hotel Astor and a brief account of the trip illustrated by lantern views was given by Worcester R. Warner, which was followed by dancing. The technical program comprised the following papers:

"Notes on the Further Operation of Large Boilers of the Detroit Edison Co.," by J. W. Parker.

"Task Setting for Firemen and Maintaining High Efficiency in Boiler Plants," by Walter N. Polakov.

"Properties of Steam," by R. C. H. Heck.

"Hoisting and Conveying," sub-committee report.

"Dynamic Braking for Coal and Ore-Handling Machinery," by Clark T. Henderson.

"Steel Under Frame Box Cars," by G. W. Rink.

"Steel Upper Frame Box Cars," by R. W. Burnett.

"Cotton Conveying Systems; their Safeguards against Fire," by H. A. Burnham.

"Specifications for Factory Timbers," by F. J. Hoxie.

"Textile Cost Accounting," by C. B. Annett and C. F. Cunningham.

"Efficiency of Rope Driving as a Means of Power Transmission," by E. H. Ahara.

"Comparative Tests of Three Types of Lineshaft Bearings," by Carl C. Thomas, E. R. Maurer and L. E. Kelso.

"Pitot Tubes for Gas Measurement," by W. C. Rowse.

"Tests of Vacuum Cleaning Systems," by J. R. McColl.

"Tests Upon the Transmission of Heat in Vacuum Evaporators," by E. W. Kerr.

"The Art of Enameling, or the Coating of Steel and Iron with Glass," by Raymond F. Nailler.

"Gears for Machine Tool Drives," by John Parker.

"Cast Iron for Machine Tool Parts," by Henry M. Wood.

"Standardizing Machinery," by Fred H. Colvin.

"A Record of Pressed Fits," by C. F. MacGill.

"A New Process for Cleaning Producer Gas," by H. F. Smith.

"The Present Status of Large Gas Engines in Europe," by Prof. P. Langer.

"Extinguishing Fires in Oils and Volatile Liquids," by Edward A. Barrier.

"The Fire Hazard in Turbo-Generators," by G. S. Lawler.

"Control of Automatic Sprinkler Valves," by Fred J. Miller.

"The Need of More Care in the Design and Construction of Elevated Tanks," by W. O. Teague.

"Fire Pumps," by Ezra E. Clark.

The entertainment included excursions to a number of power stations and manufacturing plants, among which were the tunnel construction plants of the Catskill Aqueduct, Waterside Station, P. R. R. and N. Y. C. Stations, Henry R. Worthington, Brooklyn Navy Yard, E. W. Bliss Co., Davis-Bournonville Co., etc.

The following officers were elected for the coming year: James Hartness, president; H. L. Gantt, E. B. Katte, E. E. Keller, H. G. Reist, vice-presidents; A. M. Dean, John Hunter, E. H. Whitlock, managers; W. H. Wiley, treasurer.

JAMES HARTNESS

James Hartness, the newly elected president of the American Society of Mechanical Engineers, is a son of John Williams Hartness and Ursilla Jackson Hartness; he was born in Schenectady, N. Y., 1861. The first twenty years of Mr. Hartness' life were spent in Cleveland, Ohio, where after passing through the public schools he entered practical work in machinery building plants. Following this early mechanical experience, three years were spent as foreman of a manufacturing plant in Winsted, Conn., and the next four years as foreman and inventor in a hardware manufacturing plant in Torrington, Conn.

James Hartness

In the fall of 1888 Mr. Hartness designed machinery for the Jones & Lamson Machine Co., in Springfield, Vt., and shortly afterward took an active part in the management of the company. He served successively as superintendent, manager and for the last dozen years as president. He is known in the machinery building industries as the inventor and manufacturer of various machines for metal turning, designed to take the place of the engine lathe. One of his first inventions in this line was the flat turret lathe which has been very successful, both from a mechanical and financial point of view. Another of Mr. Hartness' designs is the "Lo-swing" lathe built by the Fitchburg Machine Works, Fitchburg, Mass. Numerous patents have been taken out on other inventions, the total number of patents granted to Mr. Hartness being over eighty.

Mr. Hartness has been a consistent believer in the policy of specialization in manufacturing. When he went with the Jones & Lamson Machine Co., a large variety of machines was made, many of them being built to order. This practice was found to be unprofitable, and a change was effected in the direction of making fewer machines and manufacturing rather than building them. When the flat turret lathe was developed and put on the market, the time was ripe for specialization, and it was made the exclusive product of the company with very gratifying financial success. Mr. Hartness early recognized many of the basic principles of so-called scientific management and applied them in the design, manufacture and selling of machine tools.

A number of years ago Mr. Hartness became much interested in astronomy, and in 1910 he invented the turret equatorial telescope which had for its object the protection of the astronomer from the rigors of cold weather observation. This interesting astronomical apparatus was illustrated and described in a paper presented by Mr. Hartness before the American Society of Mechanical Engineers at the December, 1911, meeting. His accomplishment in this line is notable in that the object for which the design was made was attained without incurring the serious optical losses that had resulted from previous designs made for the same purpose.

Mr. Hartness has been a member of the American Society of Mechanical Engineers since 1891. He served as one of the

managers of the society from 1901 to 1912 and then as vice-president. He is a Fellow of the American Association for the Advancement of Science and a member of the British Institution of Mechanical Engineers, Verein deutscher Ingenieure, Astronomical and Astrophysical Society of America, London Astronomical Society, Royal Arts Society, Boston Chamber of Commerce and vice-president of the Western New England Chamber of Commerce, and an honorary degree of mechanical engineering was granted him by the University of Vermont in 1910. He is the author of "Machine Building for Profit" and "The Human Factor in Works Management." In both these books the author has shown his grasp of the psychological problems of industrialism. He is an advocate of specialization as a necessary means of making the best use of man's energies and adapting him to the world of today.

In addition to his interests in the Jones & Lamson Machine Co., Mr. Hartness is also interested in four other machinery building companies. He married Miss Lean Sanford Pond in 1885 and has two daughters: Mrs. Beardsley, wife of William H. Beardsley, M.D., of Springfield, Mass., and Mrs. Flanders, wife of Ralph E. Flanders of Springfield, Vt.

* * *

AWARD OF MEDALS BY THE AMERICAN MUSEUM OF SAFETY

An award of medals was made at the first annual dinner of the American Museum given to about four hundred guests at the Waldorf-Astoria Friday evening, December 12. These medals comprise the *Scientific American* medal, which is given for some safety or life-saving devices, invented within a recency of three years and exhibited in the museum's collections; the Dr. Louis Livingston Seaman medal, which is given for progress and achievement in hygiene and sanitation and the mitigation of occupational disease; the Rathenau medal, which is placed at the disposal of the Museum of Safety by Dr. Emil Rathenau, president of the Allgemeine Elecctricitaets Gesellschaft of Berlin; the Travelers Insurance Company medal, which is given to the American employer who has done the most for the protection of his work-people in limb and life; and the E. H. Harriman memorial medal which is given to the American railroad that has been most successful in protecting the lives and health of its employes and of the public.

The *Scientific American* medal, received by George M. Schroeder, secretary of the Welin Marine Equipment Co., was awarded his company for boat davits, lifeboats, rafts and life preservers. The Travelers Insurance medal, awarded the New York Telephone Co., was received by President U. N. Bethel and a special Travelers Insurance medal, awarded the Allgemeine Electricitaets Gesellschaft, by T. C. Martin. The Louis Livingston Seaman medal was received by President James A. Farrell for the U. S. Steel Corporation and the Rathenau medal by President G. E. Emmons for the General Electric Co. The E. H. Harriman memorial medal was awarded to the Southern Pacific Co., and received by Julius Kruttschmitt, chairman of the board of directors. Prof F. R. Hutton made the presentations.

Following the presentations, Dr. William H. Tolman briefly reviewed some of the safety and welfare work being done in the United States and in Europe, especially Germany.

* * *

The Pennsylvania Railroad has introduced an innovation in dining car service. A new steel lunch counter car was put into service between New York and Philadelphia, December 1. The new car is eighty feet long and the exterior appearance is the same as a Pennsylvania R. R. all-steel passenger car. The interior is quite different from the ordinary dining car; instead of tables, there is one long table extending over half the length of the car. Facing this counter are revolving chairs fastened to the floor, and twenty-one people can be seated at once. The pantry and kitchen are at one end of the counter. The convenience of a lunch counter car to travelers between New York and Philadelphia should make it popular with the traveling public.

EXHIBITION OF AUTOGENOUS CUTTING AND WELDING

On the afternoon of December 4, about one hundred and fifty members and guests in attendance at the annual meeting of the American Society of Mechanical Engineers, made an inspection visit to the plant of the Davis-Bournonville Co., Jersey City, N. J., where arrangements had been made to give a demonstration of autogenous cutting and welding equipments. The Davis-Bournonville plant is divided into two general sections, one of which is devoted to building cutting and welding equipments and the other to job work in welding. The exhibits in the factory consisted of mechanically-guided cutting and welding torches, all of which were shown in operation. In the welding shop, various classes of welding—both repair work and applications of the oxy-acetylene process of welding in building new equipment—were shown. In addition, the practice followed in the generation of acetylene was demonstrated, and in the yard outside the factory several exhibitions of cutting heavy metal with both the oxy-acetylene and oxy-hydrogen flames were demonstrated. All of the different exhibits were numbered and placards were provided showing what class of work was being handled in each case. This enabled the visitors to see at a glance what work they were most interested in and to study the demonstration of the work in its details.

In the exhibition of mechanically-operated welding and cutting torches, the following machines were shown: The No. 1 and No. 2 "oxygraphs" were shown cutting out various shaped pieces. The "railagraph" and the "holograph" were shown cutting off rails and cutting the holes in the webs of rails for bolting the joints together. An interesting application of the "radiagraph" consisted of cutting rings from one-inch plate to form flanges for power plant piping. Where this method is used, the flanges are cut out to fit the ends of plain pipe and are then welded in place. The automatic barrel welding machine was also shown in operation for the first time.

In the welding shop, various classes of welding work were being done. As examples of repair work, it may be mentioned that metal was added to gear-wheels at points where teeth had been broken off, in order to provide for cutting new teeth. A cracked engine cylinder and broken flue-bridges in a boiler were also welded. An interesting demonstration of the application of the oxy-actylene torch in the case of welding products in course of manufacture consisted in the production of expansion bends for use in power plants. The steel plates from which these bends are made are blanked and formed so that they fit together with a reasonable degree of accuracy. Consecutive plates are put in place so that the edges come fairly close together; the welding torch is then used to melt the metal so that it fuses together forming a tight joint. Demonstrations of the practice followed in welding aluminum, brass, iron, steel and other metals were conducted.

Among the more spectacular exhibitions of heavy cutting that were made in the yard outside the factory, the following may be mentioned: The oxy-hydrogen flame was used in cutting a slab of armor plate 16 inches thick. This slab was 12 inches wide, and a cut was made through the piece in three minutes and thirty seconds. Another interesting example of cutting was shown in connection with the emergency equipment which has been developed for use by municipal fire departments in cutting away steel bars that may impede their progress. The oxy-acetylene cutting torch for this purpose enabled three one-inch steel bars to be cut from a grillwork in a few seconds, making a space large enough for a man to pass through. Each bar had to be cut twice, making six cuts in all.

Particular credit is due to the Davis-Bournonville Co. for the efficient way in which the exhibition was handled. By having the general exhibits separated and each one continually in operation, the visiting engineers were able to see each exhibit and get a good idea of the work that was being shown. This would have been impossible if a large crowd had been gathered around each individual machine at one time when it was in operation.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LODGE & SHIPLEY UNIVERSAL TOOL-ROOM LATHE

The new model universal tool-room lathe built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, which is illustrated in Fig. 1, is made in a 16-inch nominal size but actually swings 18½ inches. To meet the requirements of various users, different types of headstocks can be furnished, *viz.*, 4-step and 5-step cone, single back-geared, 3-step cone, double back-geared and "selective head" for single-pulley belt or motor drive. As the universal tool-room lathe is designed especially for tool-room work, it has certain refinements and attachments not required in lathes for manufacturing purposes. The unit system of construction is employed throughout, so that the application or omission of various attachments which can be furnished, will in no way affect the other parts. All parts are made interchangeable so that attachments ordered subsequently can readily be applied by the customer.

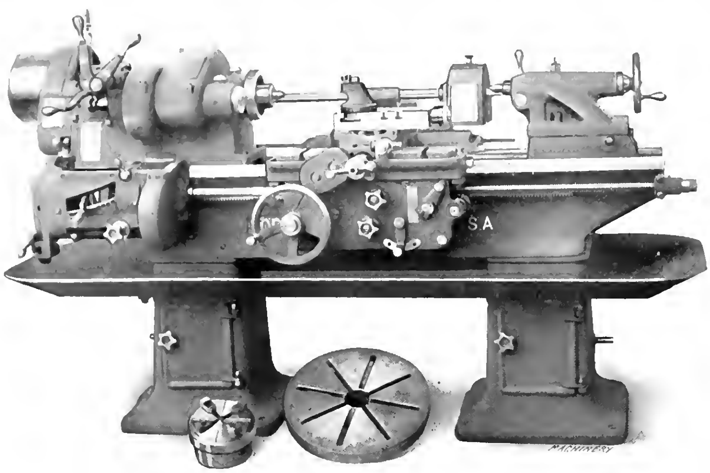


Fig. 1. Lodge & Shipley Universal Tool-room Lathe with "Selective Head"

The 16-inch by 6-foot "selective head" type is shown in Fig. 1. This lathe has full equipment comprising a pan, universal taper attachment, universal relieving attachment, translating gears for cutting metric threads in addition to English threads, draw-in chuck with collets, and step chuck with closer. Fig. 2 shows a 16-inch by 6-foot, 4-step cone-head- universal tool-room lathe without additional appliances.

Headstock and Tailstock Construction

As the selective head was described in the July, 1913, number of MACHINERY, it is sufficient merely to mention that when driven by a constant-speed belt or motor, the selective head gives twelve changes of spindle speeds obtainable through conveniently located shifting levers, and that this head derives its name from the selective type transmission used in the gear box where there are chrome-nickel steel heat-treated gears mounted on chrome-nickel steel shafts running in ball bearings. The double nose for the spindle (as formerly described in conjunction with the selective head) is used in both the selective and the cone-head lathes. It provides a pilot for centering the chuck or faceplate and a large diameter of shoulder against which the plate is screwed.

As illustrated in Fig. 2, the main housing of the cone head is carried up slightly above the center line of the spindle. This makes a very rigid construction and ties the front and rear spindle bearings securely to each other and to the head. In each of the different styles of heads, the back-gearing is designed to give uniform progression over the entire range of speeds. On the 3-step cone head the double back-gear is moved lengthwise by means of a lever conveniently located at the top of the headstock cover. In the selective head, the back-gearing is located at the front of the head and the face gear pinion may be withdrawn from mesh. The back-gear sleeve and pinion are both cut from a single steel forging.

The spindle bearings are of special white metal, interchangeable and replaceable, fitted and held into the headstock by screws. These bearings are faced and turned in halves to exact standard size, and the screw holes are drilled to jig. The end thrust of the spindle is taken against the rear housing by alternate hardened steel and bronze washers. Oil wells are provided over the spindle and back-gear bearings, and a wick oiling system delivers the proper quantity of oil by capillary attraction. All bearings in the quick change gear mechanism and apron are reached by suitable oil tubes.

The tailstock has a long bearing on the bed and is designed to allow the compound rest to be set at 90 degrees when using the tool on small diameters. Set-over screws are provided, and a hardened scale is secured to the lower side. Plug clamps lock the spindle without throwing it out of line. The spindle is made of tool steel, graduated lengthwise on top for quick reference, and has a long traverse.

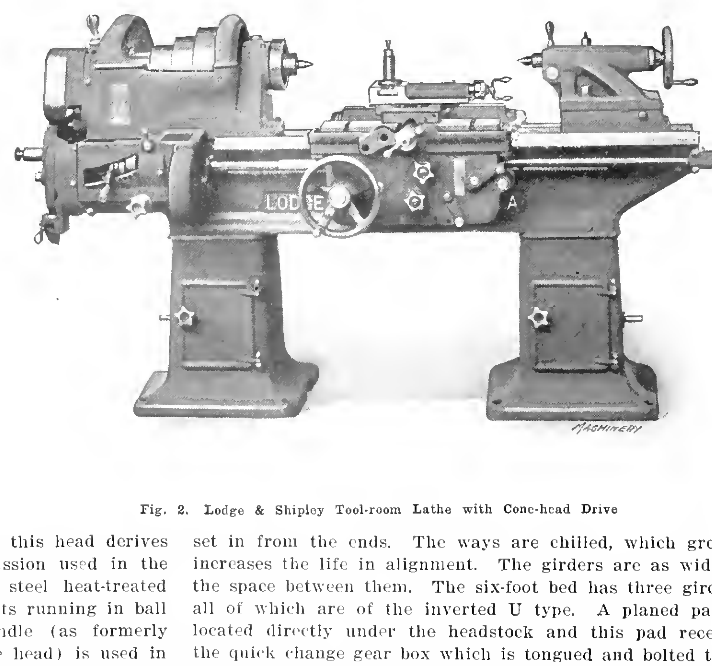


Fig. 2. Lodge & Shipley Tool-room Lathe with Cone-head Drive

The bed is of box section, wide and deep, and the legs are set in from the ends. The ways are chilled, which greatly increases the life in alignment. The girders are as wide as the space between them. The six-foot bed has three girders, all of which are of the inverted U type. A planed pad is located directly under the headstock and this pad receives the quick change gear box which is tongued and bolted to it. A coarse-pitch steel rack is bolted to the bed directly back of the lead-screw.

Carriage and Quick-return Mechanism

The carriage, a top view of which is shown in Fig. 3, has an unusually long bearing on the outside shears. It is gibbed at the front, back, and inside. The bridge has a supplementary bearing on the inside front shear of the bed, for resisting the pressure of the cut and absorbing the vibration from the cutting tool. An oil trough is cast entirely around the carriage, and shear wipers are provided for the bearing surfaces. The cross-feed screw has a large self-locking micrometer dial graduated to thousandths of an inch. All carriages are planed and drilled to receive either style of taper attachment, and also to receive the relieving attachment, and no additional fitting is required when applying these parts.

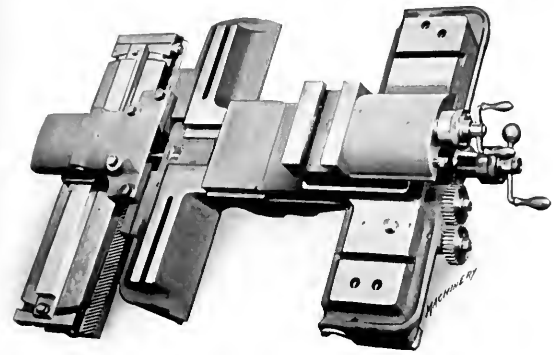


Fig. 3. Top View of Carriage with Universal Taper Attachment

The compound-rest top slide is provided with a large self-locking micrometer dial, graduated to thousandths. It is designed so that the extreme width of the swivel rests directly upon the lower slide, thus avoiding overhang of the top slide. The apron is of the double-plate type and is provided with all steel feed gearing throughout. The handwheel for imparting hand motion to the apron can be disengaged from the stem while chasing. All shafts have unusually long bearings and oil receptacles are provided to properly distribute the oil to all bearings. The half-nuts interlock with the friction feed mechanism. The apron is tongued and bolted to the carriage and the pinion engaging the rack on the bed is made of high-carbon steel and hardened. The lead-screw is set well up under the front carriage V to avoid overhang.

An entirely new quick return of the carriage for screw cutting is incorporated in the apron. The reverse is by friction and is controlled by the movement of the same lever which opens the half-nuts. By raising the half-nut lever, thus disengaging the half-nuts, the carriage stops. If the lever is raised slightly higher, the quick return mechanism is engaged, and the carriage returns four times as fast as the speed at which the thread is being chased.

Chasing Dial—Chasing Stop

A new design of chasing dial is provided which has a hardened notched disk mounted upon the shaft which is secured to a worm-wheel engaging the lead-screw threads. This notched disk has longitudinal movement and any selected index may be engaged with the stop dog which prevents the half-nuts from becoming engaged, until the proper notch in the disk is presented to the dog. This preserves the accuracy of the lead-screw on account of preventing the half-nuts from clamping on the tops of the threads, and it is also valuable in that the operator need not watch a dial.

Fig. 4 illustrates the automatic chasing stop which is attached to the dovetail of the carriage by a clamping screw and is directly connected to the lower slide of the compound rest. Its function is to form a dead stop for succeeding cuts over the thread. The rate of advancement or depth of cut can be adjusted to thousandths of an inch by knurled screws, and this cut may be varied from 0.002 inch to 0.010 inch of depth. The setting for the depth of cut is accomplished by withdrawing the cutting tool from the work. In using this device the operator need not watch the micrometer dial, but can chase the thread to the proper depth, the rest at all times coming directly against the dead stop. This chasing stop prevents breaking the point of the tool and with the quick return reduces chasing to a very simple operation.

Quick-change Gears

The quick change screw cutting and feeding attachment is bolted to a pad on the front of the bed. This attachment has two shaft centers, one for the lead-screw, and another for the cone of steel gears. The sliding tumbler is supported in a slide independent of the shaft bearings, and this slide is arranged close to the handle which moves the sliding tumbler within the slot, thus avoiding overhang of the handle and preventing binding and cramping when setting. Both shafts of the gear box extend through the left end of the box, and the change gear may be applied to either of these shafts. Power is transmitted from the feed gear on the end of the spindle, through a reverse plate to the stud in the headstock, then through a quadrant mounted on the end of the gear box which quadrant gives three changes. The gear box itself gives thirty changes, so with the quadrant, ninety changes are provided in the regular quick change gear mechanism. The housing carrying the sliding tumbler is locked into position before the intermediate gear can be meshed with the selected gear of the cone. All the shafts are short and the drive is direct. The index is simple and is attached to the top of the box where it can be seen readily by the operator. The machine may be ordered with the plain English threading index, and the metric attachment can be subsequently supplied without any additional fitting.

Equipment for Metric Threads

With the metric index it is necessary to make the cone of gears the driver, whereas in the English index the cone of gears is the driven member. When supplying the machine with the metric attachment, it is only necessary to add a gear cover, into which is mounted the translating gears. This gear cover is machined and made a duplicate of a plate which is secured to the gear box when the metric compounding gears are not supplied. When the gear box is arranged for metric pitches it is possible to cut either metric or English threads by simply turning a knob attached to the bottom of the box. By turning this knob to the left the metric pitches are obtained, and to the right, the English. It is also necessary to place the driving gear at the end of the gear box on the proper shaft; the upper shaft for the English and the lower for the metric.

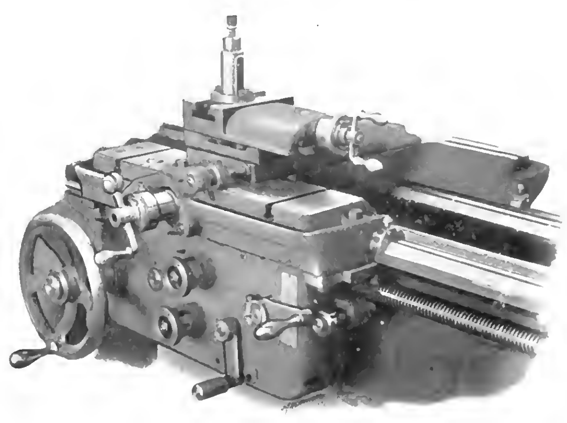


Fig. 4. Detail View of Carriage showing Chasing Dial and Stop

Plain and Universal Taper Attachments

The taper attachment requires no planed strip on the back of the bed, and therefore a special bed is not required, and the taper attachment can readily be applied to the machine at any time. All carriages are drilled to receive it. The bracket carrying the swivel bar is bolted to travel with the carriage so that at whatever part of the carriage the taper attachment may be, it can be engaged instantly. The taper attachment slide is provided with an extension which may be connected on either side, and this extension engages the

arm which clamps it to the bed and holds it stationary when the carriage is feeding. The taper attachment swivel is a steel straightedge. A gibbed shoe slides upon it, and this is secured to a slide which confines the cross-feed screw to it. The cross-feed screw telescopes through the cross-feed pinion on the front side of the carriage; thus the taper attachment may be used with a plain rest or with a relieving attachment, and the depth of cut set by the cross-feed screw. The hardened steel straightedge can be set to graduations in inches per foot, and a micrometer adjustment is provided to give extreme accuracy in setting. A nicely graduated steel scale with a compensating pointer gives accurate reading to the swivel bar.

In addition to the parts just described for a plain taper attachment, the universal taper attachment has a power traversing mechanism which provides various rates of travel.

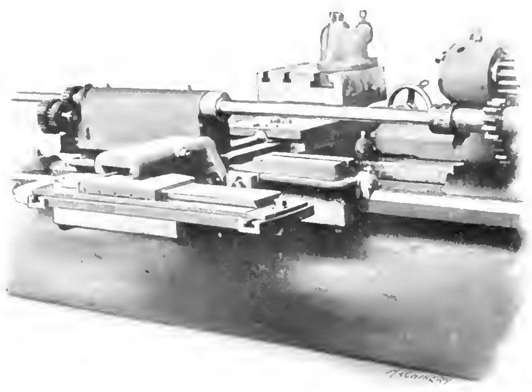


Fig. 5. Universal Relieving Attachment

Fig. 3 shows the universal taper attachment fitted to carriage. A cover plate which protects the taper attachment rack, and a cover for the gears on the front of the apron, are purposely omitted to give a clearer idea of the construction. The mechanism for giving power traverse to the swivel bar of the universal taper attachment is controlled by a shaft extending through the bridge of the carriage and operated by change gears at the front, driven direct from the apron feed train. Thus, when the universal traversing mechanism is employed, the forces necessary to produce the taper are all contained within the carriage, and all side pull is eliminated.

The plain taper attachment is satisfactory for tapers not exceeding 4½ inches per foot, but on very abrupt tapers it is impossible to feed the tool against such steep angles, and to accommodate work of this character the independent driving mechanism for the taper attachment slide has been provided. Since the slide can be fed at various speeds, it is capable of turning much longer tapers than with the plain taper attachment; in other words, if the slide feeds one-third as fast as the carriage, the carriage will travel three feet while the slide is traveling one foot, and *vice versa*. The complete range of the universal taper attachment covers tapers from 1½ inch per foot and 54 inches long, up to 13½ inches per foot and 6 inches long.

Universal Relieving Attachment

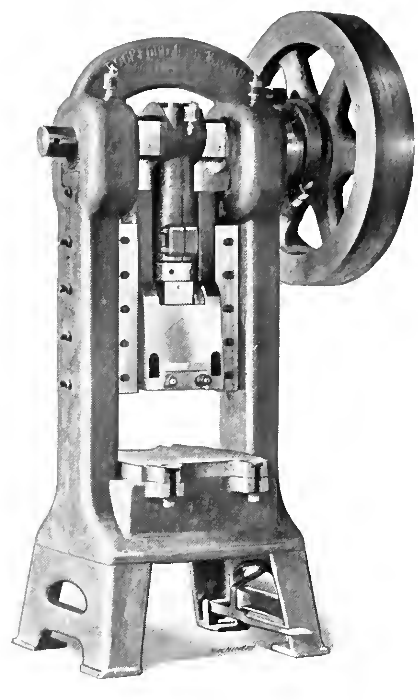
The relieving attachment illustrated in Fig. 5 is designed to produce radial, angular, end, or inside reliefs. It is never necessary to go behind the machine to make adjustment. Power is transmitted from the splined shaft at the back of the bed, through a sleeve and change gears, to a shaft below and parallel with the driving shaft. This lower shaft in the housing transmits its power through hardened spiral gears to the cam-shaft which takes its bearing in the cross-slide. This cam-shaft engages a roller mounted in a plunger. The plunger engages a bell-crank which is mounted in the top slide of the relieving attachment. The abutting portion of this bell-crank is made adjustable by an adjusting screw, and by removing the top cover this screw can be adjusted for various depths of relief from zero to ¼ inch movement of the slide. Since the power for operating the relieving slide is supplied directly through the swivel center, the swivel itself may be set at any angle without affecting the movement of the slide; thus it is possible to relieve at any angle, inside or outside, or on the face of a piece of work. The cam-shaft is placed below the surface of the bridge so that the full swing over the bridge is obtained for relieving.

Chucks and Collets

The draw-in chuck is mounted directly on the nose of the spindle. No draw tube passes through the spindle, which makes it possible for the draw-in collet to receive stock as large in diameter as the size of the hole through the spindle. Collets may be furnished for diameters from ⅛ inch to 1 5/16 inch inclusive. The collets are tightened and released by a small key wrench, which makes it unnecessary to hold the driving belt when tightening and releasing the chuck. A step chuck with adjustable jaws and closer is made to apply to the regular draw-in chuck body and is very desirable when a finished piece must be true; it is also useful for facing thin pieces of large diameter.

ROCKFORD STRAIGHT-SIDE POWER PRESSES

The No. 8 size of a line of straight-side power presses which has been placed on the market by the Rockford Iron Works, Rockford, Ill., is shown in the accompanying illustration. Like the inclinable type of presses built by this company, the



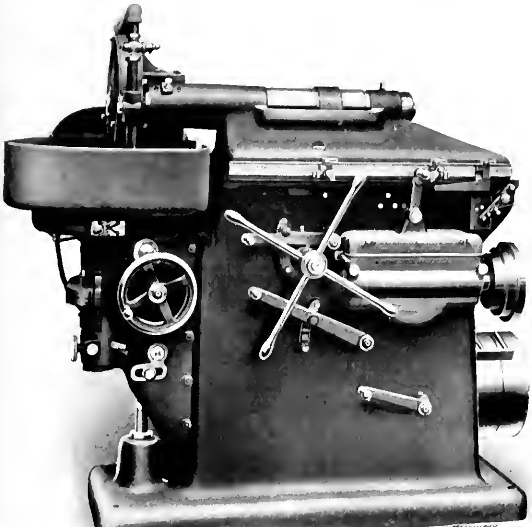
No. 8 Size of Rockford Straight-side Power Press

straight-side machines are built to meet the requirements of modern manufacturing work. The frames are of massive construction, the shafts of ample proportion, and the slides are of exceptional length and width and supported in gibs for nearly their entire length. A special feature is the construction of the main bearings which are so designed that they can be adjusted by means of a sliding wedge.

The straight-sided presses are especially adapted for such work as trimming drop-forgings and for heavy punching, piercing, stamping or forming operations. They are made in three standard sizes which weigh 5000, 7000 and 10,000 pounds, respectively. The 10,000-pound machine is shown in the illustration; this machine has a capacity for pressures up to 100 tons. The weight of the flywheel is 2000 pounds, the diameter of the shaft 4¾ inches, and the width of the main bearings 9 inches.

HEALD ROTARY SURFACE GRINDER

The 16-inch rotary type of surface grinding machine illustrated herewith is a recent product of the Heald Machine Co., 20 New Bond St., Worcester, Mass. This machine is intended for grinding flat surfaces on a great variety of work that can be rotated within its capacity, and combines accuracy with a high rate of production. The frame is of massive construc-



Heald 16-inch Rotary Surface Grinder

tion with the metal distributed in a way that insures great rigidity. The bearings are of ample proportions; all shafts are carefully ground to accurate dimensions, and the ways of the machine have broad wearing surfaces to maintain correct alignment. The grinder is driven by a single belt direct from the lineshaft, no countershaft being required.

The grinding is done by the periphery of a wheel 14 inches in diameter by $1\frac{1}{4}$ inch face. This method of using the wheel is claimed to be the most satisfactory where a high degree of accuracy and perfection of finish is necessary. When this practice is followed, feed lines and radial scratches on the work are practically eliminated. The wheel spindle is hardened and ground and runs in phosphor-bronze bearings that are provided with efficient means of lubrication and adjustment for wear. The belt pull is downward and acts in conjunction with the weight of the wheel slide to prevent the wheel from lifting under heavy cuts. This is an important factor in the high rate of production and accuracy of finish attained on this machine.

Either a 12- or a 16-inch magnetic chuck constitutes part of the standard equipment of this grinder, but other types of chucks or work-holding fixtures can be used when so desired. The 12-inch chuck has a capacity for rings up to 11 inches in diameter and disks up to 12 inches in diameter; the 16-inch chuck has a capacity for rings up to 15 inches in diameter and disks up to 16 inches in diameter. The vertical adjustment of the chuck on the grinder is 7 inches. Angular adjustment for the chuck and work spindle are also provided for use in grinding concave or convex surfaces. This adjustment is also useful in correcting slight errors of alignment which may develop after the machine has been placed in service.

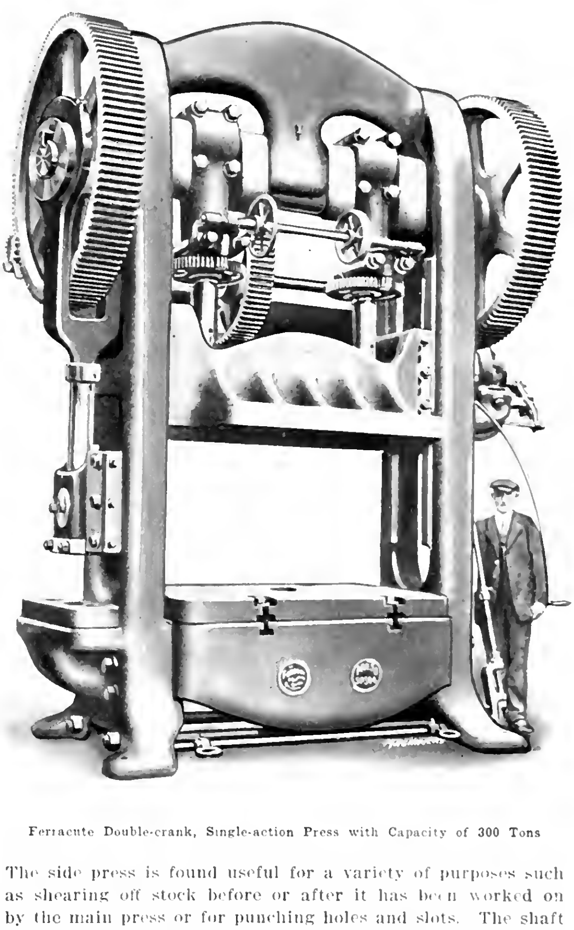
Six changes of chuck speed are available, either of which may be instantly obtained without stopping the rotation of the chuck. The work is fed to the wheel by elevating the chuck. This is accomplished by means of a screw and handwheel which is provided with a graduated dial reading to 0.001 inch. The machine may also be provided with vertical power feed as a special equipment. The wheel is fed across the work by either hand or power, the hand feed being especially satisfactory for use on small work. Three power feeds are available in connection with each work speed and each power feed is automatically reversed.

The grinder is equipped with a pump, tank and water guards for use in wet grinding. The pump furnishes a liberal supply of water which is under absolute control of the operator. The guards are designed in such a way that they prevent water from being splashed onto the operator or thrown on the floor, and also protect the bearings from being damaged by water. Centralized control is a strong feature of this machine, every lever and wheel being located within easy reach of the operator without requiring him to move from his position at the front of the machine. The maximum diameter of the surface that can be ground on this machine is 16 inches, but the machine will swing 22 inches so that it is possible to handle parts that have projecting members extending out beyond the actual surface that is to be finished. The thickness of the work that can be handled is $4\frac{1}{2}$ inches with the size of wheel that is ordinarily used; by using a smaller wheel, however, work as thick as 7 inches can be ground.

FERRACUTE SINGLE-ACTION PRESS

The Ferracute Machine Co., Bridgeton, N. J., is now building a new line of double-crank, single-action presses. These machines are made in various widths between the columns, but all of them exert the same pressure—300 tons. One of this line of presses is shown in the accompanying illustration, this particular machine having a distance of 76 inches between the columns.

These presses are equipped with side punches which make them virtually two presses combined in a single machine.



Ferracute Double-crank, Single-action Press with Capacity of 300 Tons

The side press is found useful for a variety of purposes such as shearing off stock before or after it has been worked on by the main press or for punching holes and slots. The shaft is a high-carbon steel forging with a diameter of $8\frac{1}{2}$ inches at the journals and 10 inches at the cranks. The standard stroke of these machines is 3 inches, but the presses are de-

signed for any stroke up to 24 inches; the illustration shows a press which has the maximum stroke. The adjustment of the ram is 4 inches and the height from the bed to the ram, with the ram at the top of its stroke and adjustment, is 24 inches. The ram is adjusted by means of a worm-shaft connected by gearing to the pitmans, the action on which is simultaneous. The worm-shaft may be revolved by hand, but a pulley is also provided to enable the adjustment to be made by the motor.

These presses are equipped with a combination friction clutch and brake by means of which the machines may be started or stopped at any point of the stroke. The flywheel has a diameter of 40 inches, a face width of 12 inches, and weighs 1800 pounds. The twin gears are 76 2/3 inches in diameter by 11 inches face width, the ratio of the gearing being 40 to 1. The depth of the bed from front to back is 50 inches, and there is an oblong hole in the bed 58 by 36 inches in size. The bolster is $5\frac{1}{2}$ inches thick. The press shown in the illustration weighs about 72,000 pounds.

GARVIN VERTICAL SPINDLE MILLING MACHINE

The vertical milling machine which the Garvin Machine Co., Spring and Varick Sts., New York City, has recently added to its line possesses a number of features that increase its productive capacity. Both the table and cross-slide are provided with fast feed in either direction, which is controlled by automatic trips in the same way as the regular feeds. The

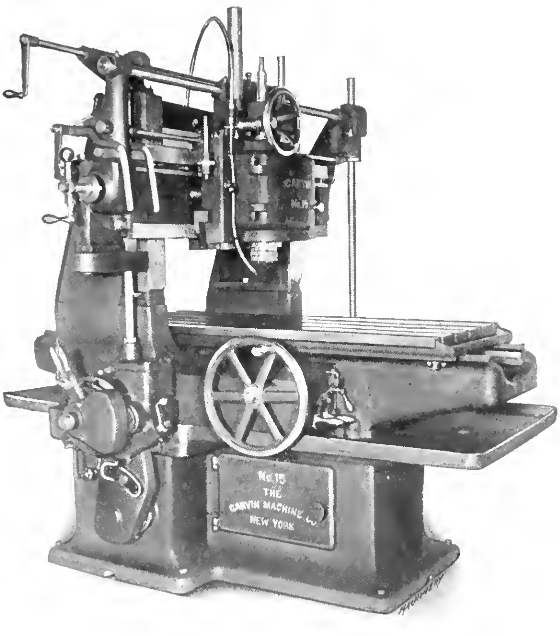


Fig. 1. Garvin No. 15 Vertical Spindle Milling Machine

drive is self-contained, power being transmitted through a cone pulley supported on a bracket secured to the base of the machine. This design lends itself readily to the application of individual electric motor drive, a silent chain being used to connect the motor to the cone pulley shaft, as shown in Fig. 2. Power is taken from the cone pulley shaft through bevel and spur gears connecting with the upper ends of the spindle and back shaft. By shifting one gear, the spindle may be driven direct at high speed or through the back-gears at slow speeds, and in each case the direction of rotation is the same. The spindle has a threaded nose $3\frac{1}{4}$ inches in diameter to take a No. 24 B. & S. cutter; and sufficient power is provided by the machine to drive a cutter 12 inches in diameter.

The table movement is obtained through a Sellers drive which is controlled by a pilot wheel. Both the table and cross-slide are equipped with double feed boxes, giving either the regular or the fast feed at the will of the operator. These feeds are thrown in by separate handles and controlled by dogs on the table and cross-slide in the ordinary way. Two styles of dogs are provided on both the table and the cross-slide. One set of these dogs provides for tripping and coming up against a solid stop, while the other set are buttons that trip the feed but permit of passing over. The fast and the regular feeds are in the same direction, so that the arrangement permits of making quick jumps over intervening spaces be-

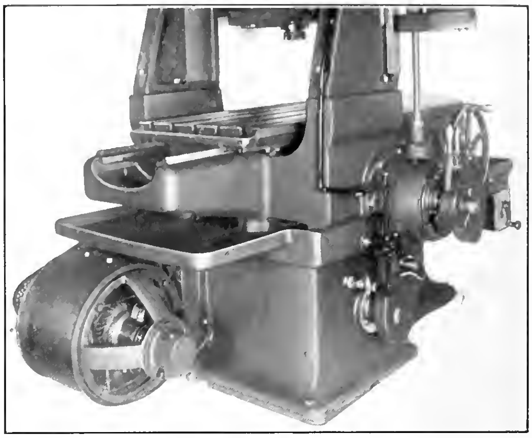


Fig. 2. Motor Drive through Silent Chain applied to Garvin Milling Machine

tween cuts. An interlocking mechanism prevents throwing in both the fast and the regular feed at the same time. One turn of the change feed handle throws the gearing in the feed box out of action, and when this is done another handle on the box may be operated to traverse the table and cross-slide rapidly back or forth by power. The second handle is interlocked with the feed-box to prevent the possibility of accidents.

STOW PORTABLE ELECTRIC TOOLS

The accompanying illustrations show a toolpost grinder and a breast drill which constitute recent additions to the line of portable electric tools made by the Stow Mfg. Co., of Binghamton, N. Y. The toolpost grinder is particularly adapted for grinding lathe centers, dies, cutters and a variety of other classes of work, and it handles both internal and surface grinding. It will be seen from Fig. 1 that a flexible cord and

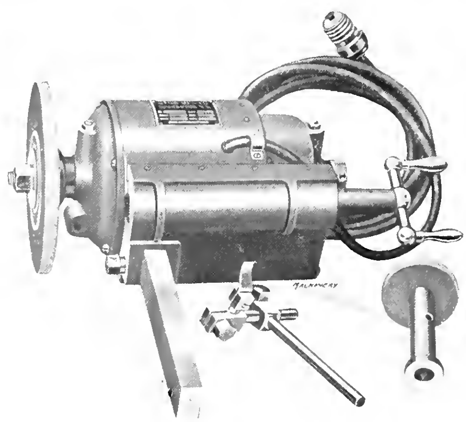


Fig. 1. Stow Electric-driven Toolpost Grinder

plug are used to supply current to the motor, the plug being connected to an ordinary lamp socket. The motor for this grinder is made for 110- or 220-volt, 60-cycle alternating current; or for 110- or 220-volt direct current. The wheel used for external work is 6 inches in diameter by $\frac{3}{8}$ inch face and the attachment for internal grinding is shown beside the motor.

Fig. 2 shows this company's new breast drill which has a capacity for drills up to $\frac{1}{2}$ inch. This tool is equipped with

either a Jacobs or Pratt chuck for straight shank drills. Like the toolpost grinder, the drill motor is provided with a flexible cord for connection with a lamp socket. There is a switch in the handle for controlling the motor. The motor is for use on 110- or 220-volt, 60-cycle alternating current circuits; or for 110- or 220-volt direct-current circuits. Particular attention has been paid to having all parts of the drill carefully balanced so that it is convenient to handle.

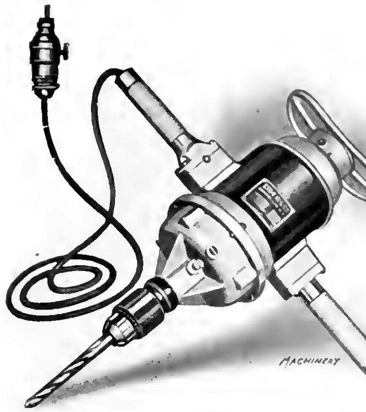


Fig. 2. Stow Portable Electric Breast Drill

CINCINNATI EIGHTY-FOUR INCH PLANER

The accompanying illustrations show an 84-inch planer which has been added to the line of the Cincinnati Planer Co., Cincinnati, Ohio. In designing this machine particular attention has been paid to the means for obtaining rapid manipulation of the heads; all of the control levers are also conveniently placed for the operator, so that this planer is just as handy to run as a smaller machine. Rapid power traverse in both directions is provided for all the heads, and all movements are independent of each other and can be operated whether the table is moving or not. The motor at the top of the machine is used for driving the rapid power traverse and feed to the heads, and for elevating or lowering the cross-rail. The motor pinion engages a large gear on the horizontal rapid traverse shaft from which the pinion that drives the feed clutch receives its power; the latter is shown at the right-hand end of the shaft. Near the center of the horizontal shaft there is a gear that meshes with a pinion on the gear-case of the elevating mechanism, through which power is transmitted for moving the cross rail. A lever from this gear-case passes to the left hand side of the machine and operates the clutches for raising or lowering the cross rail.

The power feed to the heads receives its power from the driving clutch which has a bell-crank and link motion to the bevel gear on the horizontal shaft. This bevel gear meshes with a gear on the vertical shaft which drives the trigger gears on the end of the rail and side heads through spur gears. The driving clutch is tripped by a rod that receives its motion from the tumbler and dogs on the side of the table and bed. The feed is varied by graduated heads which indicate the exact amount of feed at all times, thereby eliminating guesswork. The rapid power traverse receives its power from a second vertical shaft on the side of the housing, the arrangement being similar to that employed for the feed. The small handles seen at the end of the rail and side heads operate the rapid power traverse and feed. Turning these handles to the left engages the rapid power traverse, and turning them to the right engages the regular feed. It is impossible to engage both movements at the same time. The handle at the bottom of the rail is used for reversing the direction of the rapid power traverse. The gearing is contained in the case at the end of the rail, and the operator can make any desired change without moving from his position.

All the heads are taper gibbed and the clapper box is held by a heavy clamp and three screws. The housings are of massive box construction, tongued and doweled to the sides of the bed and fastened at the top by an arch. The cross-rail is secured to the housings by inside and outside clamps which give great rigidity. The table is also of box form and is heavily ribbed to give the required stiffness. The ways are oiled by forced lubrication provided by a pump at the back of the housing. The bed is of the four-wall type and exceptional care has been taken with the bracing. It is bored to receive the driving shaft boxes, which are of large diameter and provided with oil chambers of ample size. All driving gears are of steel and the pinions and table racks are cut from steel forgings. Fig. 1 shows one of these planers with a 34-foot table; and Fig. 2 shows the arrangement of the reversible motor drive, in which the motor is connected direct to

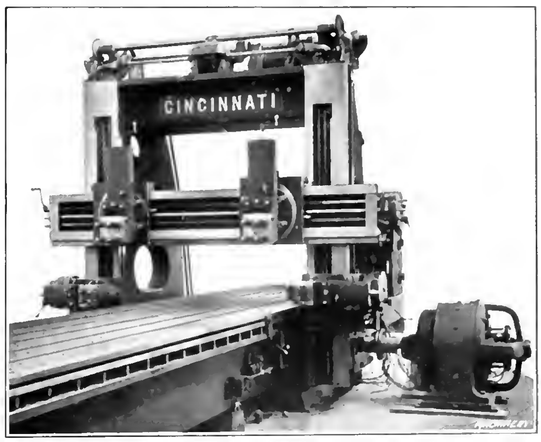


Fig. 2. Arrangement of the Reversible Electric Motor Drive

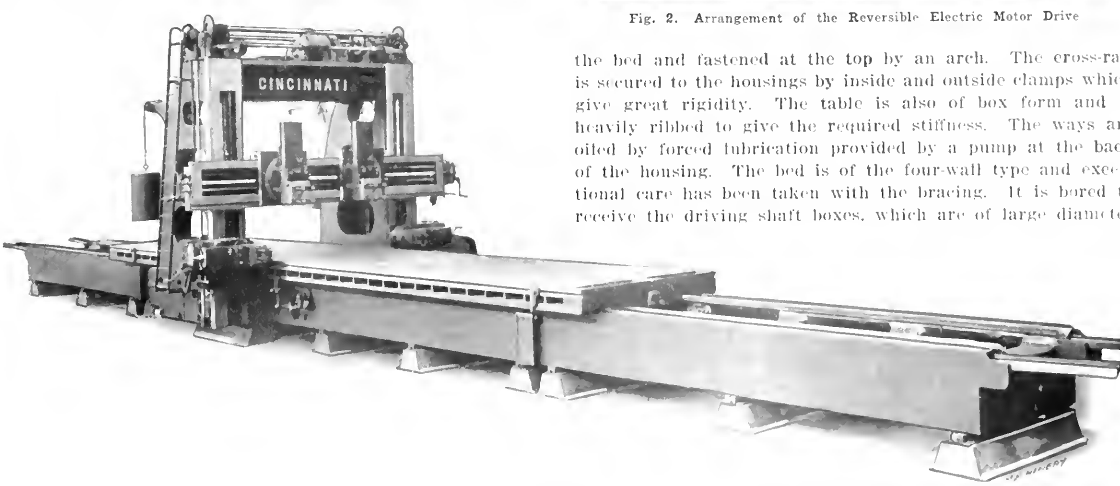


Fig. 1. Cincinnati 84-inch Planer equipped with Reversible Motor Drive and a 34-foot Table

the driving shaft through a flexible coupling. The motor controller is mounted on the housing. Planers of this type are being built in different sizes and lengths.

LANGELIER SWAGING MACHINE WITH SEMI-AUTOMATIC HOLDER

The swaging machine illustrated in Figs. 1 and 2 is a recent addition to the line of swaging machines built by the Langelier Mfg. Co., Providence, R. I. The functions of the machine and holder, taken as a unit, are to feed, reduce or size and automatically withdraw from the machine dies, solid stock, round, hexagonal, square or other sections requiring one plain unreduced butt or end and a reduced shank or blade. This machine handles such work as valve push-rods, nut tapper taps, single-butt automobile spokes, gun cleaning rods and similar parts ranging up to ½ inch diameter and from 8 to 14 inches long. The operator's duties consist only in loading, starting the machine, and unloading the holder; the swaging, feeding and withdrawing of the work from the dies is done automatically.

The reductions of stock are effected without waste of material or removing the surface. An idea of the economy of the swaging process both as to the saving of material and time of production may be obtained from Fig. 3, which shows the lengths of several blanks and also the lengths of the swaged samples. In addition, the saving in grinding expense may be considerable, as the parts are swaged very close to the finished size so that very little grinding is necessary. In many cases the parts are swaged so close to size that grinding is eliminated.

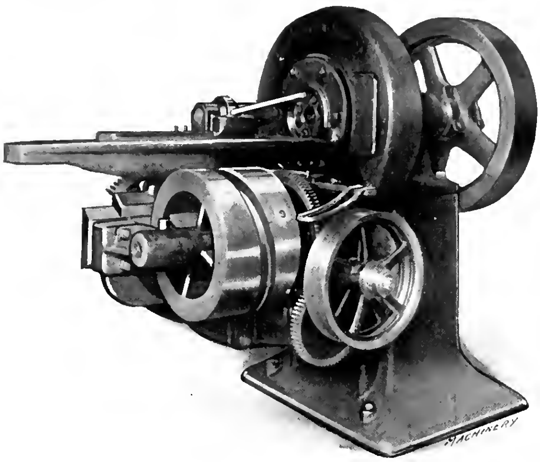


Fig. 1. Langelier No. 4 Swaging Machine with Semi-automatic Holder

The particular machine illustrated is so built that the size to be swaged can be controlled very closely. The machine is heavily constructed throughout to secure a rigid unit so that an unskilled operator can maintain steadily a high degree of accuracy and a large output without injury to the machine. The spindle, which is a vital part, is made unusually large and heavy. It is of hammered steel, turned and ground, and is bored the entire length so that long pieces can pass through and beyond the dies. The spindle is slotted across the enlarged end to receive a pair of hammer-blocks and dies. All sides of the slot are lined with hardened and ground steel plates securely riveted in place, thus practically enclosing the dies and hammer-blocks in a hardened steel box. This construction keeps the dies in true alignment and insures long life to the surfaces in contact.

The hammer-blocks carry on their outer ends two hardened and ground steel rolls which come into contact, during every revolution of the spindle, with a number of hardened steel rolls located in the machine head of the spindle. As the head rolls are in fixed seats, the hammer-blocks and dies are caused

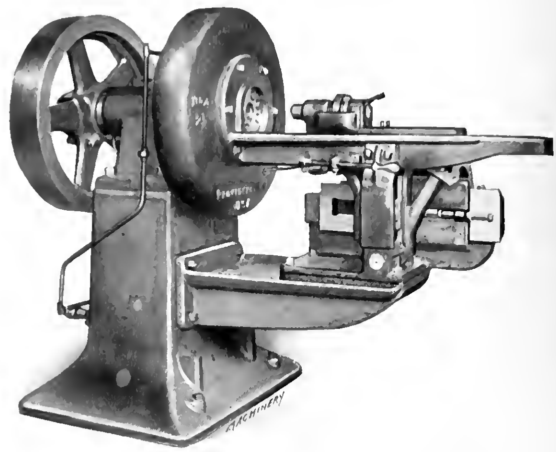


Fig. 2. Opposite Side of Langelier Swaging Machine illustrated in Fig. 1

to strike many sharp, quick blows in rapid succession for each revolution, thus producing a permanent set in the metal being swaged and imparting a high surface finish. The dies are made of high-speed steel and maintain their size for a long time. These dies can be quickly removed if desired. To control the proper die opening and maintain the reduced size required for the stock, two conical pointed screws are let into the front plate in the slotted end of the spindle and project into corresponding holes in the end of the hammer-blocks. Washers of the proper thickness are used under the heads of these screws to retain the distance which the conical screw points enter the hammer-blocks. By adjusting these screws in or out, different amounts of opening between the dies are obtained.

The spindle has an extra long bearing and is provided with loose floating sectional cast-iron bushings which serve to greatly decrease the surface velocity and increase the wearing surface. These bushings are perforated all over and the oil holes act as small reservoirs and serve to distribute the oil over the bearing as the bushings gradually revolve with the spindle. The flywheel is heavy and the hub is bolted and keyed to the spindle. At the rear end of the spindle a clamp nut is provided that serves both for taking up end play which

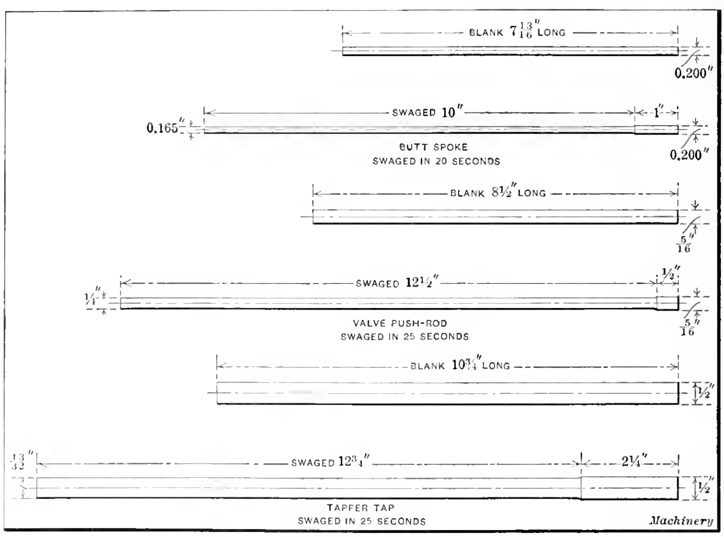


Fig. 3. Comparative Lengths of Blanks and Swaged Samples and Rate of Production

might occur as a result of long service, and for holding the flywheel in position endwise. An automatic oil pump driven from the main spindle, circulates oil through the running parts of the machine and is connected to the large oil reservoir in the machine base. The ample capacity of this reservoir permits running the machine a long time with only periodical attention to the oiling.

The holder consists of a rigid projecting rail bolted to the front of the machine, which provides long bearings on which a crosshead and saddle reciprocate. This crosshead carries an interchangeable and self-centering spring chuck with a hand lever tightener for holding the stock firmly, even when the grip is very short. The crosshead feeds the stock to be swaged, then it pauses slightly to allow the stock to be swaged neatly against the shoulder, joining the unswaged and swaged portions, after which it starts on the return stroke. The crosshead recedes at twice the feeding speed and the stock is automatically withdrawn from the dies; when near the end of the return stroke, the driving belt shifting device for the holder mechanism operates, thus shifting the belt to a loose pulley. This causes the holder to stop in the "loading" position. As the next blank is gripped by the chuck, the operator shifts the driving belt to the tight pulley, thus starting the crosshead again on the feeding or forward stroke. This cycle of motions is repeated for every blank.

The crosshead can be set at any desired position on the holder rail, and the forward or backward travel of the crosshead can be varied according to the length of the blank before and after swaging. The length of the feeding and return strokes of the crosshead are determined by the arc which a segment gear (partly shown in Fig. 1) which meshes with a rack on the under side of the crosshead saddle, describes as it is actuated by a straight-line movement of an adjustable stud on the lower crosshead. By setting this stud at different positions the length of the arc is varied. On the rear of this lower crosshead another stud is provided, carrying a roller which engages the large cylinder cam seen in Fig. 2. This cam is rotated by a wormwheel and worm driven through reducing gears and tight and loose pulleys, from the overhead countershaft.

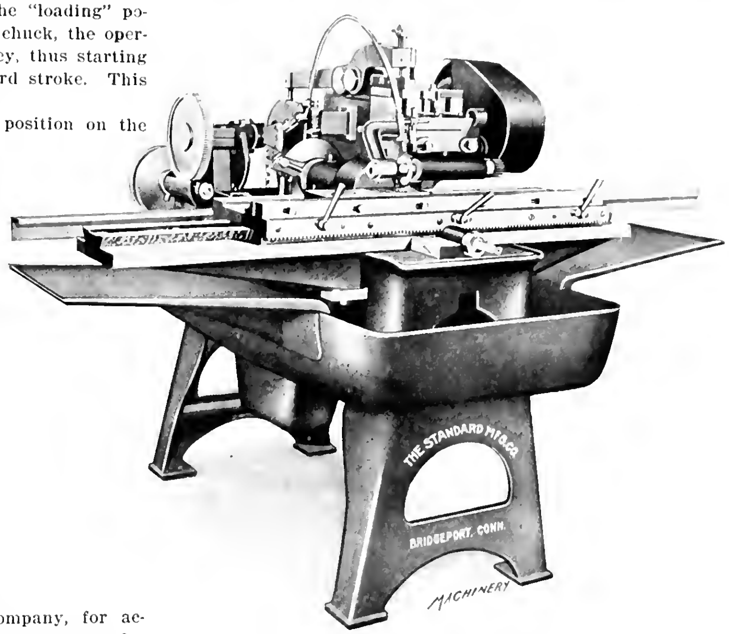
This same type of feeding and withdrawing mechanism can be applied to other types of swaging machines built by this company, for accommodating longer lengths and larger diameters or for reducing tubing. When equipped with high-speed steel dies 2½ inches long, the machine illustrated herewith reduces cold-rolled steel stock 0.311 inch in diameter down to 0.250 inch, in two operations. The feed is at the rate of 30 inches per minutes, and the piece is withdrawn at the rate of 60 inches per minute. Faster feed and return speeds can be used if the size and nature of the stock will permit.

STANDARD RACK CUTTING MACHINE

The Standard Mfg. Co., Bridgeport, Conn., has recently placed on the market an automatic rack cutting machine which has a capacity for work up to 30 inches in length. It will be seen from the illustration that this machine is provided with a deep oil pan equipped with detachable wings. This pan, in combination with an efficient oil pump, insures an adequate supply of oil being delivered to the cutter without the oil being splashed or wasted. The low substantial legs of the machine are a factor in providing for increased stability.

The cross-rail is keyed to the table, clamped by set-screws and fastened underneath. The vise is provided with long bearings and a gib on the inside to enable any wear which may develop to be compensated for. An adjustable steel jaw runs the entire length of the vise. The vise is equipped with a rack with which a pinion meshes that is operated by a crank; this rack and pinion provide for returning the vise to the starting position after the work has been completed. There is an adjustable trip for disengaging the feed when the work has been finished.

To insure accuracy and eliminate vibration, the cutter spindle bearing has been made of ample proportions, and an overhanging support is also provided to hold the arbor at its outer end. The slide which carries the cutter spindle is provided with both vertical and horizontal adjustment by means of screws, and a micrometer adjustment is provided for accurately gaging the depth of the cut. Four-stroke cams are regularly furnished for ordinary work and special stroke cams for special work. This machine has all the regular features of the Standard gear-cutting machines, such as quick return for the cutter; means for raising the cutter free of the work on the return stroke, thus obviating the necessity of again passing through the rack; and allowing the indexing to be done during the return stroke. The locking of the index plate, means of quickly changing the amount to be indexed and similar features of the gear-cutting machines have been retained on this rack cutter. If desired, the rack cutter may be converted into a gear-cutting machine. The rack cutter is made in sizes corresponding to the Nos. 1, 2 and 3 gear-cutting machines made by the Standard Mfg. Co.



Standard Rack Cutting Machine for Work up to 30 Inches in Length

MONITOR A. C. MOTOR CONTROLLER

The Monitor Controller Co., Baltimore, Md., has recently perfected a controller for use on either single, two- or three-phase alternating-current motors. This controller is similar to the pre-set speed type of direct-current equipment manufactured by this company. With alternating-current motors, the dynamic brake for stopping cannot be used; consequently it is necessary to employ a foot-brake on the machine or a magnetic brake on the motor. Where the magnetic brake is used it can be operated from the new Monitor controller.

The accessories used with this new type of controller are identical with those used on the corresponding type of Monitor direct-current apparatus, *i. e.*, provision is made for starting, stopping and reversing the motor and for making slight movements of the machine. Every movement is controlled by either a push button or a safety lever, as shown in the illustrations. The distinctive feature of this controller is that, in starting the motor, a proper amount of resistance is automatically inserted in each phase which gives absolutely correct starting characteristics and is the same under all running conditions. The starting effort required of the motor is

the same, regardless of the position of the regulating handle. After the rotor has attained the proper speed, the starting resistance is automatically cut out by the controller, and the regulating resistance, which has been previously determined by setting the handle, is automatically thrown in, thus bringing the motor to the desired speed, which may be anything

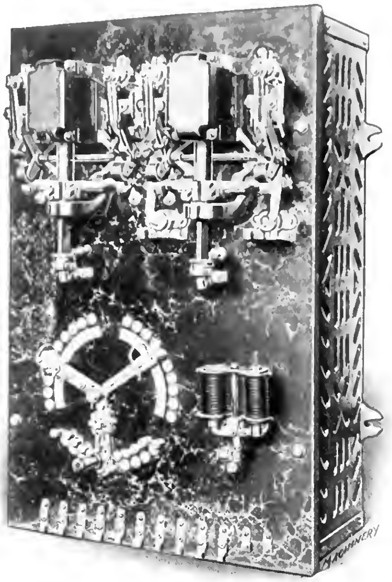


Fig. 1. Monitor Alternating-current Motor Controller

between normal and the lowest specified speed. A no-voltage release is provided with the controller so that in the event of a failure of the line voltage and the consequent stopping of the motor, the entire system is automatically cut out of the circuit and will not start again with the return of the voltage until the operator has moved the starting lever or button.

Fig. 2. Control Station

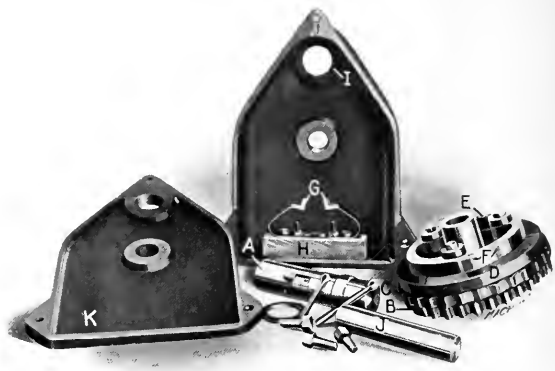
When this is done the starting cycle is again gone through, to place the motor in operation. These controllers are built for one or two motor drive, depending upon the amount of speed variation required, and will eventually be built in all sizes. At present they are made for motors whose rotor current does not exceed 150 amperes.

The control station shown in Fig. 2 is mounted on the machine, and in the case of large machines more than one of these stations will be used. The lever is shown in the "start" position at *A*, the "ready" position at *B* and the "stop and safety" position at *C*.

CLEVELAND CRANE LIMIT SWITCH

In order to perform its essential function of protection in the face of careless operation, a crane limit switch must be designed in such a way that it will always be in operating condition when required. It is impossible to design any mechanical device that will not sooner or later get out of order, and in the case of a limit switch the essential feature is to have an arrangement which will give warning if there is anything wrong. In the closed circuit type of limit switch made by the Cleveland Crane & Engineering Co., Wickliffe, Cleveland, Ohio, this idea has been applied by connecting the switch into the hoist motor circuit in such a way that the electrical operating parts are always charged with current when the hoist is in operation. Should any defect—such as a broken wire or loose connection—develop, it at once throws the motor out of commission the same as though the hoist had been run up to the limiting point. In this way, positive assurance is obtained that the switch mechanism is unfailing in its action when the hoist is running. A feature of the design is the simplicity and accessibility of all parts and the facility with which the switch may be installed.

The parts of this limit switch are shown in the accompanying illustration, from which the method of operation will be readily understood in connection with the following description: The tripper *A* is connected to one end of the hoisting drum shaft by two pins driven into the end of the



Cleveland Closed Circuit Type of Crane Limit Switch

drum shaft. Four holes drilled in the end of the tripper allow for one-quarter turn positive adjustment. A tooth at the end of the tripper engages one tooth of the tripper sprocket *B* at each revolution of the drum. An oval recess cut at the side of the tooth in the tripper permits the check sprocket *C* to rotate while the tripper tooth is engaged in the tripper sprocket. The conformation of the teeth on the outside of the check sprocket to the contour of the tripper prevents the sprocket wheel from turning while the tripper is completing the revolution. Attached to the sprockets by small insulated through bolts is a fiber insulating ring *D* and a brass contact ring *E*. Two fiber contact blocks *F* are inserted in the brass contact ring at a distance apart which depends upon the number of revolutions of the drum required to raise the hoist block between the two extreme positions. Mounted on a fiber block *H* are two contact springs *G* which form electrical connection with the brass contact ring *E*. The circuit leads are attached to terminal posts on the contact springs and are connected to the coil of a magnetic switch which controls the hoist motor current, the switch being located in the cage within easy reach of the operator. When the block reaches the limit of its travel, the switch is opened by the breaking of the circuit in the switch coil, due to the contacts *G* resting on the fiber blocks *F*. The cast-iron box *I* encloses the entire mechanism and is attached to the frame of the trolley by through bolts. One end of the pin *J* which carries the

contact ring and sprockets is held by a bearing in the box, and the other end by a bearing in the cover *K*. The tripper pin is supported in the same way. When the cover is removed from the box every part is instantly accessible and may be readily removed. The small size of this switch makes it particularly convenient to install.

BROWN & SHARPE GEAR CUTTING MACHINES

In developing the Nos. 3-H and 13-H automatic gear cutting machines (Figs. 1 to 4), the intention of the Brown & Sharpe Mfg. Co., Providence, R. I., has been to produce machines that are adapted for taking heavy cuts on coarse pitch gearing and at the same time produce work of a high degree of accuracy. With this idea in view, particular care has been taken in the distribution of the metal to secure the greatest possible rigidity and consequent freedom from vibration. The wheels and levers for controlling all of the movements, as will be seen in the illustrations, have been placed at the front where they are within easy reach of the operator. This is obviously a great convenience in setting up work and in the subsequent operation of the machine. Referring to the illustrations, it will be evident that the No. 3-H machine shown in Figs. 1 and 2 is simply adapted for cutting spur gears, while the No. 13-H machine is intended for cutting both spur and bevel gears. The design and construction of the two machines is essentially the same with the exception of the cutter slides. The No. 3-H machine is described first and the same descriptive matter will apply to the No. 13-H machine with the exception of the cutter slide and one or two other details which will be referred to.

The No. 3-H Spur Gear Cutting Machine

Referring to the rear view of the No. 3-H machine illustrated in Fig. 2, it will be seen that the drive is through a single pulley. In the line-cut Fig. 5 *A* is the shaft on which the driving pulley is mounted. The feed of the cutter slide is taken from this shaft by means of spur gears which transmit through the shaft *B* to the change gear box shown at the right-hand end of the machine in Fig. 1. From the change gear box the drive is back through the shaft *C* which carries a worm meshing with the feed worm-wheel *D* mounted

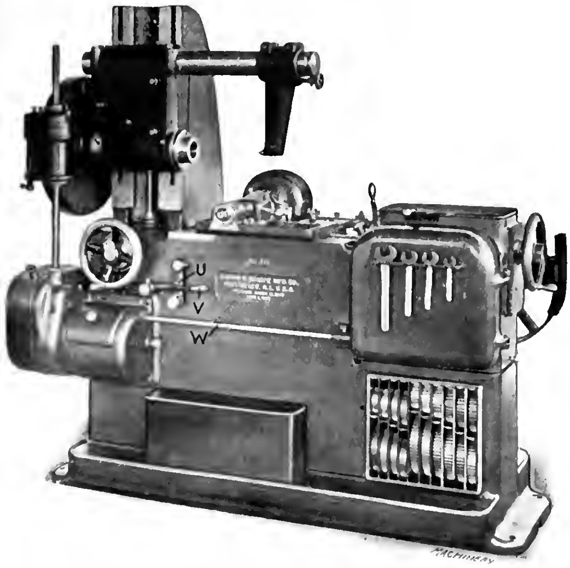


Fig. 1. Front View of Brown & Sharpe No. 3-H Gear Cutting Machine

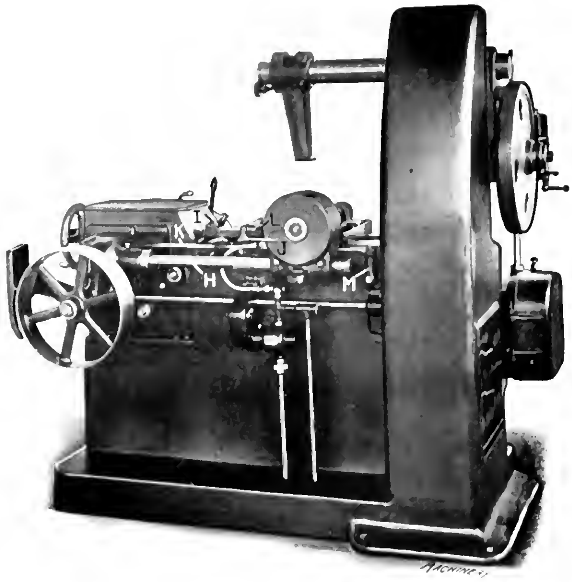


Fig. 2. Rear View of No. 3-H Gear Cutting Machine

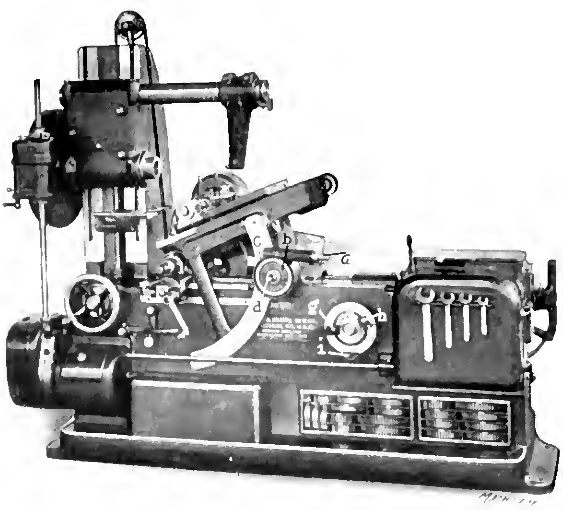


Fig. 3. Front View of Brown & Sharpe No. 13 H Gear Cutting Machine

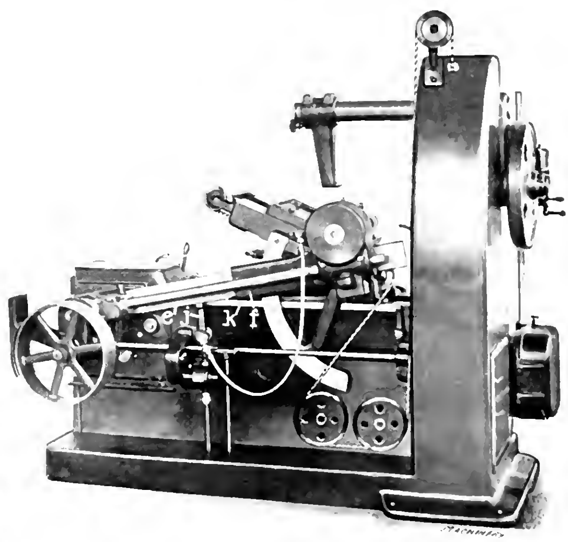


Fig. 4. Rear View of No. 13-H Gear Cutting Machine

on the feed shaft E. The cutter slide is moved by this threaded feed shaft. Sixteen changes of feed are provided by the change gears; these feeds are in geometrical progression and cover a range of from 13/16 to 15 3/4 inches per minute.

The speed changes for the rotation of the cutter are obtained by change gears in the same box in which the feed gears are mounted. The drive to the cutter is carried back through the shaft F, Fig. 5, which drives the shaft H, Fig. 2, by means of bevel gears. There are twelve speed changes provided which are in geometrical progression and cover a range of from 30 to 156 revolutions per minute. An outer bearing has been provided for the cutter spindle which gives additional support to adapt the machine for heavy classes of manufacturing work. Another distinctive feature is the application of a heavy balance wheel on the cutter spindle. This balance wheel is employed to carry the cutter through hard spots in the work or to compensate for any other inequalities that would have a tendency to cause the speed of rotation to vary.

When the cutter has been fed across the face of the work, the movement of the cutter slide is reversed by the action of the dog I which engages the stop J mounted on the horizontal shaft K, Fig. 2. The operation of the mechanism may be briefly explained as follows: When the dog I engages stop J it continues to move forward and carries the stop with it. This, in turn, carries the shaft K forward and operates the clutch mechanism shown in the line-cut, Fig. 6. This illustration shows the feed worm-wheel D and the quick return worm-wheel G which are mounted on the cutter-slide feed rod. Either of these worm-wheels may be secured to the feed rod by means of an intermediate clutch which is operated by the arrangement of the dogs shown in Fig. 2. When the dog I engages the stop J and pulls the shaft K forward, a stop on the end of the shaft K engages with the end of the lever N, Fig. 6. Further movement of the shaft K causes the lever N to swing on its pivot; and the roller carried at the lower end of the lever N runs over the pointed plunger O and pushes this plunger down against a compression spring. This movement continues until the roller has passed the top point of the plunger, when the action of the spring causes the lever N to be thrown over with great rapidity.

A pin carried by the lever N works in a slot in lever P. At the time when the roller has reached the top of plunger O, this pin is engaged with the end of the slot and further movement of lever N causes a corresponding movement of lever P. The cam surface at the lower end of lever N engages with the projection Q on the locking plunger R and causes this plunger to be pushed down against the tension of a spring. The depression of the plunger releases the clutch from the feed worm-wheel D and allows it to be thrown over by the action of lever P so that it engages with the quick return worm-wheel G. When the clutch engages with the worm-wheel, it is locked in engagement by means of the locking plunger R' and remains locked until the carriage has been returned to the starting point. The clutch is then released from the return worm-wheel and thrown back into engagement with the feed worm-wheel. Referring back to Fig. 5 it will be seen that the quick return worm-wheel G is geared direct to the main driving shaft A by means of a pair of spur gears. This drive allows the cutter slide to be returned at fifteen feet per minute.

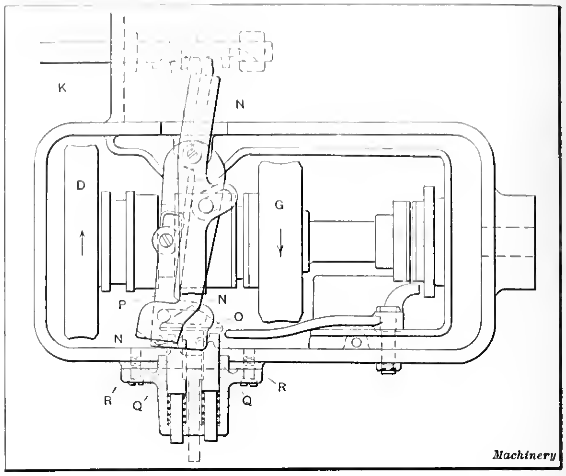


Fig. 6. Mechanism for engaging Feed and Quick-return Worm-wheels

A handwheel is provided at the end of the feed shaft for feeding the cutter slide by hand. This wheel is secured to the shaft by sliding it into engagement with a clutch. It is evident that when the feed of the cutter slide is reversed so that the quick return comes into action, the handwheel would be rotated in the opposite direction at a high speed. Were such a condition allowed to take place, there would be a risk of injuring the operator. To avoid this danger, a lever is provided which acts automatically to throw the handwheel out of engagement with the clutch before the quick return is engaged. This lever is operated by the lever N, Fig. 6, from which the arrangement will be readily understood.

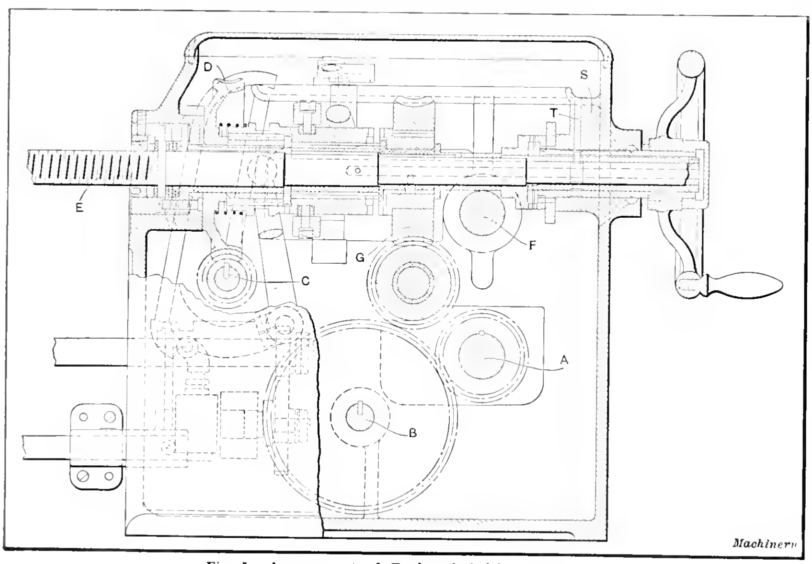


Fig. 5. Arrangement of Feed and Quick-return Drives

It will be remembered that the maximum feed employed on this machine is 15¾ inches per minute while the cutter slide is always returned at the rate of 15 feet per minute. Evidently this change of speed in connection with the reversal of the cutter slide would result in subjecting the gearing to a serious shock. To overcome this difficulty, the arrangement shown in Fig. 7 has been employed. In this illustration G is the worm which meshes with the quick return worm-wheel on the feed shaft. At the moment when the clutch engages with the quick return worm-wheel, the worm is allowed to move over on its shaft against the tension of a stiff spring, and in this way the shock of reversal is taken up by the spring instead of being borne by the gearing. This eliminates damage to the gearing and also does away with the shock and consequent vibration which would result if such a method were not employed. This method of

taking up the shock is a new device which has been recently adopted.

When the cutter slide is being returned to the starting point the dog L, Fig. 2, engages with the stop J carried on the shaft K. This causes the lever N, Fig. 6, to be thrown in the reverse direction. The roller on lever N acts over the spring plunger O as previously described and causes the cam on lever N to disengage the locking plunger R'. In this way, the clutch is released from the quick return worm-wheel G and comes into engagement with the feed worm-wheel D. The cutter slide is then ready for the next cut. The dogs I and L are adjustable so that the traverse of the carriage may be regulated as desired.

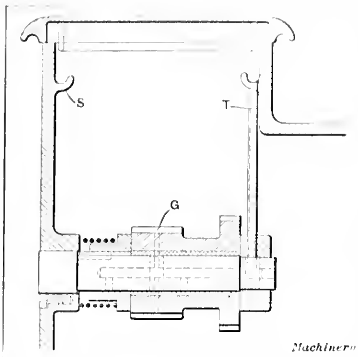


Fig. 7. Spring for absorbing Shock of Reversal and Oil Trough

The gear pump which is provided for supplying lubricant to the cutter is shown in the rear view of the machine illustrated in Fig. 2. This pump delivers lubricant from a large tank which extends all of the way under the machine. This tank is of ample size to insure having an abundance of cool lubricant available at all times ready to be supplied to the cutter. The chips and oil drop down into a pan located under the work. This pan is perforated at the bottom to allow the oil to drain back into the reservoir while the chips are retained so that they may be easily removed.

The gear-box which provides the feed and speed changes is now built as a unit ready to be mounted on the machine, instead of having the different parts of the change gear mechanism assembled in the machine as separate pieces. An improved method of lubrication has also been applied on these machines. This consists of a geared oil pump which delivers lubricant to a trough S shown in the sectional views, Figs. 5 and 7. Small brass taps T are let into the bottom of this trough which deliver oil to all of the bearings. The oil from the bearings runs back to the reservoir from which it is pumped back to the trough S. In this way there is a continual flow of oil being delivered to all of the bearings.

The index mechanism is driven by the lower of the three horizontal shafts shown at the back of the machine in Fig. 2, and the index mechanism is contained in the case shown at the left-hand end of the machine in Fig. 1. Provision is made for cutting all numbers of teeth from 4 to 50 and all numbers from 50 to 100 except prime numbers and their multiples. The placing of the indexing mechanism at the front of the machine is one of the changes referred to in placing all control levers within reach of the operating position. Another change was that of placing the change gears for the index mechanism as shown in Fig. 2, where they are particularly convenient for the operator. The operation of the index mechanism is entirely independent of the speed of the cutter and the rate of feed that is being employed, the indexing taking place during the period that the cutter slide is being returned. Indexing occurs when the cutter slide has reached the end of its reverse stroke.

The way in which the indexing is effected is as follows: When the dog L engages the stop J and pulls the shaft K backward, Fig. 2, it swings the lever M to the left. This lever is carried on a shaft which extends through to the front of the machine and has the small lever U mounted on it. The movement of the lever M rocks the lever U and throws up the lever V. The movement of the lever V engages the index mechanism and at the same time disengages the feed through the action of horizontal shaft W which extends from the index mechanism to the feed change gear-box. This shaft W trips an arrangement of levers which positively disconnects the clutch from the feed worm-wheel. The arrangement of the index mechanism is essentially the same as that employed on the standard No. 3 machine. One slight change may be mentioned in connection with the method of disengaging the worm from the index worm-wheel in order to enable the work to be rotated by hand. This is done by releasing the binder lever X. It will be seen that the upper and lower sections of the case in which the worm is mounted are secured to the case over the worm-wheel. The central section can be swung back when the binder lever is released, and in this way the worm is disconnected from the worm-wheel so that the work may be rotated. This device is found to be a decided convenience in setting up work and making adjustments.

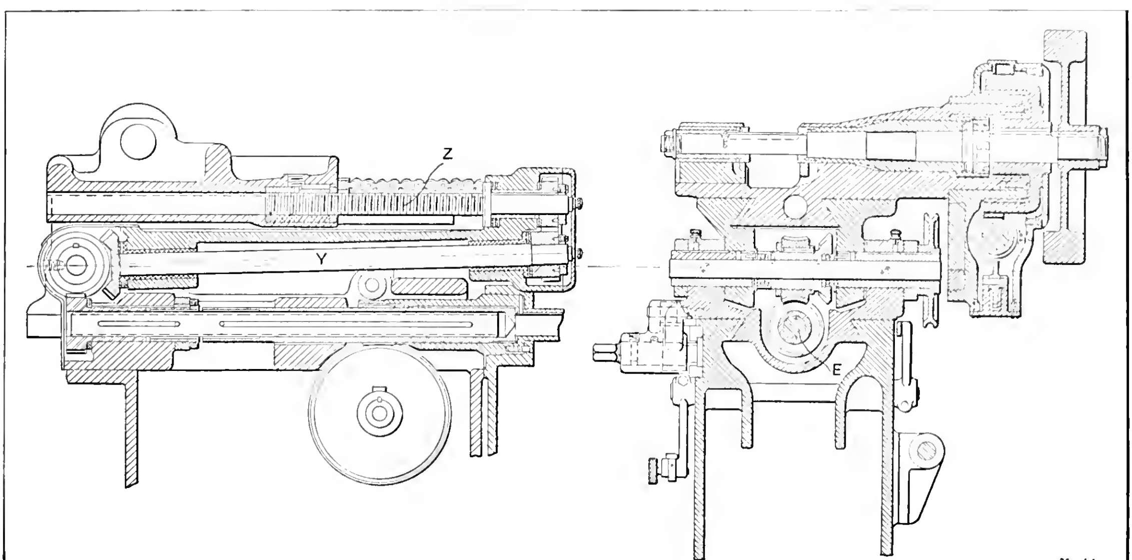


Fig. 8. Longitudinal and Cross-sectional Views of Cutter-slide

The arrangement of the work-spindle slide is evident from the illustrations. In this connection it may be mentioned that a departure from preceding designs of Brown & Sharpe gear cutting machines has been made in the introduction of T-slots in the face of the upright to which the work-spindle slide is clamped by three bolts. The slide is adjusted by means of a screw and handwheel equipped with a dial graduated to 0.001 inch, which facilitates making accurate settings of the depth to which the teeth are to be cut. The thrust on the

screw is taken by a ball bearing. The work-spindle has a No. 11 taper hole and is fitted to receive a faceplate or fixture. There is a hole through the spindle 1 13/16 inch in diameter which provides for the use of a bolt to clamp the mandrel upon which the work is carried in place in the spindle. The over-arm construction employed on this machine is particularly heavy, and as shown in the illustrations, the outboard support is fitted with an adjustable center to engage the mandrel. When so desired, a bushing may be used instead of this center.

The capacity of the No. 3-H gear cutting machine is for spur gears up to 24 inches in diameter and up to 8 inch face width. Gears as large as 3 diametral pitch may be cut from cast iron and 4 diametral pitch in steel. The machine occupies a floor space 85 inches in length—measured at right angles to the cutter spindle—by 45 inches in width. The net weight of the machine is about 4400 pounds.

No. 13-H Combination Spur and Bevel Gear Cutting Machine

Front and rear views of the No. 13-H combination spur and bevel gear cutting machine are illustrated in Figs. 3 and 4. The arrangement of the drive, the change gears for the feed and speed of the cutter, the method of indexing and the design of the work-spindle slide are essentially the same as on the No. 3-H machine. The difference in the design of the No. 13-H machine lies in the provision for making angular settings of the cutter slide for handling bevel gears. First among the improvements in this machine may be mentioned the provision of two segment gears for elevating the cutter slide instead of a single gear. It will be seen that the two segment gears are located at either side of the machine and in connection with the two trunnions which support the cutter slide provide four points of support. This effectually does away with any tendency for the cutter slide to tilt out of alignment.

Fig. 8 shows cross and longitudinal sectional views through the cutter slide. In this illustration E is the feed rod which remains in a horizontal position in the base of the machine. This rod drives the feed-screw in the cutter slide by means of a worm and worm-wheel, a pair of bevel gears and an intermediate shaft Y which transmits the motion to the feed-screw Z through a pair of spur gears. It will be evident that the use of the worm and wheel and the pair of bevel gears allows the cutter slide to be set at any required angle. The angular settings of the slide are made by means of a crank fitting onto the squared shaft a, Fig. 3. This shaft carries a worm meshing with the worm-wheel b and the worm-wheel drives a pinion which meshes with the segment gear. Any angle up to 90 degrees may be obtained by means of a scale graduated on the inner edge of the segment gear. This scale runs under the indicator c which acts as the reference point in making angular settings. After the desired setting has been obtained, the slide is clamped in place by means of a wrench fitting over the end of the squared shaft d.

When the slide is set to angles greater than 30 degrees, a counterweight is employed to relieve the pressure that would come on the feed-screw. This weight is supported by a cable running over pulleys, the arrangement of which is clearly shown in Fig. 4. The counterweight runs down inside the upright of the machine, which represents another improvement in design. This arrangement eliminates the possibility of the weight falling and injuring a workman. To protect the shaft which drives the cutter from strain, a supporting member e has been provided, as shown in Fig. 4. This support is trunnioned at the left-hand end of the machine and runs in a bearing f which is pivoted to the cutter slide.

The method by which the feed and quick return of the cutter slide are obtained is slightly different from that employed on the No. 3-H machine. On the No. 13-H machine the dogs g and h, Fig. 3, rotate and engage with the stop i. This stop is at the end of a crank carried by a shaft which extends through to the back of the machine, Fig. 4. This shaft carries a crank j which moves the horizontal link k. This link corresponds with the horizontal shaft K on the No. 3-H machine. The operation of the clutches and indexing mechanism from the link k is then exactly the same as described for the No. 3-H machine.

The capacity of this machine is for spur or bevel gears up to 24 inches in diameter by 6 inches face width. Cast iron gears up to 3 diametral pitch may be cut and steel gears up to 4 diametral pitch. The floor space occupied is 103 inches long—measured at right angles to the cutter spindle—by 16¾ inches in width. The net weight of the machine is about 5300 pounds.

"STANDCO" HOLLOW SET-SCREW

The "Standco" hollow set-screw is a recent product of the Standard Pressed Steel Co., Philadelphia, Pa., for use in connection with the "Hallowell" cold-rolled steel safety set-collar of this company's manufacture. These hollow set-screws are made from steel bar stock of a special analysis which has been found exceptionally well suited to this purpose.

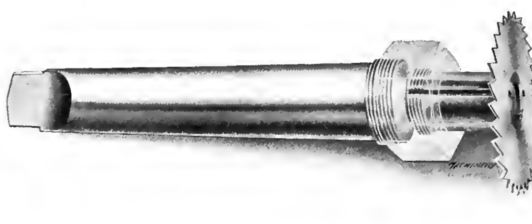
The "Standco" Hollow Set-screw

The heat-treatment and hardening process to which these set-screws are subjected have been given particularly careful attention with the result that they are uniform in hardness and toughness and able to stand up under the most severe service. "Standco" safety set-screws are made with either a hexagonal or a square hole, and in almost any diameter and length. They are furnished with different forms of threads and points to suit the requirements of a variety of classes of service for which they are adapted in addition to their application on the "Hallowell" set-collars.

GRANT INTERNAL GRIP ARBOR

There are many milling operations where the nut or the end of the arbor extending out beyond the cutter interferes with the work or clamps, and in such cases end or face mills have to be used. The effective radius of cutters and saws used on an ordinary arbor is also reduced by an amount equal to the thickness of the wall of the clamping collars. To overcome these difficulties the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn., has brought out an internal-grip arbor which is shown in the accompanying illustration. No nut is used on this arbor that would interfere with the work and, for any given operation, the size of the cutter or saw that is required is materially reduced.

This arbor has the usual form of taper shank, and at the opposite end there is a tapered extension over which fits a



Grant Internal-grip Arbor for Milling Cutters and Saws

split sleeve. The end of this sleeve is threaded left-hand, while the end of the arbor is threaded right-hand. The sleeve is first screwed into the clamping nut, after which the nut is screwed onto the arbor. This causes the split sleeve to be drawn up on the tapered end of the arbor and expanded sufficiently to secure a firm grip on the inside of the cutter. To release the cutter from the arbor it is merely necessary to loosen the nut.

Many shops are not well equipped with face milling cutters and the arbors for holding them. The use of this internal-grip arbor enables ordinary side-tooth cutters to be employed for face milling operations, thus adding materially to their

field of usefulness. The sleeves provided for use on these arbors are made in different lengths to suit all cutters of ordinary width. An arbor of this type is also made, which is adapted for use in the vertical attachment for the milling machine. This allows the entire equipment of standard cutters in a shop to be used in the vertical attachment, where formerly only end-mills or special cutters provided with taper shanks could be employed. The standard arbors of this type are made with either No. 9 or No. 10 B. & S. taper shanks, and they are equipped with sleeves for cutters having holes 7/8 or 1 inch in diameter.

THE BRIGHT BALL-BEARING HANGER

The Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, has introduced a new ball-bearing hanger which is the result of a careful study of hanger requirements. Before referring to this hanger it may be well to call attention

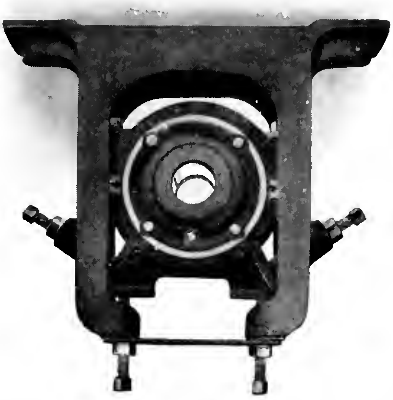


Fig. 1. Bright Ball Bearing Hanger of Universal Swiveling Type

to some of the reasons for its construction and arrangement. As is quite generally known, the ball-bearing hanger formerly manufactured by this company consists principally of a box frame carrying a heavy yoke which is free to swivel about a vertical axis and contains the box and bearing. The box is held within the yoke upon horizontal set-screws, thus providing a universal swiveling movement for the bearing and box. This hanger, which was developed from the four-point screw suspension type, has given satisfactory results,

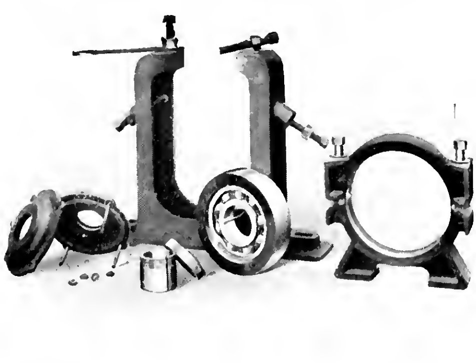


Fig. 2. Component Parts of the Bright Ball Bearing Hanger

although in some instances trouble was experienced because of careless erection. If a millwright when installing the hanger tightened the two horizontal set-screws (which hold the bearing and box within the yoke) excessively, the box body and hence the bearing might be distorted, and even if this distortion were very slight it would subject the close-fitting balls to enormous pressure as they passed the narrow places thus formed between the races. To make it impossible to distort the bearing in this manner and, at the same time, retain the universal swiveling movement the new hanger shown in the accompanying illustrations was designed.

This hanger was originated by Mr. Fred E. Bright, President of the Hess-Bright Mfg. Co. It has a rigid box frame, the jaws of which are flanged on the inside to retain a yoke which holds the bearing box and bearings. This yoke is divided on the horizontal center line, and it is securely held in position by four set-screws which come against the base. Two of these set-screws bear against the bottom of the base and provide vertical adjustment, whereas the other two set-screws are inserted through the sides, near the base, at an angle of 45 degrees and bear against a surface on the base which is at right angles to them. With this arrangement the yoke is held securely, but the clamping screws cannot possibly cause distortion of the box as the result of excessive tightening. The yoke is provided with a machined spherical seat for the box which contains the ball bearing. This feature enables the bearing and box to swivel in any direction. The bearing is enclosed within the box, and as both move together in case there is any deflection of the shaft only a very slight clearance is required between the shaft and the box covers at the ends, thus excluding dust and protecting the races and balls. This improved form of swiveling box and bearing will be applied to the post type of hanger and also to floor stands and pillow blocks.

GARDNER PATTERNMAKERS' ROLL SANDER

The roll sanding machine shown in the accompanying illustration is made by the Gardner Machine Co., Beloit, Wis., and is used in making wood patterns. A typical application

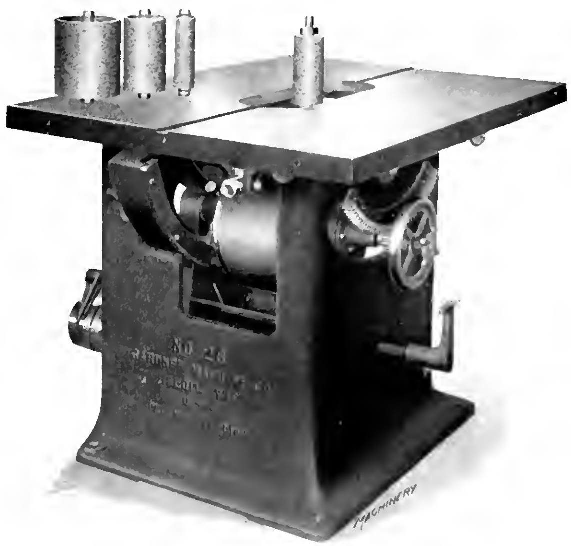


Fig. 1. Gardner Patternmakers' Roll Sander

of the machine is for finishing core boxes. The cutting member consists of a metal roll covered with a strip of "netbac" garnet paper. This strip of paper is joined on an oblique line in order to avoid the "chug" which would take place at each revolution if the ends were butted on a perpendicular line. The roll, which oscillates slightly up and down, is driven by a friction pulley, and its speed can be increased or diminished according to the size of the roll which is being used. This speed adjustment is made by a regulator screw located on the under side of the housing; and a speed variation of from 2000 to 6000 revolutions per minute can be obtained. The equipment includes four rolls, which are 7 inches long by 2, 3, 4 and 6 inches in diameter, respectively. The smaller the roll, the higher the speed required in order to obtain an efficient cutting speed.

Helical hardened steel gears are used to produce the oscillating motion of the roll spindle. Instead of tilting the table for sanding work at an angle, simple means are provided for tilting the roll spindle and locking it in any required position,

as shown in Fig. 2. This allows the operator always to work with the table flat, which is said to be an advantage. The angle to which the roll is tilted is accurately indicated by graduations located on the rim of the segment gear directly behind the handwheel. The opening in the table through which the roll passes is elongated to provide for moving the table laterally. This lateral motion, which is governed by a screw equipped with a micrometer dial, is utilized when fix-

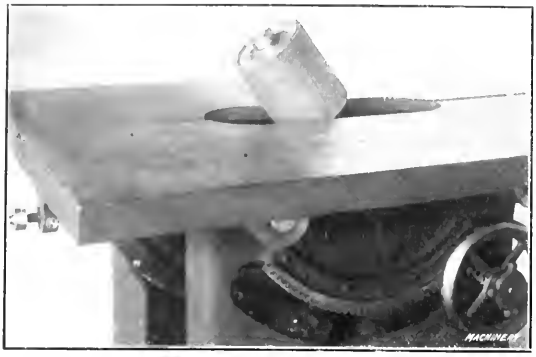


Fig. 2. Method of tilting Roll on Sander

ture are employed in sanding a large number of duplicate pieces. If small pieces of work are to be sanded, the opening in the table around the roll is closed by dropping a removable plate into place, this plate usually being made of hard wood. One of these plates is shown in use in Fig. 3. The table is 36 inches wide by 48 inches long and the height from the floor is 36 inches.

It will be evident from the preceding description and illustrations that this machine is adapted for sanding both in-

Fig. 3. Finishing an Internal Angular Curve on Gardner Sander

ternal and external work with either perpendicular or inclined faces. Fig. 3 shows the method of finishing an internal, inclined curve. This is typical of a class of work which is frequently met with in almost every pattern shop, the piece shown being the head of a core box for an ordinary straight core. For handling this work, the roll is tilted to an angle of 20 degrees and the operator simply follows the line which has been laid out on the work. The convenience of having the table flat is particularly marked on work of this kind. A feature of this sanding machine is that knots, nails, or the grain of the wood do not interfere with its operation in any way. The complete equipment includes four rolls, cement and an assortment of "netbac" garnet strips. No countershaft is required. A dust hood can be suspended from above to keep the top of the table clear. The floor space occupied is 6 by 8 feet and the complete weight of the machine 1700 pounds.

MC CROSKY VARIABLE SPEED AND REVERSING ATTACHMENT

The "Wizard" variable speed and reversing attachment for drill presses shown in Figs. 1 and 2 is a recent product of the McCrosky Reamer Co., Meadville, Pa. This attachment combines the functions of a drill speeder and tapping attachment, with an addition of two speed changes. By operating the small knurled handle at the front of the attachment either of three forward speeds may be obtained; the rotation of the tool is also reversed by this handle. As an example of the work for which this attachment is intended, consider a case in which it is necessary to drill a small and a large hole and tap one of the holes. The variable speed feature provides for driving the small drill at a high speed and the large drill at a low speed, while the reverse enables the tap

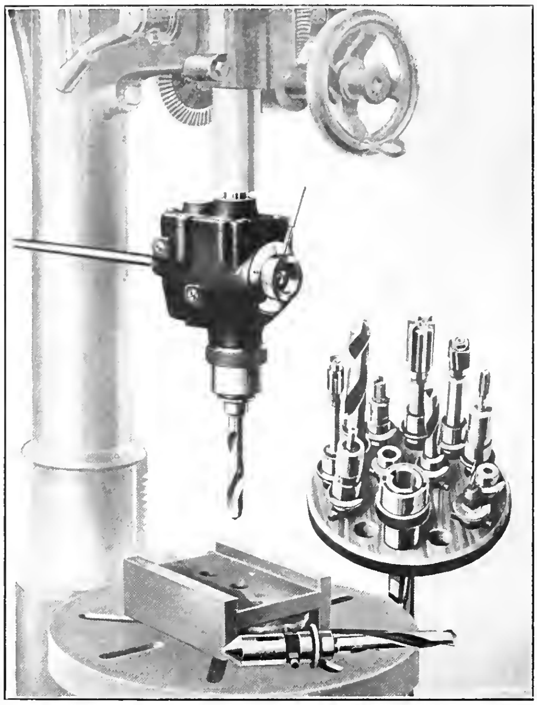


Fig. 1. Drill Press equipped with McCrosky Attachment

to be backed out of the work after the tapping operation is completed. The tapping may be done at slow speed and the tap backed out at high speed.

All bearings are bushed—the four main bearings with special cast iron and the loose gears with phosphor-bronze. There are no sliding gears, the transmission being effected by two positive clutches. All gears are of hardened steel. Taps, large drills and similar tools should be run at the slow or direct speed and for such work the gears run idle. The direct speed is the same as the speed of the drill press spindle and, of course, can be easily regulated to suit the work in hand. The intermediate speed is about two and one-half times faster than the direct speed, while the high speed is about five times that of the spindle.

This attachment is regularly furnished with the "Wizard" quick-change collet chuck. This chuck is used in connection with individual collets which are kept on the different tools which are used in succession in machining a piece of work. By holding the knurled sleeve on the chuck back against the rotation of the spindle the collet carrying the tool which has finished its operation may be removed without requiring the machine to be stopped. A fresh tool is mounted in the chuck in the same way, it being merely necessary to hold the sleeve

back against the rotation of the spindle and then slip the collet up into the chuck. In Fig. 1 a drill press is shown equipped with one of these McCrosky variable speed and reversing attachments. Beside the table of this machine a rack will be seen in which a series of tools mounted in collets are carried. The ability to operate the tool at the most desirable speed and to make quick changes from one style of tool to another materially reduces the cost of machining operations.

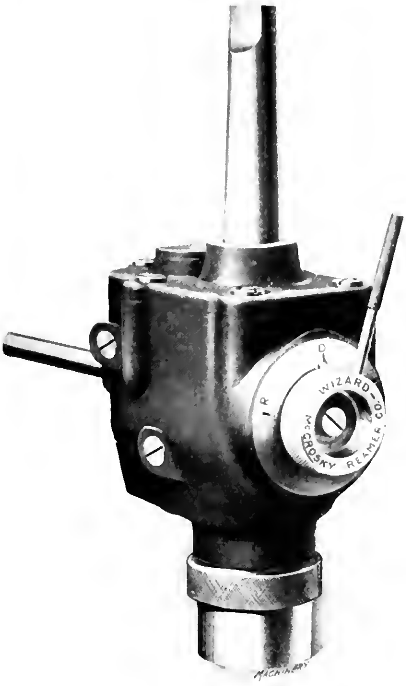


Fig. 2. McCrosky Variable Speed and Reversing Attachment

WALDEN COMBINATION SOCKET WRENCH

The No. 6 combination ratchet socket wrench set shown in the accompanying illustration is a product of the Walden Mfg. Co., Worcester, Mass. Referring to this illustration, it will be seen that the equipment consists of a 9-inch ratchet wrench, an extension bar, a universal joint and sixteen assorted sizes of sockets, including a long spark plug socket. The sockets cover a range of sizes from ½ to 1¼ inch and fit cap-screws from 5/16 to 1 inch, U. S. S. nuts from ¼ to ¾ inch, and A. L. A. M. nuts from 5/16 to ⅞ inch. The wrench is packed in a fiber box and weighs five pounds.

The No. 6 Walden Combination Socket Wrench

A No. 4 combination wrench set of similar design is made by this company which consists of the wrench, a universal joint, an extension bar and a set of eight sockets. A No. 10 set is also made which includes three wrenches, 5, 9 and 12 inches in length; an extension bar; a universal joint; and a set of thirty-one sockets. These wrenches are primarily intended for the use of automobile owners and mechanics employed in garages, but the same style of wrench could be used to advantage in many machine and assembling shops. The different combinations that are possible will be evident from the illustration.

ACME SEMI-AUTOMATIC NUT TAPPERS

To meet the demand for a nut tapping machine of simple construction, capable of turning out a large production, the Acme Machinery Co., Cleveland, Ohio, maker of forging, nut making and threading machinery, has brought out a line of semi-automatic nut tapping machines, the 1-inch size of which is shown in Fig. 1. The machine illustrated has a capacity for tapping either square or hexagon nuts from ⅝ to 1 inch (this is the diameter of the tap used). It is possible to obtain a much greater output with this machine than with the older types of six-spindle machines, the increase in production ranging from 50 to 100 per cent.

Each tap-holding spindle is operated independently. It is counterweighted to prevent breakage of taps and is provided with an automatic lifting device consisting of a worm and auxiliary mechanism. By means of this device the tap is lifted after one nut has been tapped, allowing the next nut to be fed in automatically from the chute to the nut holder. The operation of the feeding mechanism of the machine can be seen more clearly by referring to Figs. 2 and 3. As the tap passes through the nut, the worm shown at the top of the spindle drops, and in so doing comes in contact with a bronze washer or collar. This collar, through a bell-crank arrangement of levers, pushes a shoe into contact with the threads of the worm, whereupon the latter rises and lifts up the tap and the nuts on it clear of the nut holder, allowing another nut to be fed in. The nut is fed in by a feeding finger, operated from a rod at the rear of the machine, through a system of levers which come into action as the spindle is lifted.

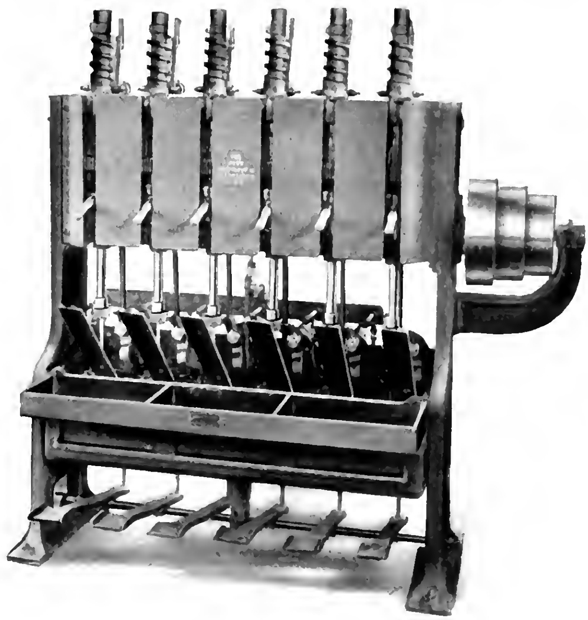


Fig. 1. One-inch Size of Acme Semi-automatic Nut Tapping Machine

Fig. 2 shows the tap spindle in the "up" position and the feeding finger pushing another nut into the nut holder. Fig. 3 shows the tap just as it has passed through the nut being tapped. The cycle of operations outlined is repeated until

the shank of the tap is filled with nuts, whereupon the tapping spindle ceases to operate, owing to the filled tap preventing the worm from contacting with the bronze collar previously mentioned. As soon as the tapping spindle ceases working the operator removes the filled tap by depressing the foot-lever. This lifts the spindle, and consequently the tap, clear of the nut holder, enabling the tap to be easily removed; quick-acting ring chucks are provided so that this can be done while the spindle is rotating. The nuts are then slipped off the shank of the tap, the latter is replaced in the quick-acting chuck, and as the operator removes his foot from the foot-lever the machine begins operating again.

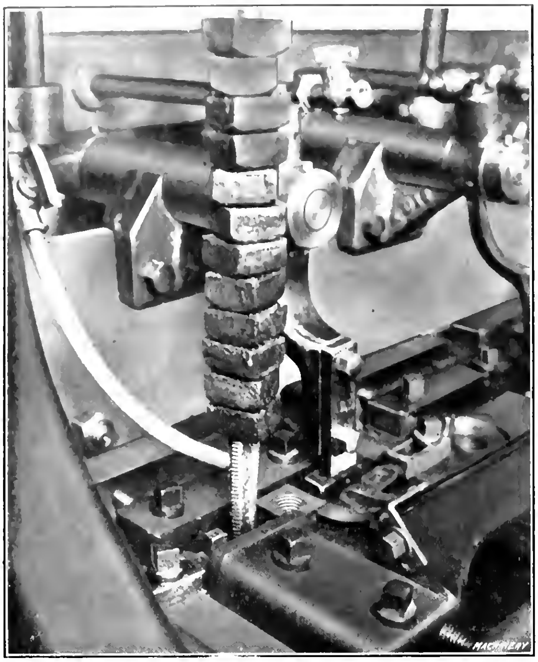


Fig. 2. Close View showing Tap raised and Nut being fed in

The worm cannot drop until the threads on the tap have cleared the nut, so that if the trips on the machine are properly set it is impossible for two nuts to be on the threaded portion of the tap at the same time. The nuts are fed to the machine through a chute, which can be adjusted to suit various sizes of nuts within the range of the machine, as can also the nut holder. A rotary oil pump is furnished so that a copious supply of cooling liquid is supplied to the taps at all times, keeping them cool and clean and allowing the maximum speed to be obtained. Movable chip pans with screen bottoms are provided which allow the oil to drain from the chips and permit the chips to be easily removed.

This type of nut tapper is also built in ½-inch size. The regular equipment furnished with the machines consists of a rotary pump, a countershaft, the necessary wrenches, a chip pan, and six quick acting ring sockets of any size within the capacity of the machine. This equipment can be changed, however, to suit individual requirements.

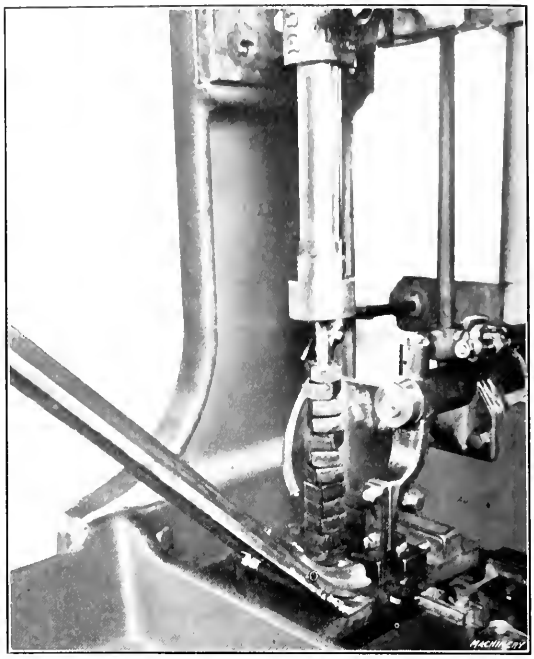
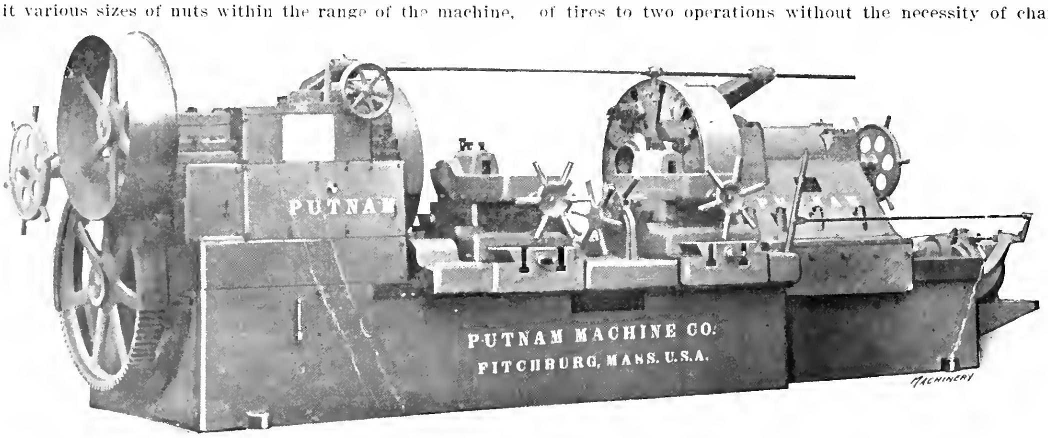


Fig. 3. Close View showing Tap in Action

PUTNAM COACH WHEEL LATHE

In the May, 1913, issue of MACHINERY a 42-inch coach wheel lathe manufactured by the Putnam Machine Co., Fitchburg, Mass., was illustrated and described. Since that time the design of this lathe has been improved in several ways, which add materially to its efficiency of operation. These improvements will be described in the following:

An improved form of combination tool-slide which has been applied to the lathe reduces the work of turning a pair of tires to two operations without the necessity of changing cutting tools except in the case of tool failure or breakage. This tool-slide is self-contained and is not dependent upon compressed air or manual labor for its function of holding the cutting tools. In case of tool failure, the arrangement is such that a change of tools can usually be effected while the companion tool is cutting and without loss of time. The



Putnam Coach Wheel Lathe of Improved Design

divided nut on both the transverse and longitudinal feed screws in the tool blocks provides for taking up any backlash which may develop. The tool-slide has one roughing and one full width forming tool mounted side by side, each of which is readily detachable for the insertion of a fresh tool. The single screw tool clamp is positive in action and holds the cutting tools rigidly under all operating conditions. It is only necessary to tighten a single screw to clamp the tools. The binder arm is of steel and hardened on the contact point. The tools are clamped down onto the hardened steel plates having corrugated surfaces.

Another improvement consists of the provision of power longitudinal movement of the tailstock in connection with an automatic tailstock clamping device. The tailstock motor is started up under no load, the control being entirely mechanical. The tailstock is run forward until taper surfaces engage with corresponding surfaces on the bases of the tool blocks to automatically stop the tailstock and clamp it to the bed. The motor is then released by a friction relief. Reversal of the tailstock motor releases the clamping device and allows the tailstock to be run back away from the headstock. When the tailstock is clamped the downward force of the work against the cutting tool and the force tending to lift the tailstock up off the bed counteract each other. This result is obtained by having the tool block overlap a projection on the tailstock, a similar construction being used between the tool block and headstock.

NIAGARA BOTTOM FLANGING MACHINE

The accompanying illustration shows a bottom flanging machine recently built by the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is intended for turning out bottoms and tops for barrels, tanks, etc., and it is particularly useful where it is required to produce heads of different diameters, as it would often be out of the question to make dies, owing to the limited number of pieces to be formed. Other shaped flanges besides the square ones shown in Fig. 2 may be formed by substituting the required shape of rolls. The machine may also be used for cutting circular disks and for slitting sheets, in which case rotary cutters are substituted in place of the flanging rolls.

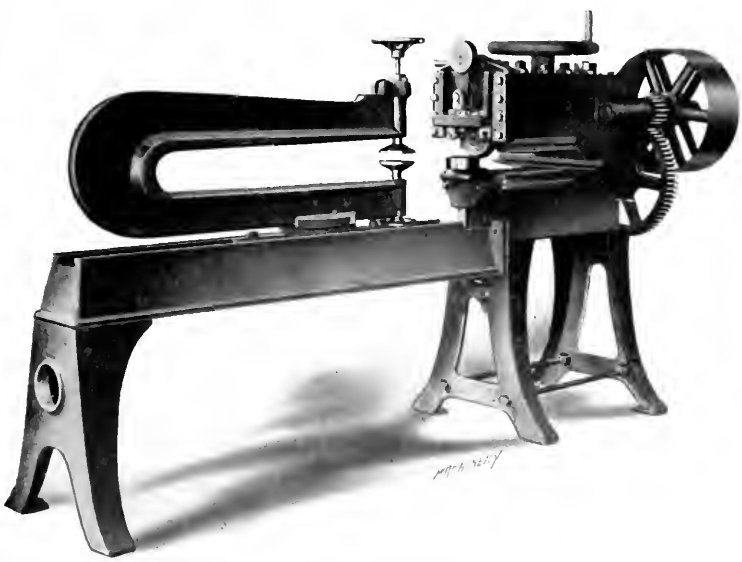


Fig. 1. Niagara Machine for forming Flanged Tops and Bottoms for Barrels or Tanks

The machine is single back-geared and provided with tight and loose pulleys. The main gear is mounted on the lower shaft, from which power is transmitted to the upper shaft through a compensating connecting gear. The lower flanging roll is mounted on a vertical shaft that is driven from the main shaft through bevel gears. The upper shaft can be adjusted laterally to allow for variation in the thickness of the material. For this purpose there is an eccentric segment lever located at the front of the machine within easy reach of the operator. The upper shaft may be raised and lowered, but always kept in horizontal alignment by means of an arrangement of screws and gears operated by a handwheel located at the top of the machine.

In order to prevent the metal from becoming distorted during the flanging operation, two hold-down rolls are provided on the slide in front of the upper flanging roll; and to facilitate the removal of flanged disks, the hold-down rolls can be quickly raised and lowered by an eccentric lever. The machine shown in Fig. 1 will flange disks from 14 to 60 inches in diameter. For material up to No. 10 gage soft sheet steel, the maximum height of the flange that can be produced is 1½ inch. The machine will cut metal as heavy as No. 8 gage and disks can be cut ranging from 8 to 53 inches in diameter.

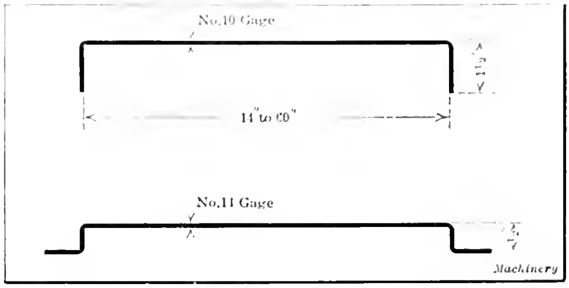


Fig. 2. Range of the Machine in Nos. 10 and 14 Gage Soft Steel

LANDIS PLAIN GRINDING MACHINE

The accompanying views are of a large motor-driven plain grinding machine just completed by the Landis Tool Co., Waynesboro, Pa. This machine has a capacity for work 30 inches in diameter and 20 feet in length. As will be seen, it is driven by three motors; one for driving the grinding wheel, one for revolving the work and traversing the grinding wheel, and one for driving the water pump. The work and traversing motor drives the gear box at the end of the machine which is arranged with a clutch mechanism so that the drives can be started and stopped independently, or together independent of the motor. The motor runs at a constant speed and the speed changes of both the work and wheel traverse are made by an arrangement of gear shifts and clutches, all of which are operated from one position at the front of the machine. There are sixteen different work speeds, ranging from 2 to 45 revolutions per minute; and ten changes of wheel traverse speed, ranging from 2½ to 84 inches per minute.

The grinding wheel is driven by a variable speed motor, the speed of which is controlled by the electric apparatus shown mounted upon the main wheel carriage. The standard size wheel for this machine is 30 inches in diameter and has a wearing range of 8 inches on the diameter, the electric controller being arranged to give the proper cutting or peripheral speed with the wheel at any size within its range of wear. As will be seen by the rear view, the grinding wheel motor is mounted upon a separate carriage which travels on a track formed on the base of the machine. The wheel and motor carriages are entirely independent except for an arm connection for propelling the motor carriage with the traversing movement of the wheel carriage. The motor carriage is mounted on large rollers which are fitted with ball bearings. The track surfaces upon which this carriage travels are protected by metal guards. The electric current is transmitted to the wheel motor through sliding contact shoes and feed wires located along the body of the machine.

These wires are also protected by a shed formed metal guard to prevent anything falling on them from directly above.

The grinding wheel slide, for feeding the wheel to and from the work, is arranged with a rapid mechanical feed mechanism which is operated by the vertical lever located between the feed handwheel and the motor controller as shown in Fig. 1. This is for the purpose of moving the wheel away from the work quickly when changing from piece to piece, or from one size to another, in case various diameters are being ground on the same piece and for feeding the wheel in quickly to the grinding position. The transverse movement of the wheel is in the same direction as the movement of the operating lever; to feed to the work the lever is pulled in the same direction and *vice versa*. In addition to this, there is the usual hand feed, as well as automatic feed for feeding the wheel at the reversing points.

The grinding wheel motor is controlled by an automatic motor starter and field rheostat with rheostat relay. This makes a very efficient arrangement, as the controller can be set to give the wheel the proper peripheral speed for any size of diameter within its wearing range, and the motor is then operated by an ordinary knife switch. This arrangement gives a positive control of operation and with the automatic starter the speed picks up gradually after the starting switch has been thrown into contact. Another feature of the construction of this machine is that all bearings of spindles which run continuously while the machine is in operation are made of bronze, and the spindles are of hardened and heat treated steel.

The starting box of the water pump motor is mounted directly upon the motor itself, which places it in a very convenient position for the operator. The starter for the work-drive and wheel-traverse motor is not shown, as this is mounted to meet existing requirements when the machine is installed. This machine is intended for grinding a line of large shaft work, the largest piece to be handled occupying the full distance between centers, and the diameters will range up to 24 inches. It is strictly a manufacturing grinder and is particularly well suited for such work as engine crankshafts, steam turbine shafts, armature shafts and heavy roll work. This machine is also built for 40 inches swing when desired.

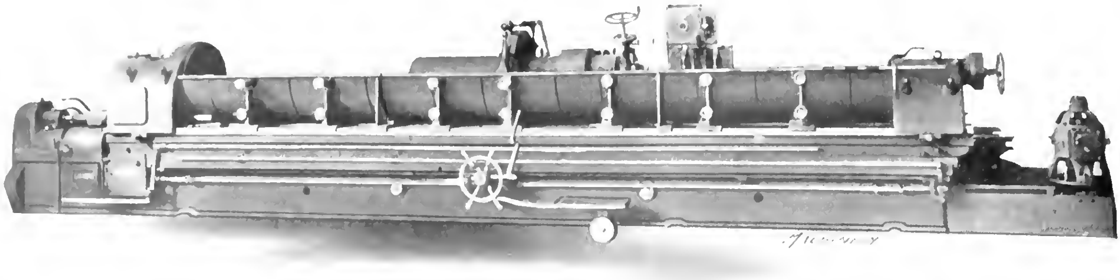


Fig. 1. Front View of Landis Motor-driven Plain Grinding Machine

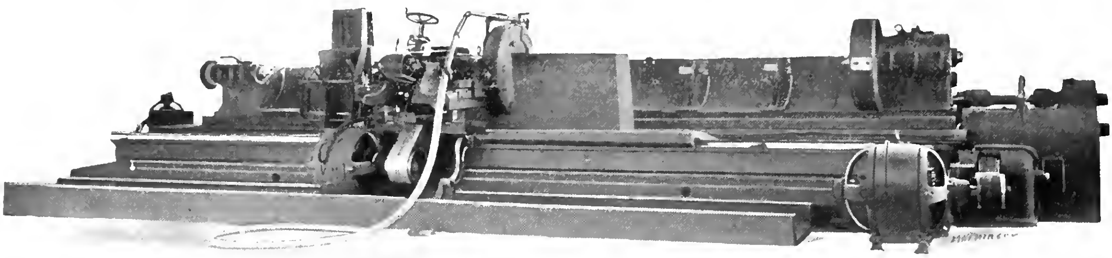


Fig. 2. Rear View of Landis Grinding Machine shown in Fig. 1

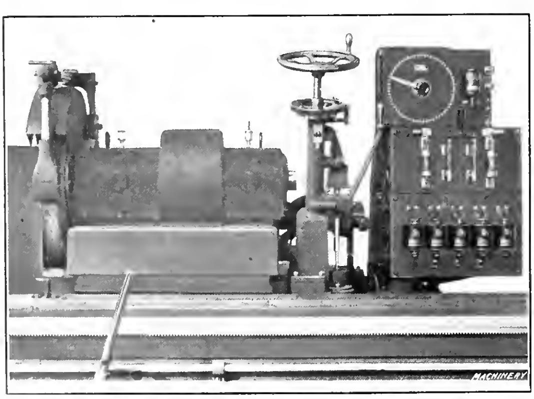


Fig. 3. Electrical Apparatus for controlling Grinding Wheel Motor

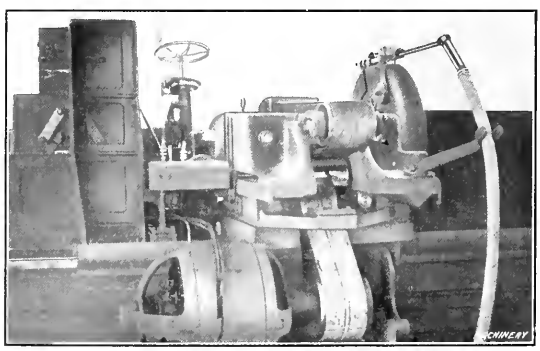


Fig. 4. Rear View showing Wheel Drive and Pump Connection

NORTON PLAIN GRINDING MACHINE

The Norton Grinding Co., Worcester, Mass., is now building the small machine for grinding cylindrical work shown in Figs. 1, 2 and 3. It is made to swing 3 inches in diameter in order to afford room for suitable steadyrests for supporting work ranging from 1/8 inch to 1 inch in diameter and up to

18 inches in length. The machine is particularly adapted for handling work from $\frac{1}{8}$ to $\frac{1}{2}$ inch in diameter and is designed for finishing cuts where there is not more than from 0.004 to 0.008 inch of stock to be removed from the diameter of the work. It is especially useful for grinding small twist drills, tool work, and the parts of cream separators, sewing machines, electrical apparatus, phonographs, roller bearings, and similar classes of work.

The machine is self-contained, no overhead works being

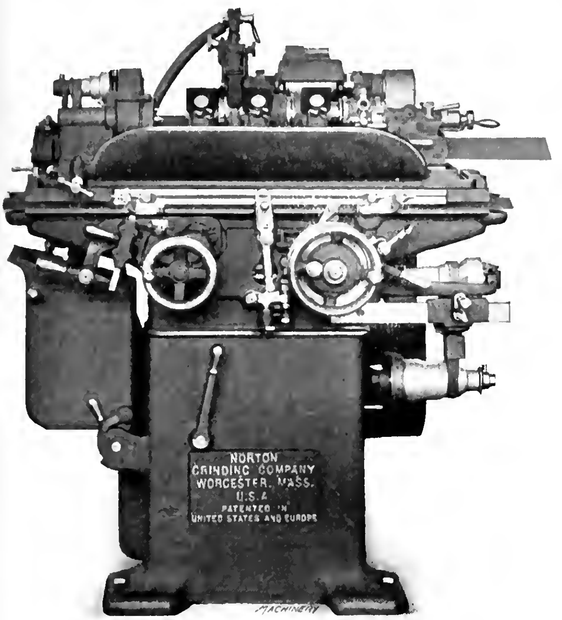


Fig. 1. Front View of Norton 3 by 18-inch Plain Grinding Machine

required. The drive is by a belt either from above or below, or by a motor placed on the floor at the back of the machine. The table reverse is pneumatically cushioned, making it possible to operate the table at a maximum speed of 27 feet per minute. Eight table speeds are provided, the slowest of which is 17 inches per minute. The automatic and hand cross-feed, while of entirely new design, sacrifice nothing in the matter of accuracy in sizing the work. The control of the revolution of the work and of the table traverse is unusual, in that while either can be started separately or both simultaneously, the stopping of the work always stops the table and the table cannot be started unless the work is revolving. Stopping the table connects the handwheel for moving the table by hand, and this handwheel is disconnected when the table is started. The footstock covers the dovetail ways on which it slides and protects them from damage. The steadyrests are especially designed for small work; they are provided with micrometer stops and arranged for quick handling. Three universal steadyrests are furnished with the machine and also a set of hardened steel work shoes for one diameter of work. These shoes are designed to give a quick change from one size of work to another; they provide convenient means for making adjustments and rigid support for long work of small diameter. The work shoes are of steel, hardened and ground.

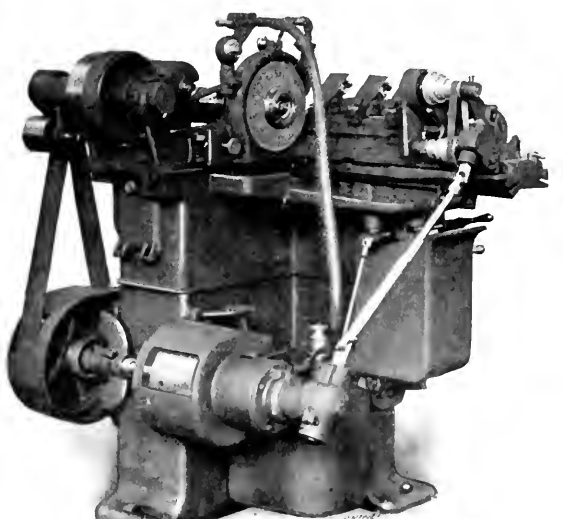


Fig. 2. Rear View of Grinding Machine shown in Fig. 1

Four work speeds are provided, ranging from 160 to 640 revolutions per minute. The wheel spindle is a chrome-nickel steel forging carefully heat-treated. The shafts are self-oiled and the loose pulley runs on a self-oiling roller bearing. The footstock spindle, in common with a number of other parts of the machine subjected to wear, is hardened to insure satisfactory wearing properties. The pump provides an ample supply of lubricant to the wheel and work, and the settling tank is conveniently arranged for cleaning. The machine carries wheels 10 inches in diameter by $\frac{3}{4}$ inch face width, and tapers up to 2 inches per foot can be ground.

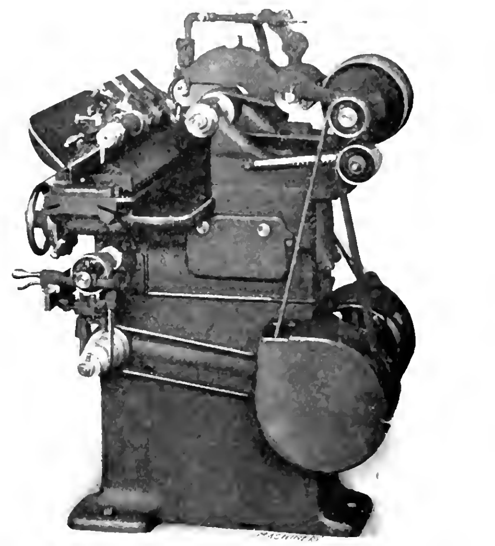


Fig. 3. Right-hand End of Norton Plain Grinding Machine

The regular equipment provided with the machine includes two wheels, three complete universal steadyrests, three work shoes for one size of work, a diamond for dressing the grinding wheel, a center grinding attachment and a suitable equipment of wrenches. All belts are furnished in place ready for use with the exception of the main driving belt. The weight of the machine is about 1950 pounds.

WILLEY ENGINE LATHE

In bringing out the lathe illustrated in Figs. 1 and 2, the purpose of the Willey Machine Co., Jeffersonville, Ind., was to meet the demand for a small machine equipped with a simple and reliable motor drive. When desired, this lathe can also be driven by a belt from the countershaft. It is a standard lathe with a standard motor and a standard cone drive from the motor to the lathe.

The bed is made narrow under the headstock so that the belt can pass down to a cone pulley on the countershaft. The countershaft is provided with means for vertical adjustment to take up slack in the endless belt. The motor is started and stopped by a handle near the headstock. There is one large

vee at the front of the bed and a flat way at the back of the bed upon which the carriage and tailstock are mounted. The motor regularly used in this lathe develops 1/4 horsepower and is found to be ample for the requirements of the average shop. A 1/2 horsepower motor is required to pull the lathe to the limit of its capacity. The cone pulleys take a belt 1 1/2 inch in width. The diameter of the front spindle bearing is 1 3/8 inch,

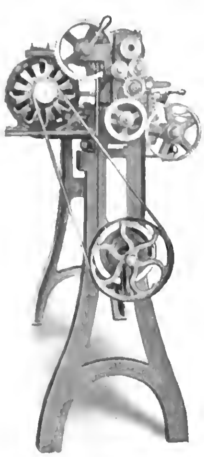


Fig. 1. End View of Willey Lathe

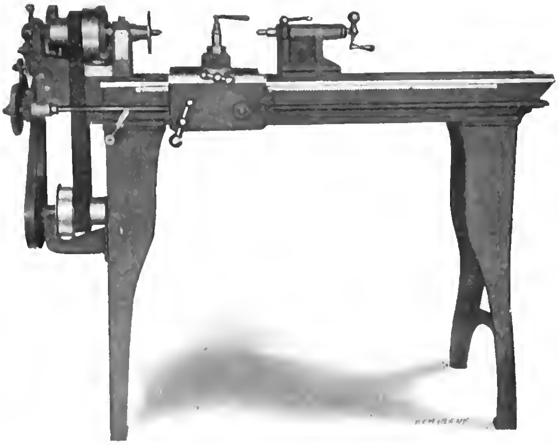


Fig. 2. Front View of Willey Engine Lathe

and the diameter of the back spindle bearing 1 1/8 inch. The lead-screw is 7/8 inch in diameter, and the lathe swings 10 1/4 inches over the bed and 6 inches over the carriage. The weight of the machine is about 500 pounds.

GREAVES-KLUSMAN GEARED HEAD LATHE

The accompanying illustrations show a 17-inch quick-change geared-head lathe with single pulley drive, which is a recent product of Greaves, Klusman & Co., Cincinnati, Ohio. In the design of this lathe the use of frictions in the geared head has been entirely eliminated, all speed changes being obtained through sliding gears. The arrangement is similar to the sliding gear transmission used on automobiles; it consists of few parts, and thorough tests have demonstrated its durability. In the automobile sliding gear transmission the operation of two levers is required for throwing out the friction clutch and obtaining speed changes. On this lathe a single vertical lever on the headstock operates the speed changes and engages the friction clutch driving pulley. Before any speed changes can be obtained it is necessary for the operator to disengage the friction clutch. This relieves the gears of all strain and allows them to slide freely and without shock or jar.

Ten spindle speeds are provided, any of which can be obtained instantly without stopping the lathe and while the tool is cutting. A single in or out movement of the vertical lever operates the friction clutch on the driving pulley to start or stop the lathe, and by moving this lever to the right or left into notches which are plainly marked, any desired spindle speed can be instantly obtained. The action of this vertical lever is self-locking, and in connection with the notched segment and direct reading index plate, it forms a most convenient method of control.

The horizontal lever at the top of the headstock provides for driving the spindle either direct or through the back-gears. By placing this lever in the neutral position, the spindle is disengaged to provide for revolving it by hand. Power is transmitted through heat-treated steel gears which are driven by a single friction-clutch pulley which delivers ample power to the cutting tool under all conditions. The spindle is driven at a point close to the front bearing, thus reducing vibration and torsional strain on the spindle to a minimum. The arrangement of the gearing is such that only those gears required for any one speed can be engaged and there are no idle revolving gears to add to the frictional load.

An interior view of the headstock is shown in Fig. 3. The initial driving shaft transmits power through gears to a driven shaft having a cone of five gears. Power is then transmitted to a second driven shaft having a cone of three sliding gears which engage with three of the cone gears on the first driven shaft. On one end of the three sliding gears there is a positive stepped clutch and by sliding these three cone gears along on the shaft they connect with a spring tensioned cone of two gears with a positive stepped clutch. When in this position, the five sliding cone gears are connected and power is transmitted to the fourth cone gear on the second driven shaft. By sliding these five gears still further along, the fifth cone gear on the second shaft is engaged. This makes

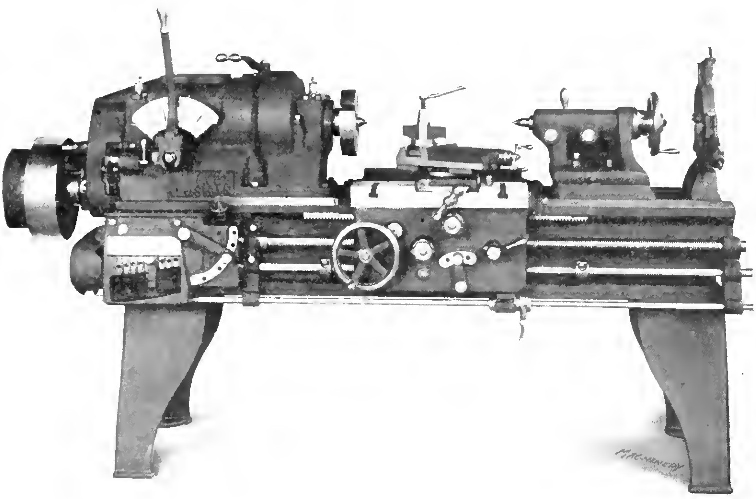


Fig. 1. Greaves-Klusman 17-inch Quick-change Geared-head Lathe with Single Pulley Drive

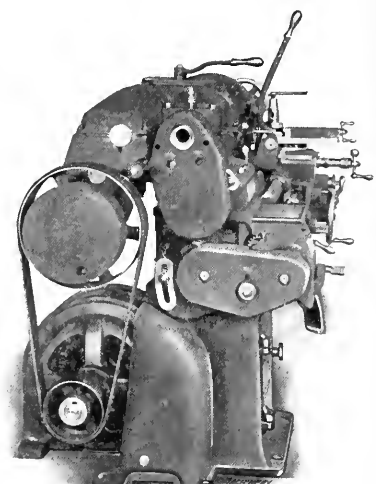


Fig. 2. End View of Greaves-Klusman Lathe with Motor Drive

five changes of speed direct to the spindle, and by engaging the back-gears, five additional speed changes are available, giving a total of ten speeds, all of which are controlled by the vertical lever. Both cone shafts are mounted in anti-friction ball bearings at both ends and in the center. Two of these ball bearings on the second driven shaft are placed close to the face wheel pinion to carry the heavy load that is imposed upon this pinion.

The headstock is of box section with the sides extending up to the center line of the spindle. Heavy internal braces extend both lengthwise and crosswise and make an exceptionally rigid construction. The headstock forms an oil reservoir which keeps the gearing well oiled, increases its efficiency and reduces wear. All of the mechanism is located inside the headstock and the top of the headstock is hinged to afford access to the gearing and other parts. The spindle is of chrome-nickel steel with the front bearing hardened and runs in phosphor-bronze boxes. The spindle bearings are lubricated by sight-feed oilers. The end thrust is carried by alternate hardened steel and bronze thrust washers. A phosphor-bronze flanged sleeve is secured to the headstock and the friction driving pulley runs on this sleeve, thus relieving the driving shaft of all belt pull. The driving pulley is enclosed at the outer end and the hub is provided with an oil well, the construction being such that the oil passes through a felt pad which filters it before it reaches the bearing. In addition to the vertical lever on the headstock for engaging the friction clutch pulley, connection is made direct to the apron so that the operator can start or stop the lathe without leaving the working position. For this purpose a lever is attached to the lower left-hand end of the apron, as will be seen in Fig. 1.

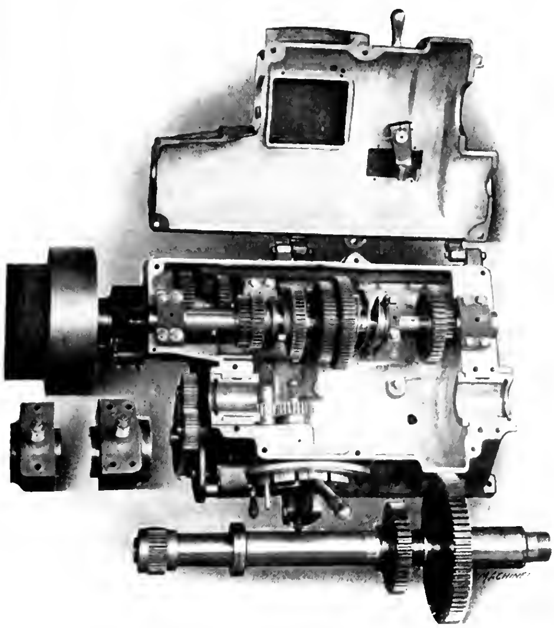


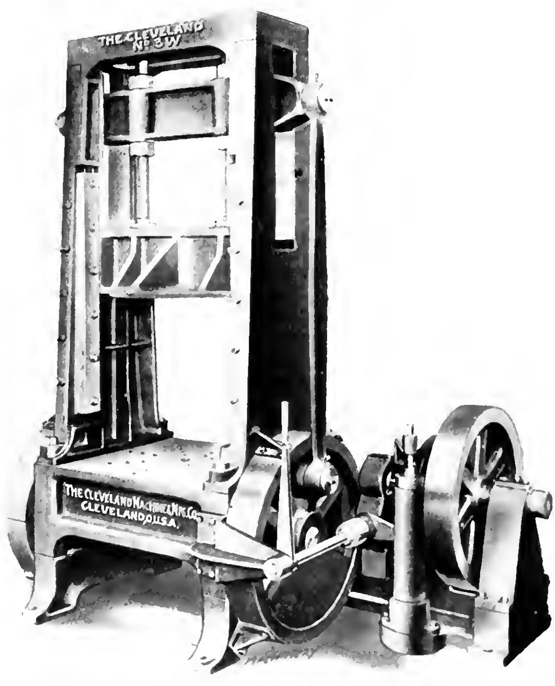
Fig. 3. Interior of Headstock of Groaves-Klusman Lathe

With the constant speed single pulley drive, the lathe can be belted direct from the lineshaft, or a single speed tight and loose pulley countershaft or a double friction pulley countershaft may be used. Fig. 2 shows the end view of a lathe equipped with individual motor drive which requires no additional floor space. The motor is attached to an oscillating plate inside the cabinet leg, this plate being pivoted to allow the motor to be raised and lowered. This affords means of obtaining the desired belt tension at all times, and as the motor is located close to the floor, it does not have any tendency to produce vibration in the lathe. If desired, direct-connected motor drive may be employed by substituting a friction gear for the friction drive pulley and mounting the motor upon the rear of the cabinet lathe. Any standard make of direct- or alternating-current, constant- or variable-speed motor may be used. All of the features of Greaves-Klusman lathes are included in this machine, among which may be mentioned the heavily reinforced bed; the elimination of tool overhang when turning work of the largest diameters; the double clamp, single-acting tailstock; a double walled apron with double supports for all studs and shafts; and the feed-rod supported at each end of the apron with automatic stop in both directions.

CLEVELAND WIRING AND FORMING PRESS

The long stroke wiring and forming press illustrated herewith is a recent product of the Cleveland Machine & Mfg. Co., Cleveland, Ohio. This machine is intended for deep forming operations on light sheet metal parts and for wiring the edge of wash tubs, water pails, ash cans and similar articles. The bed area is 32 inches square, and the stroke of the slide is 20 inches. In order to secure a rigid frame and proper gib construction, the uprights or housings are made unusually deep from front to back and they are heavily ribbed to obtain the desired stiffness. Lugs on the back of the gibs fit into cored pockets in the housings and take the pressure of the adjusting screws. The construction gives an unusually good bearing for the slide, and at the same time permits the slide to be removed from the machine without taking down the housings.

The machine is double-geared, the ratio of the gearing being 10 to 1, and it is belt driven through the flywheel which acts as a pulley. A cone friction clutch mounted in the flywheel is operated by a cam on the main shaft under the bed, which automatically releases the clutch on the up stroke and applies a brake to the driving shaft. Pressure on the foot treadle releases the brake, and the clutch is thrown in by a weight which is cushioned in a dash-pot. For setting dies, the automatic arrangement of the clutch can be disengaged by loosening a nut on the lever shaft and the machine can then be operated by means of the hand lever shown. The total weight of this wiring and forming press is 7000 pounds.



Cleveland Wiring and Forming Press

CLEVELAND 7 3/4 INCH AUTOMATIC SCREW MACHINE

The following description will give some of the most interesting facts concerning the largest and most powerful full automatic screw machine that has ever been built. This machine, a front view of which is shown in Fig. 1, is the product of the Cleveland Automatic Machine Co., Cleveland, Ohio, it will handle round rough bar stock up to 7¾ inches and varying 1/16 inch in diameter anywhere along the bar. A ten foot bar of 7¾ inch round stock weighing 1584 pounds is handled with the same ease, and fed out to the same exactness, as regards length, as a two-inch bar. This machine represents an unusual development in automatic machinery for producing parts from bar stock; with suitable magazine attachments it will also handle castings and forgings.

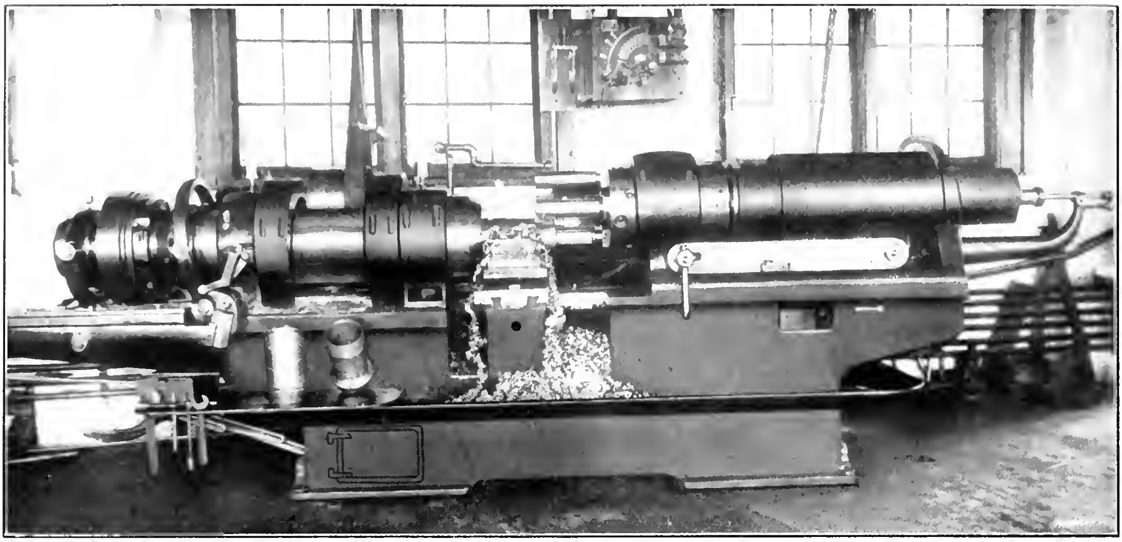


Fig. 1. Front View of 7¾-inch Cleveland Automatic Screw Machine (Gear Guards removed)

The Head and Spindle

Some idea of the massiveness of the machine will be gained from a study of the head. The work-spindle, made from a semi-steel casting, is 58⅞ inches long, has an average diameter of 12¼ inches, and weighs 1100 pounds. The bronze bearings of the work-spindle have a total bearing surface of 630 square inches. The chucking pressure is approximately 1500 pounds. In order to operate the chuck by hand when setting up the machine, it was necessary to provide a powerful toggle-joint device, which the operator brings into action by a long lever, as shown in Fig. 3. This toggle is disconnected from the chuck opening and closing mechanism, when the chuck is operated by power. The greatest length of stock feed is 16⅝ inches, and this mechanism is operated by a cam on the rear shaft, the variations in length of feed being effected by adjusting the feed slide along the bed extension provided for that purpose. The chuck is closed and opened by another cam on the rear shaft. The hood on the nose of the spindle which envelops the work-holding chuck is 15⅝ inches in diameter, and the spring chucks used are of the "pad" type; that is, those parts of the chuck which grip the bar are in the form of pads held by screws in the chuck proper.

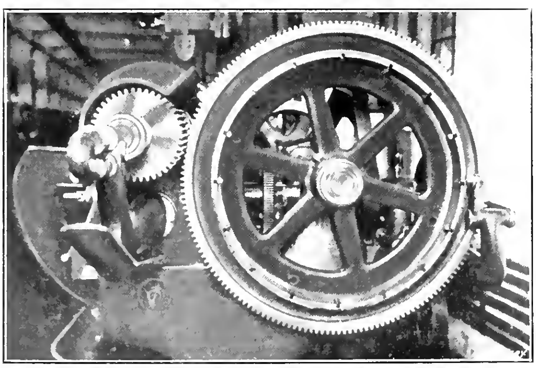


Fig. 2. End View of Cleveland Automatic, showing Regulating Drum and Auxiliary Mechanism

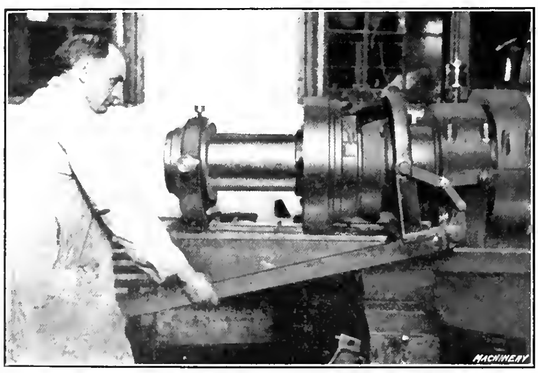


Fig. 3. Operator closing the Chuck by Hand when setting up—Chucking Pressure 1500 Pounds

Turret and Turret Head

The turret, which is of the barrel or drum type, is 18⅜ inches long by 14¼ inches diameter, and weighs 555 pounds. It is provided with four 2¼-inch holes for holding the end-working tools. The turret head has a longitudinal adjustment along the bed of 7¼ inches. The shortest distance between the face of the chuck and the end of the turret, with the turret advanced is 10 inches, whereas the greatest distance between these two members, with the turret advanced, is 17¼ inches. The greatest length of bar that can be turned is 9 inches. The turret is advanced at the proper speed by means of a regulating drum (see Fig. 2) through a friction feed, differential and worm-gearing. The cam which controls the forward advance of the turret is held on the turret-operating drum, and rotates against a roll which is rigidly supported on the machine bed. This roll is presented at a slight angle to the line of pressure on the turret tools, which not only tends to increase rigidity, but enables much heavier feeds to be taken as well. Variation in the feed given to the tools is accomplished by shifting the positions of strip cams on the large regulating drum, this action changing the position of the friction roll between the friction disks. When indexing the turret, bringing the tools up to the work, etc., the turret and all the automatic movements are operated at fast speed, being driven direct and not through the friction disks.

Cross-slides and Other Details

The cross-slides comprise one solid casting 37⅞ inches long by 11⅝ inches wide, weighing 410 pounds. This slide, which generally carries a forming tool on the front and a cut-off blade at the rear, has a travel of 13¼ inches and is operated through a bell-crank lever receiving power from cams on a drum held on the rear shaft. The feed of the cross-slide tools is also controlled, in conjunction with the cams on the drum, by the large regulating drum located at the right-hand end of the machine.

Fig. 4. An Example which shows to a Remarkable Extent what this Machine will do. It removed 105 Pounds of Chips to form a Spring Collet in 48 Minutes

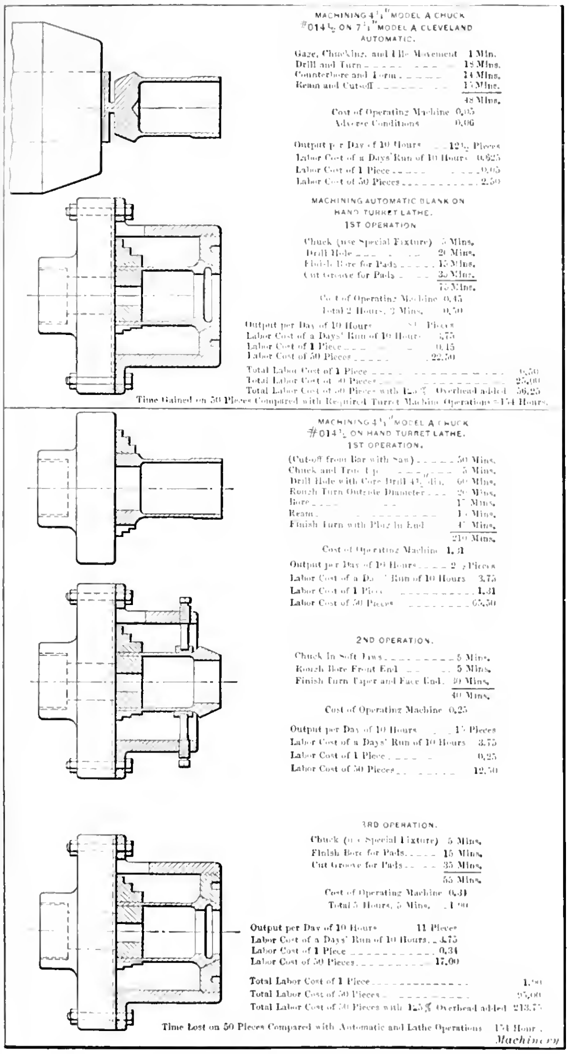


Fig. 5. Improved and Former Methods of making a Spring Collet, illustrating the Advantage obtained by performing First Operation on 7¾-inch Cleveland Automatic Screw Machine

The oil pump on this machine is positive driven and has an air cushion pressure chamber, which provides for a steady flow of the cooling liquid. It has a capacity for pumping oil at the rate of 23 gallons per minute. Oil is pumped to the end-working tools, such as drills, counterbores, etc., through a tube passing through the turret and connecting at each of the turret holes. The over-all length of the machine shown in Fig. 1 is 16 feet 6 inches, the bed casting weighs 6300 pounds and the entire weight of the machine, everything included but not crated, is 15,000 pounds—over seven tons. The machine is fully provided with guards over the exposed working parts and has ample chip room and oil guards.

Example of Work done on 7 3-4 inch Cleveland Automatic

An example of work which illustrates to a remarkable extent the productive capabilities of the machine shown in Fig. 1 is a spring collet or chuck for a 4¼-inch Cleveland automatic screw machine. Two of these collet blanks appear on the tray of the machine in the illustration. This spring collet is made from a rough round bar of 7½-inch 40-point carbon open-hearth steel. It is approximately 11 inches long, and the largest diameter is 7⅜ inches. Fig. 4 gives a comprehensive idea of the amount of work necessary to produce this piece, where it can be seen that 105 pounds of chips has been removed. A solid bar of 7½-inch stock equal in length to the spring collet weighs 143 pounds, whereas the spring chuck, in the condition in which it is dropped from the machine, only weighs 38 pounds. It requires exactly 48 minutes to complete one piece, so that approximately 2¼ pounds of chips is removed per minute—a somewhat remarkable performance for an automatic screw machine.

Another illustration of the economical manufacturing possibilities of this machine is a comparison of the present and former methods of making this spring collet for the 4¼-inch Cleveland automatic screw machine. In Fig. 5 the present and former methods are laid out diagrammatically. Here it can be seen that the time required to complete one of these spring collets on a hand-operated turret lathe was 5 hours 5 minutes at a labor cost of $1.90. The time now required to finish one chuck complete, including the hand turret lathe operations, is 2 hours 3 minutes at a labor cost of 45 cents; this represents a saving in time on each piece produced of 3 hours 2 minutes and a saving in labor cost of $1.45. The time gained by using the improved method on 50 pieces is 154 hours, and the saving in cost on this number, overhead charges of 125 per cent being added in both cases, is $157.50.

The reason for performing the third operation on the hand turret lathe is that this operation was added after it was found that the entire machining on the nose of the collet and in the hole could not be accomplished with the collet held in the manner illustrated for performing the second operation. The chief objection was that it was found impossible to get the hole to run true with the tapered end, owing to the heavy cutting necessary in producing the holes for the pads. The tapered end and the rear bearing of this collet is ground before hardening, the work being held on an arbor. This method was found to be much quicker than filing and polishing. The collet is not ground after hardening.

STANDARD ROLLING MILLS

The Standard Machinery Co., 7 Beverly St., Providence, R. I., is now building the two styles of cold rolling mills illustrated in Figs. 1 to 4. Figs. 1 and 2 show front and rear views of the No. 6 mill with rolls 8 inches in diameter by 10 inches face width. The No. 7 mill, front and rear views of which are shown in Figs. 3 and 4, has rolls 11 inches in diameter by 10 inches face width. The face width of the rolls on both machines can be varied to suit the requirements of different cases. On the No. 6 mill the rolls can be anywhere from 6 to 14 inches face width, while the No. 7 mill can be made with rolls from 8 to 18 inches face width. The standard No. 7 mill has rolls 10 inches in diameter by 15 inches face.

The No. 6 mill is direct connected to a type HF Westinghouse motor equipped with a special controller and special resistance coils in the circuit which are located under the bed of the machine. The motor develops 20 horsepower and

runs at 1150 revolutions per minute, it is capable of a 50 per cent decrease in speed with a corresponding decrease in horsepower. This variation of speed and power is governed by setting the controller lever in different notches and allows the operator to start the mill with heavy stock and then vary the speed and power as required. Roller bearings are provided on the roll journals which are said to effect a saving in power consumption of from 35 to 60 per cent. Without the use of roller bearings a 30-horsepower motor would be required to drive this mill. The rolls are made of chrome alloy steel with hardened journals and hardened bodies, the face of the roll being lapped to a mirror finish.

The adjusting screws seen directly below the large spur gear in Figs. 1 and 2 have a dial which is graduated to provide for making adjustments to 0.001 inch. The screws are left-hand and the gear ratio is 5 to 1; ample pressure is

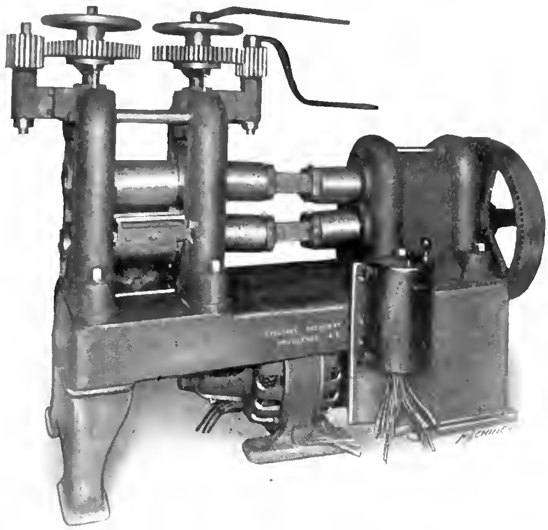


Fig. 1. Front View of Standard No. 6 Rolling Mill

supplied for rolling heavy and dense stock. The handwheels are provided for raising the screws rapidly when it is required to release the pressure from the work. The housings are of heavy construction. The machine is equipped with a running-out table at the rear, which is shown in Fig. 2, and a running-in swivel table with guides is provided at the front of the mill. Cut steel herringbone gears are provided in the gear housings and there are also two trains of spur gears exclusive of the motor train. The motor pinion is of rawhide and all other gearing is of steel with cut teeth.

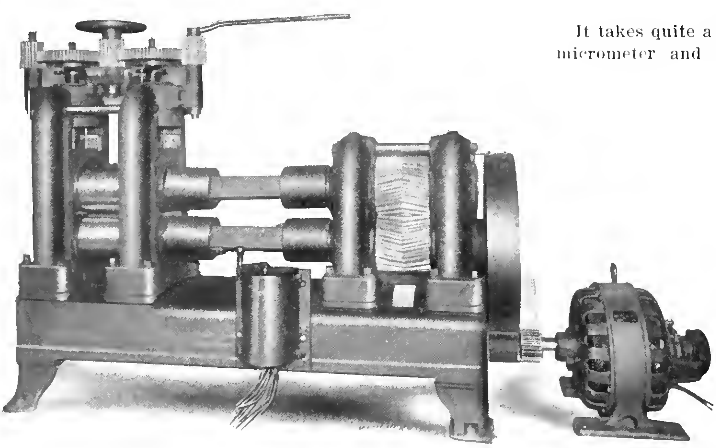


Fig. 3. Standard No. 7 Cold Rolling Mill

The No. 7 mill shown in Figs. 3 and 4 is of similar construction to the No. 6 machine. This mill is driven by a 30-horsepower alternating-current motor which runs at 1150 revolutions per minute. The same provision is made for varying both the speed and horsepower of the motor that was previously described for the No. 6 mill. The roll journals run in ball bearings, but the way in which the rolls are adjusted is somewhat different from that described for the

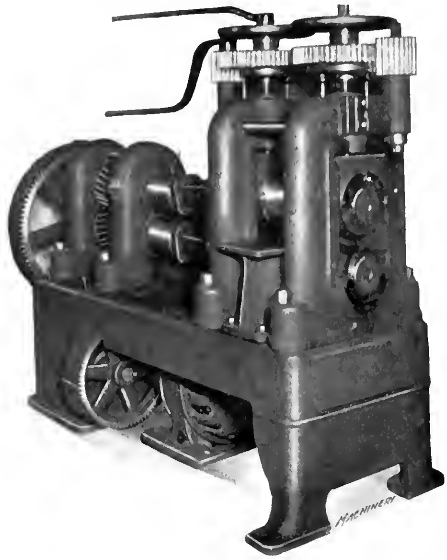


Fig. 2. Opposite Side of Standard Rolling Mill shown in Fig. 1

preceding machine. It will be seen that a center handwheel is provided which adjusts the two rolls simultaneously. The center pinion is so arranged that it can be slipped off, thereby allowing an independent adjustment from either of the screws or pinions. The screws are provided with dials for making adjustments to 0.001 inch. It will be seen that the motor is placed at one end instead of being underneath the bed of the machine. The transmission includes a pair of cut steel herringbone gears and three trains of spur gears. All of the gears, with the exception of the motor pinion, are of steel. The rolls are of hardened and ground chrome alloy steel, lapped to a mirror finish. The bed of the machine is cast in one piece. Below the inner gear housing there is a heavy rib which is bored at the same time that the outside bearings at the rear of the bed are bored; this affords a double bearing for each gear shaft. All of the bearings are bronze bushed.

BROWN & SHARPE DIRECT-READING MICROMETER

It takes quite a little experience to learn to use an ordinary micrometer and obtain the required measurement quickly,

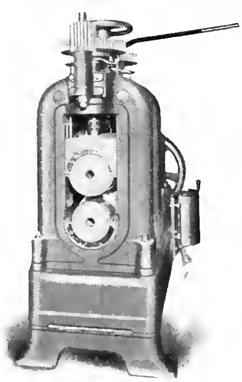


Fig. 4. Reverse Side of No. 7 Mill

and even the most experienced operator is likely to make a mistake in taking the reading. There are two classes of men to whom these difficulties are particularly objectionable, *i. e.*,

purchasing agents who desire to use a micrometer in measuring the gage of sheet metal, etc., and have not had sufficient experience to use the tool with any degree of rapidity; and inspectors who have to use a micrometer so often that the time involved in taking the readings is considerable. With the view of overcoming these difficulties, the Brown & Sharpe Mfg. Co., Providence, R. I., has brought out a direct reading

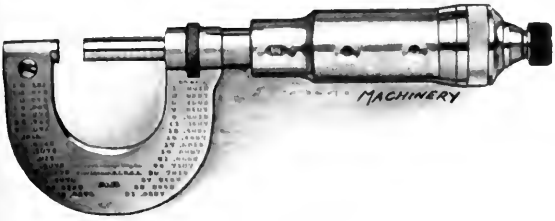


Fig. 1. Brown & Sharpe Direct Reading Micrometer

micrometer, shown in Fig. 1. This tool has a capacity up to 1 inch and is provided with the usual ratchet mechanism to prevent the possibility of damaging the screw. The micrometer, is used in the ordinary way, figures coming up in the three holes in the sleeve to give the reading direct. While arranged to give readings to 0.001 inch, the graduations on the collar enable the fourth decimal place to be accurately estimated.

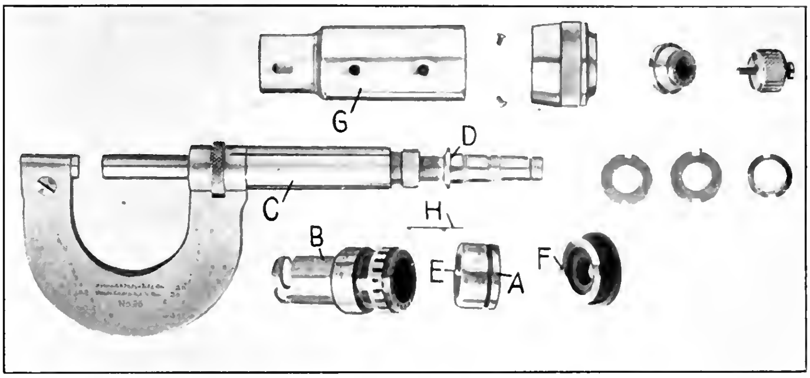


Fig. 2. Parts of the Brown & Sharpe Direct Reading Micrometer

The parts of the micrometer are shown in Fig. 2 and referring to this illustration the method of operation will be readily understood in connection with the following description. The part A is known as the first "counter" and is graduated with two series of figures as follows: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, which are equally spaced around the counter. These figures indicate thousandths of an inch. The part B is the second counter which is similarly graduated, this counter indicating hundredths of an inch. The barrel of the micrometer C is graduated with one s t of figures, similar to the two sets on the counters A and B, these figures indicating tenths of an inch. The counter A is a press fit on the measuring screw D. This counter has a small pin E sliding in it engaging with the cam F which is held stationary in the sleeve G by means of two screws. The measuring screw is 50 pitch so that one revolution gives a lateral movement of 0.020 inch. Bearing in mind the graduation on the first counter A, it will be evident that one revolution of the screw causes all twenty figures on this counter to appear in succession through the hole in the sleeve.

When the counter A has made one-half revolution, the "carrier" pin E is pushed forward by the cam F so that it enters a hole in the end of the second counter B. At the same time the "locking" pin H, which normally fits into a slot in the counter B to prevent it from rotating, is drawn back through the action of a teat on this locking pin which runs in the cam groove in the first counter A. Under these conditions the counter B is moved through one-twentieth of a revolution to expose the "1" figure, indicating 0.010 inch. When this has been done, the teat on the locking pin H causes this pin to be pushed back into the next slot in the counter B and hold it stationary until the counter A has been rotated through another half revolution. When the locking pin is thrown back into engagement, the "carrier" pin E is moved back by the pressure exerted on its tapered end. This cycle is repeated each time the counter A is rotated through one-half revolution, which corresponds to a lateral movement of 0.010 inch of the measuring screw. For each half revolution of the counter A, the counter B is moved through one-twentieth revolution which also corresponds to 0.010 inch.

It has already been stated that the figures indicating tenths of an inch are graduated on the barrel of the micrometer. These figures are covered by the sleeve at the left-hand side of the counter B, the proper figure being exposed by a spiral groove cut through this sleeve which moves under the hole in the sleeve G. Each time the counter B has been rotated through one-half revolution so that ten figures have been brought up, a figure is brought up on the counter C indicating tenths of an inch. The principle upon which the operation of this micrometer is based will be clearly understood from the preceding description if it is borne in mind that the figure in each adjacent hole to the left has ten times the value of the corresponding adjacent figure to the right of it. The design of the mechanism has been cleverly worked out.

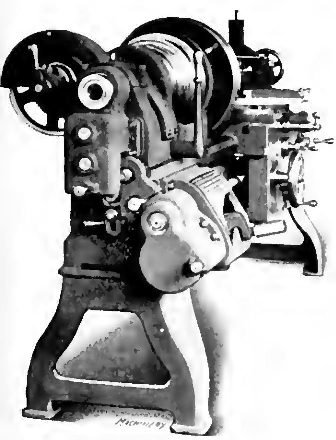


Fig. 1. End View of Cisco Lathe

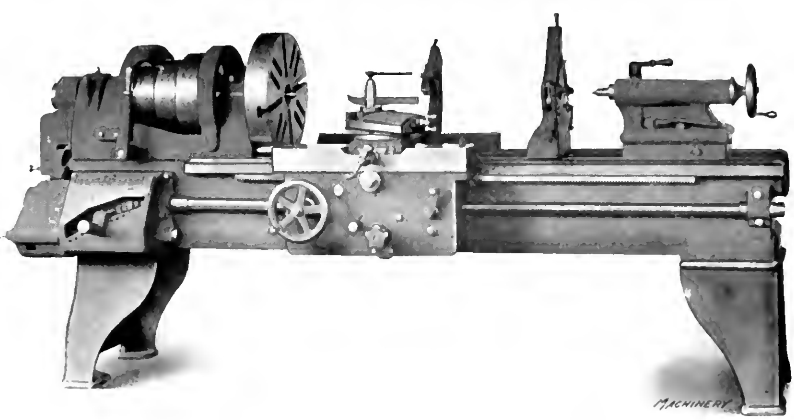


Fig. 2. Front View of Cisco 18-inch Lathe with Double Back-gears

CISCO EIGHTEEN-INCH LATHE

The Cincinnati Iron & Steel Co., Cincinnati, Ohio, has recently equipped its 18-inch lathe with a 3-step cone pulley and double back gears, a machine built in this way being shown in Figs. 1 and 2. The lathe is of very heavy construction and while nominally an 18-inch lathe it will actually swing up to 19½ inches. The hollow spindle will take

1⅞ inch stock and from 2 to 46 threads per inch may be cut. The ratios of the double back gears are 10 to 1 and 3.17 to 1, respectively. Particular attention is called to the sizes of the bearings which are 3½ by 5¾ inch at the front of the headstock and 3 by 1½ inches at the rear of the headstock. The lathe is of simple design and only two wrenches are needed for the entire machine.

All screws are hardened and all gears are of steel. All thread and feed changes are obtained instantly without requiring the removal of any gears or stopping the lathe. The thread and feed changes are obtained by means of two pull pins and the tumbler in the change gear box. The apron is worm-driven by means of a steel worm-wheel and bronze worm, the worm-wheel running in oil. A large graduated dial is provided for thread cutting, and the worm-wheel which operates this dial may be disengaged from the lead-screw when not in use by removing a single screw. The apron is of the double-plate type to provide back support for the studs. The design is such that the half-nut lever cannot be accidentally engaged and a non-interfering device makes it impossible to throw the feed and half-nut into engagement at the same time. The compound rest and cross-feed collars are graduated in the usual way. An efficient form of taper-turning attachment forms a part of the equipment. This lathe is built with beds ranging from 6 feet up. The 18-inch by 8-foot lathe weighs 3500 pounds and each extra foot of bed means an additional weight of 170 pounds.

HISEY-WOLF ELECTRIC DRILLS

The Hisey-Wolf Machine Co., Cincinnati, Ohio, has recently added to its line three types of universal electric drills which can be operated interchangeably on alternating or direct current. These drills are made in five sizes which have capacities up to 3/16, 5/16, ⅜, ½, and ¾ inch, respectively, and range in weights from 6 to 35 pounds. The motors have ample torque and speed characteristics and a liberal factor of safety has been allowed in designing. Their ability to operate on either alternating or direct current makes these drills particularly convenient; they are connected from an ordinary lamp socket.

One of the noteworthy features of these tools is their simplified construction. The electrical and mechanical units are entirely separate so that injury to the mechanical parts does not affect the electrical parts, or *vice versa*. Anyone can take the drill apart in a short time and no other tool than a screw-driver is required. The drill can be assembled with equal ease and without danger of misplacing the electrical connections. By simply taking out four screws the back cap can be removed to expose all of the working parts on the commutator end. The drill can be run with the back cap removed so that the operating of the brushes, commutator, etc., may be inspected. The bearing is not carried in the back cap, but is supported by a separate bracket, as shown in Fig. 2. Besides the convenience of this arrangement for inspecting or making repairs, it avoids binding of the bearings and causing any unnecessary frictional load. All strains are carried on the frame and not on the working parts.

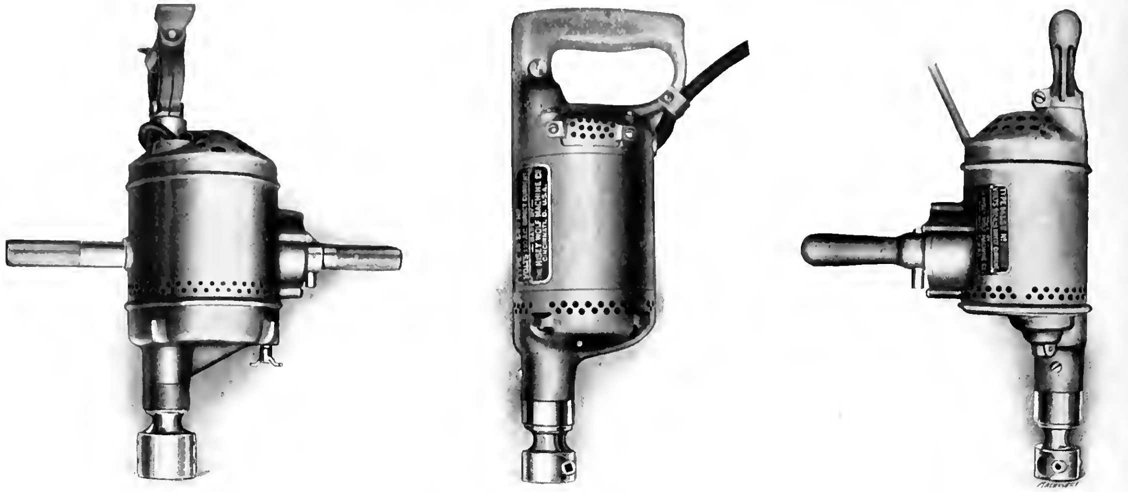


Fig. 1. Three Types of Hisey-Wolf Portable Electric Drills for use interchangeably on Direct or Alternating Current

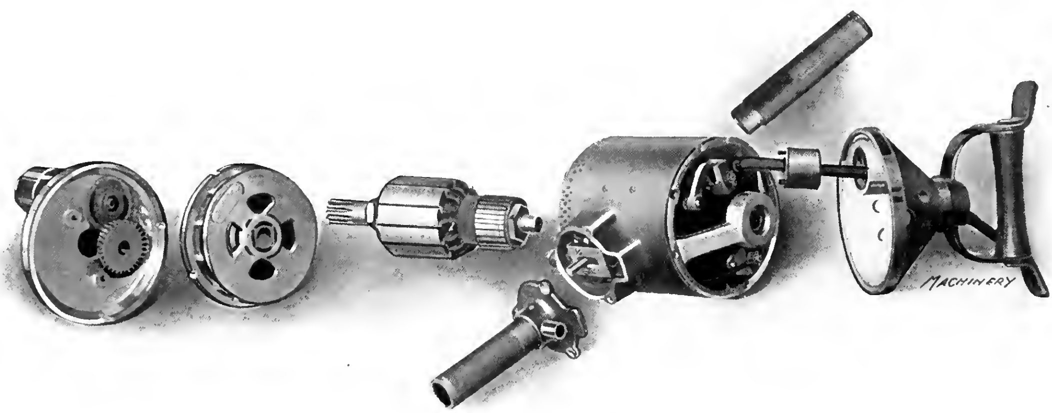


Fig. 2. Parts of a Hisey-Wolf Universal Drill

Taking out four screws will also enable the front cap containing the gears to be taken off to expose the armature, which can be readily removed without interfering with any of the wiring. The gears can be removed from the gear case with equal facility and all parts are interchangeable so that repair parts can be supplied. The leads to the motor are attached

to a terminal plate on the back bearing bracket. The cable is attached to corresponding terminals and protected by a fiber insulating cap. In case of damage to the cable, it can be readily replaced without danger of interfering with the motor connections. To do this, it is simply necessary to remove the insulating cap and attach a new cable to the terminals. The switch is of simple design and entirely enclosed. It is operated by a trigger in the permanent handle of the drill and the arrangement is such that the operator cannot get a shock.

All parts of the drill are made of aluminum where this material is suitable; other parts are made of steel. This construction insures the lightest weight that is consistent with satisfactory service. The armature shaft runs in ball bearings and a ball thrust bearing takes the load from the chuck spindle. All bearings are enclosed and run in grease. The gear-case is enclosed and all bearings on the chuck end of the drill are lubricated from the gear-case. The motor is air-cooled by a fan on the armature shaft.

TERRELL'S STEEL SHELVING WITH LOCKED DOORS

Steel doors that may be readily attached to any of the standard shelving units made by Terrell's Equipment Co., North Grand Rapids, Mich., provide tightly closed compartments for the safe storage of material that is too delicate or valuable to be kept on open shelves. These doors may be supplied with new shelving or added to existing installations, and like all of the other equipment built by this company, they are made on the unit plan which provides for expansion or rearrangement. They are hinged to a channel frame of special design, which is fastened to the unit in such a way that no bolts are exposed, making it impossible for the doors to be opened or removed without unlocking. The doors are furnished in four heights and widths, so that open and closed compartments may be combined in a single installation, as desired.

Steel racks equipped with these locked doors afford protection against the theft of material or loss from fire. The channel frames that carry the doors are provided with lugs by means of which they are bolted to the uprights. The attachment of the doors does not interfere with the adjustment of the shelving in any way. As previously stated, the doors are built on the unit system, each unit comprising a complete frame and pair of doors. The doors are fitted with a three-way locking device that secures them at three points, *i. e.*, a center latch and a locking rod at the top and bottom. The doors can be fitted with master-key locks, with padlock attachments, or without locks. The frames can be stacked, so that where the shelving is higher than the highest standard door, smaller doors may be used in double or triple tiers.

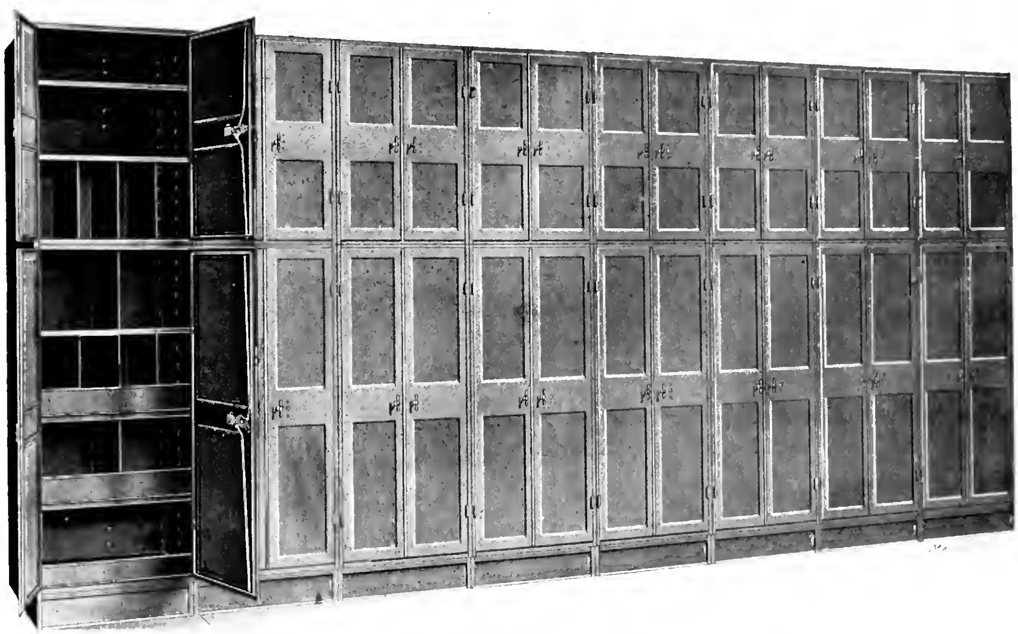


Fig. 1. Installation of Terrell's Steel Shelving provided with Locked Doors

NEW MACHINERY AND TOOLS NOTES

Motor-driven Grinder: Forbes & Myers Co., Worcester, Mass. This company is now building its motor-driven grinding machine mounted on a column which makes it entirely self-contained.

Fig. 2. Rear View of Door showing Method of Attachment

Polishing Machines: W. V. Robinson Co., Owosso, Mich. Two automatic polishing machines; one of these machines is intended for pipe polishing and the other is used for polishing stove tops, sad irons and similar classes of work.

Safety Lathe Dog: E. J. Michaud, Willimantic, Conn. A straight tail lathe dog which has no protruding set-screw that may endanger the operator. The screw boss or crown on the dog is longer than the screw, thus effectually covering it.

Nut Tapping Machine: Erie Machine Shops, Erie, Pa. An automatic nut tapping machine equipped with a stationary tap and belt conveyor for feeding work to the spindle. The machine is intended for tapping either square or hexagon nuts.

Electric Lamp Bracket: W. H. Hill, Cambridge Springs, Pa. An adjustable lamp bracket provided with universal adjustment that is particularly adapted for use in machine shops for obtaining the most advantageous light in the operation of machine tools.

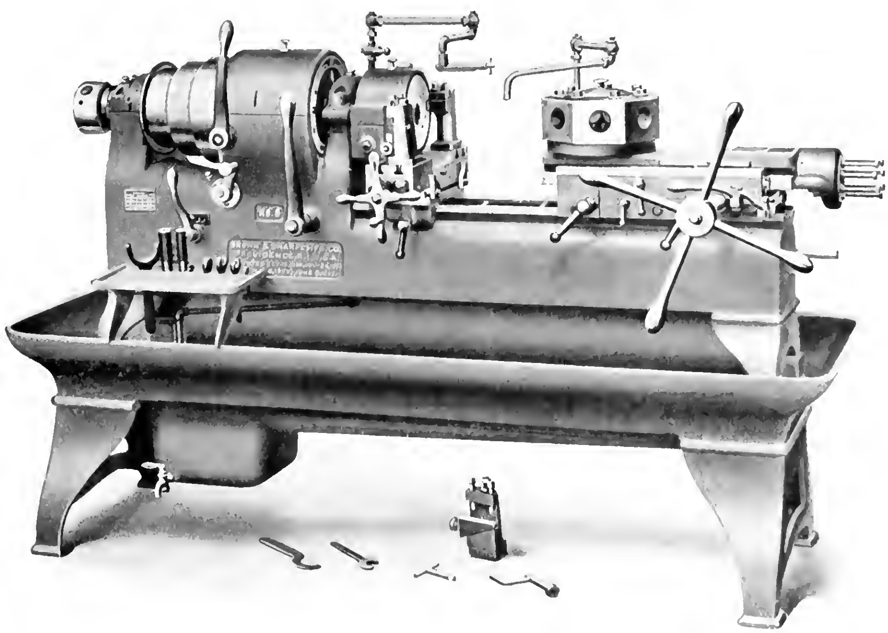
No Extra Collets

By means of a wrench furnished with the machine the jaws of the Automatic Chuck can be set the same as a Universal, to grip any size of stock within its capacity. The same chuck takes either round, square or hexagonal stock with equal facility.

This Saves Time and Equipment

An expensive stock of heavy collets is avoided. There is no time spent hunting up and adjusting collets when changing jobs. No long waits are necessary for collets to hold odd sizes of bars. The machine is always ready.

The adjustment of the chuck is easily and quickly made. The grip is unusually strong because of the powerful leverage. It is always the same along the bar, for the chuck compensates for variations in the stock.



No. 6 Wire Feed Screw Machine
Capacity: Takes stock ½″ to 2″ in diameter. Turns 10″ long.

CO., Providence, R. I., U. S. A.

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Vise: E. A. Lueck Co., Milwaukee, Wis. A drill press vise equipped with a coarse pitch screw to provide for rapid operation. V-slots are provided for holding round work. The maximum opening between the jaws is 4⅞ inches and the vise weighs 31 pounds.

Factory Truck: George P. Clark Co., Windsor Locks, Conn. A shop truck provided with a lifting device operated by the handle of the truck. This lifting device is controlled by an arrangement of cams and gears which reduces the effort required in lifting the load.

Two-spindle Drilling Head: Nelson-Blanck Mfg. Co., Detroit, Mich. The spindles of this head are adjustable to adapt it for handling a large variety of work requiring two holes to be drilled. The maximum distance between centers is 8¾ inches and the minimum 1⅝ inch.

Alligator Shear: Hilles & Jones Co., Wilmington, Del. A motor-driven shear mounted upon a truck to adapt it for portable service. The knives are 14 inches long and the machine operates at 50 strokes per minute. The capacity is up to 1½ inch square soft steel bars cut cold.

Straightening Rolls: Hilles & Jones Co., Wilmington, Del. A set of heavy plate straightening rolls which are said to be among the largest rolls of this type which have been built in this country. The machine is operated by a 100 horsepower Westinghouse variable speed motor and weighs 120,000 pounds.

Crank-driven Planer: Newton Machine Tool Works, Inc., Philadelphia, Pa. The notable feature of this machine is the incorporation of a geared speed box which provides a useful range in cutting speeds with a single pulley drive. The machine may also be equipped with electric motor drive when so desired.

Lathe: Von Wyck Machine Tool Co., Cincinnati, Ohio. A 16-inch quick change gear lathe equipped with double back gears. The machine has a chasing dial which permits thread cutting to be handled without stopping the lathe or reversing the lead-screw. The double back gear ratios are 12 to 1 and 3½ to 1.

Keyseating Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A keyseat milling machine built for the C. Morgan Smith Co., York, Pa. This machine is intended for milling the keyseats in locomotive engine axles, the full depth, width and length of the keyseat being finished in a single operation.

Milling Machine: John Steptoe Shaper Co., Cincinnati, Ohio. This company has improved its hand milling machine by adding a quick return mechanism for the table feed, a new lever latch, and a table of increased length. These improvements have been added to the regular screw elevating knee type of milling machine.

Multiple Punch: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A large multiple punching machine for use in steel car fabricating work. The machine has a capacity for punching sixty 3/16-inch holes in a 1 1/2-inch steel plate. The punches are arranged in two rows of thirty each and their positions are adjustable.

Milling Saw: Henry Disston & Sons, Inc., Philadelphia, Pa. A 36-inch high-speed segmental milling saw composed of six segments. The spaces between these segments take up temporary strains which might damage a solid saw. Making the saw in segments is also said to afford a possibility of getting better results in hardening.

Lathe: National Lathe Co., Batavia, Ohio. A 17-inch lathe. The carriage of this machine is gibbed front and back and the apron is equipped with an interlocking mechanism. The head is provided with a reverse mechanism which adapts the machine for cutting right- and left-hand threads. The change gear device is of a special patented construction.

Hydraulic Steam Pump: Hydraulic Press Mfg. Co., Mt. Gilead, Ohio. A line of steam-driven hydraulic pumps equipped with a new form of speed and pressure regulator. Based on the steam end dimensions, this line of pumps comprises twelve sizes, and on the water end dimensions, seventy-one sizes. The pump is of the single cylinder, double-acting pattern.

Multiple Spindle Drilling Machine: Moline Tool Co., Moline, Ill. A multiple spindle machine built along the established lines which are followed in the construction of the machines of this company's manufacture. This machine is intended for hollow milling work; it is equipped with drill chucks for holding the work and hollow mills made by the Modern Tool Co.

Boring Tools: Davis Boring Tool Co., St. Louis, Mo. A set of boring tools which has some unusual features, among which the following may be mentioned. The cutters are unusually heavy and the bodies of the tools are also made heavier to afford the necessary support for boring operations on a particularly tough grade of steel. The bodies are made flat on two sides to afford the necessary chip clearance.

Milling Machine: American Milling Machine Co., Batavia, Ohio. A No. 1½ plain milling machine in which particular attention has been paid to the provision of safeguards over all dangerous parts. Another noteworthy feature of the design is the simplicity of the operating mechanism. Twelve geared feed changes are provided which are in geometrical progression and cover a range from 0.005 to 0.030 inch per revolution of the spindle.

Belt Tension Scale: Tabor Mfg. Co., 18th & Hamilton Sts., Philadelphia, Pa. A gage particularly adapted for use in textile mills where there are a large number of small belts of the same approximate thickness and length. This device is placed on the belt and a handle is turned which causes tension to be applied by means of a spring, the tension being indicated on a scale. In this way accurate information may be obtained as to whether the belt requires tightening.

Shop Goggles: T. A. Willson & Co., Inc., Reading, Pa. Improved shop goggles for use in operating grinding machines and similar classes of work. The lenses are pivoted to the bridge so that they may be adjusted to fit closely around the nose and eyes of different wearers. A special flange construction is said to make it impossible for the glass to be forced inward in event of the lenses being broken. The usual form of gauze guards are provided to prevent chips from flying into the workman's eye from the side.

Multiple Drill Head: Covington Multiple Drill Co., E. 5th & Scott Sts., Covington, Ky. A drill head adapted for clamping directly to the spindle sleeve of an ordinary drilling machine. The main driving gear of the head is driven by a double-end key placed in the tang slot or drift hole of the spindle. The head is made to take drills with No. 2 Morse taper shanks in sizes up to 29/32 inch. The head has a maximum spread of 11 1/16 inches and a minimum of 4 5/16 inches. The body of the head has a circular dovetail around it. The brackets holding the spindles are gibbed to this dovetail and may be adjusted to different positions.

* * *

NEW YORK STATE COMPENSATION ACT FOR WORKMEN

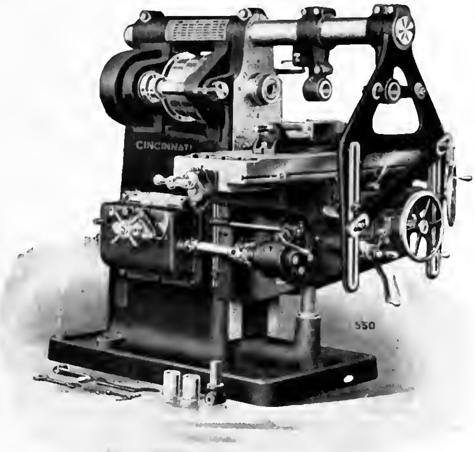
The New York State Legislature passed a workmen's compensation act December 12 which is said to be the most carefully drawn compensation law yet passed by any American state. Following are the principal features of the law:

1. It requires employers in forty-one enumerated groups of the hazardous industries to insure the payment of compensation to their injured employes and makes such compensation the exclusive remedy.
2. It gives employers the choice of four methods of insurance: (*a*) in the state fund created by the act; (*b*) in employers' mutual insurance associations; (*c*) in casualty companies; or (*d*) to carry their own insurance on satisfying the state compensation commission of their financial ability to pay all lawful claims.
3. It creates a compensation commission of five members to administer the state fund and to investigate, settle and pay the claims of all injured employes, acting as the agent of the state fund or of the other insurance carriers.
4. It gives this commission adequate powers to organize the force of deputies, actuaries, examiners, etc., necessary to the efficient performance of its duties.
5. It prescribes a carefully balanced scale of compensation, based on two-thirds of the wages of the injured employe and the limit of $15 a week as a standard, and includes all of the important provisions suggested by European and other experience. The payment of compensation begins on the fifteenth day after the injury.
6. It requires employers to provide medical attendance, medicines, surgical appliances, hospital care, etc., "to a reasonable amount" from the time of the accident until sixty days thereafter, but with careful limitations designed to protect employers from unreasonable charges and to prevent malingering.
7. It authorizes employers in any one of the enumerated groups to organize mutual associations for the prevention of accidents and to draft rules, which when approved by the industrial board, shall have binding force.

* * *

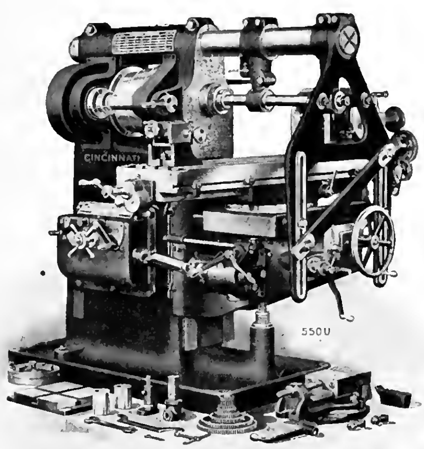
The Red D steamship *Zulia* sustained a peculiar accident while loading a forged steel shaft weighing several tons at her pier in Brooklyn December 8. The shaft, which was about eighteen feet long, was encased in a wooden shipping box, and as it was being hoisted aboard by a sling around the middle, the shaft overbalanced and one end swung downward. The heavy shaft broke through the box and plunged into the hold, breaking a hole through the bottom of the vessel. The hold was flooded with water, causing a loss of $25,000 to the cargo.

Much of the Milling in most Shops is not Heavy Cutting



The No. 4 Plain High Power Miller with Cone Drive

Front or operator's side showing arrangement of all operating levers



The No. 4 Universal Power Miller with Cone Drive

On this work the very powerful single pulley millers do not increase production.

An up-to-date, properly designed, cone-driven machine like our No. 4 Horizontal often proves the better investment.

It is our High Power Miller with cone-driven spindle.

We have simply replaced the Single pulley, Geared Spindle Drive box with a Double Back Geared Cone of large diameter.

It has ample power for all that work requiring a large machine, but not excessively heavy cutting.

It can be depended upon for long, hard, continuous service, because of its massive "High Power" construction.

Its maintenance cost is low because of its simplicity.

AND IT IS HANDY.

The Feed Changers and Back Gear Lever are where the operator stands to shift the belt.

The Table always feeds in the direction in which the Engaging Lever is set.

This same lever also reverses the feed.

All Controlling Levers are at the front of the knee and saddle. So is the Quick Return.

Everything that has to do with its operation is within easy reach.

And there is an additional lever at the side of the knee controlling the feeds from behind the table, for end-milling or boring or similar work which can't be successfully done when the operator stands in front, as he must do on all other Millers.

Let us help on your milling problems. We make the largest variety of machines and therefore can recommend the ones best suited for your work.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS: Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St Petersburg Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

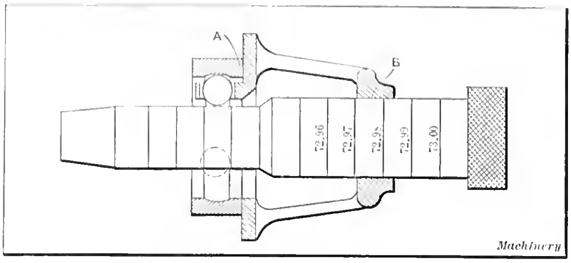
CANADA AGENT: H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS: McPherson's Pty., Ltd., Melbourne.

JAPAN AGENTS: Andrews & George, Yokohama. CUBA AGENTS: Krajewski Pesant Co., Havana.

ARGENTINE AGENTS: Robert Pusterla & Co., Buenos Aires.

GAGE FOR BALL BEARING RACES

The accompanying illustration shows a gage for measuring ball bearings, which was recently patented in Germany. This gage has a new shape of mandrel which gives reliable and accurate readings without the addition of delicate parts. Instead of a conical tapering shape, the mandrel has a series of steps or cylindrical surfaces of varying size. These steps differ very little in diameter, the difference depending upon the degree of accuracy required. The contact bodies between the



Gage for testing Ball Bearing Races

gage and the race to be measured should, preferably, be of the same steel as the balls to be used in the bearing. Three or more of these balls are inserted in the race, and the face of the supporting frame of the gage is placed against the finished face *A* of the ring. The cylindrical portion or shank of the mandrel passes through guide ring *B* and the step-shaped measuring end is pushed through between the balls. The face of the guide *B* forms an edge from which the reading is taken, as indicated by the graduations.

* * *

WESTINGHOUSE MACHINIST TWENTY-TWO YEARS ON ONE MACHINE

In the East Pittsburg Works of the Westinghouse Electric & Mfg. Co. is a man who has worked constantly at one machine for over twenty-two years, and furthermore holds the remarkable record of having been late to work in the morning only once during this period of years. The man posses-

Charles Heisler and the J. & L. Machine on which he has worked Twenty-two Years

sing this record is Charles Heisler, who was born in Gutenberg, Germany, in 1864 and came to this country in 1881. After working in several different machine shops he secured employment in April, 1891, at the Westinghouse Electric Co.'s shops then located on Garrison Alley, Pittsburg, Pa. The young machinist was assigned to work on a two-inch Jones & Lamson turret lathe and has operated it continuously ever since.

This constancy in his daily work is entirely of his own choosing, as Mr. Heisler has on several occasions been offered work on other machines and of more modern design necessitating less labor to operate, but he has consistently refused, preferring, like the shoemaker, to "stick to his last." But long service is not a rare occurrence at the East Pittsburg works; in the same division with Mr. Heisler, which employs something like seventy men, there are eight employes whose time of service with the company ranges from seven to twenty-two years. In fact, most of the men now occupying the highest executive positions with the company have attained them through promotions from their respective departments. In the case of Mr. Heisler, the conditions surrounding his work were not particularly conducive to his advancement along the lines that some of the others followed, but his devotion to his work and continuity of purpose show a record seldom equaled and rarely exceeded in industrial circles.

* * *

PERSONALS

I. H. Page has retired from the position of treasurer of the Stevens-Duryea Co., Chicopee Falls, Mass.

W. H. Shafer, factory manager of the Rochester Boring Machine Co., Rochester, N. Y., has resigned his position. Mr. Shafer has as yet made no plans for the future.

J. M. Schaeffer of Waterbury, Conn., who has been the European representative of the Waterbury Farrel Foundry & Machine Co. for the past year and a half, has returned to Waterbury from abroad.

W. S. Parrish, who for the past three and a half years has been acting manager of the Kirkham Motor Mfg. Co., Bath, N. Y., has resigned his connection with the company. Mr. Parrish has made no definite plans for the future.

E. W. Cleveland, formerly chief draftsman for the Fox Machine Co., Grand Rapids, Mich., and designer of the Fox line of adjustable multiple spindle drills, is now with the National Automatic Tool Co., Richmond, Ind., in a similar capacity.

Dr. Ing. Herbert Kienzle, a German electrical engineer, who is interested in the design and construction of automatic screw machines and has written a book on the subject, is at present in this country with the intention of visiting the various concerns making automatic machinery. Dr. Kienzle expects to stay a month in America.

David L. Ballard on January 1 severed a connection of seventeen years standing with the Jones & Lamson Machine Co. in the selling field. His territory ranged from the Middle States to the Pacific Coast, but he is known and loved as "Uncle Dave" the country over among machine tool sellers and machine tool buyers. His friends in Chicago and vicinity gave him a farewell banquet on December 5 at the Auditorium Hotel. Here the older men to whom he has been a brother, and the younger men to whom he has been a father, met to express their regard for him, and to do him the honor at his retirement that the character of his active life has so richly merited.

* * *

OBITUARIES

William Deering, founder of the Deering Harvester Co., which was absorbed into the International Harvester Co., died at his winter home in Cocoanut Grove, Florida, December 9, aged eighty-seven years. He began the manufacture of harvesting machines at Plano, Ill., in 1873. His estate is valued at $12,000,000 to $13,000,000.

DANIEL M. BARTON

Daniel M. Barton, general purchasing agent of the General Electric Co., died at his home in Schenectady, N. Y., December 8 after an illness of only five days, aged seventy years. Mr. Barton was one of the oldest employes of the General Electric Co. He was born in Moriah, N. Y., in 1843; he lived there but a few years, his parents moving to Ware, Mass., when he was still a child. At the age of nineteen he enlisted in the army, with his brothers, in the Tenth Regiment Massachusetts Volunteers and fought at Fredericksburg and Gettysburg. In 1883 the Thomson-Houston Electric Co. was formed by citizens of Lynn, Mass., and a brother, Silas A. Barton, was an active organizer of the new company. Three years later Daniel M. Barton became production manager of the company. In 1893 Mr. Barton was made assistant purchasing agent of the newly organized General Electric Co., and a few years after the main office of the company was established at Schenectady he became general purchasing agent, which position he ably filled to the time of his death. He was well and favorably known throughout the business world, and his many friends and business associates will read of his death with regret. Mr. Barton is survived by his wife, a daughter, Mrs. Robert E. Nivison, and three grandchildren. He also leaves a brother, Silas A. Barton of Waltham, Mass., and a sister, Vila Barton of Northampton, Mass.

COMING EVENTS

January 3-10.—Fourteenth Annual Automobile Show, Grand Central Palace, New York City, under the auspices of the Automobile Chamber of Commerce, S. A. Miles, manager.

April 4-11.—First National Efficiency Exposition and Conference, Grand Central Palace, New York City. Walter H. Tallis, director, Efficiency Society, Inc., 41 Park Row, New York City.

May 1-October 31—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

The Metric Carat. 12 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 43 of the Bureau of Standards.

The Testing of Materials. 89 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 45 of the Bureau of Standards.

House Heating Fuel Tests. By W. H. Meeker and H. W. Wagner. 85 pages, 6 by 9 inches. 16 illustrations and diagrams. Published by the Engineering Experiment Station of the Iowa State College, Ames, Iowa, as Bulletin 33.

Coal-Mine Accidents in the United States and Foreign Countries. Compiled by Frederick W. Horton. 102 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 69.

Preliminary Report on Uranium, Radium and Vanadium. By Richard B. Moore and Karl L. Kithil. 101 pages, 6 by 9 inches. Published by Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 70, Mineral Technology 2.

Fees for Electric, Magnetic and Photometric Testing. 23 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 6 of the Bureau of Standards.

This pamphlet quotes the charges made for testing electric, magnetic and photometric apparatus by the Bureau of Standards at Washington.

Mechanical Refrigeration. By H. J. Macintire. 346 pages, 6 by 9 inches. 121 illustrations. Published by John Wiley & Sons, Inc., New York City. Price $4 net.

This treatise for technical students and engineers describes the progress of mechanical refrigeration during the last decade. Not only has the construction been improved, but experimental work has been done to determine the properties of the refrigerants, etc. The contents by chapter heads are: Types of Refrigerating Machines and Their Construction; Auxiliaries; The Theory of Mechanical Refrigeration; Refrigerating Mediums—Their Choice and Properties; Testing the Refrigerating Machine; Insulation; Applications—Cold Storage; Applications—Cooling of Air; Applications—Cooling of Liquids and Solids; Economy of Refrigeration, etc. The chapter on refrigerants has been made as complete as possible, comprising experimental tests on anhydrous as well as aqua ammonia installations. Four chapters are devoted to applications. The work is one that should meet with appreciation by students and engineers and others identified with refrigerating plants.

Electrical Blue Book 1913-14. 227 pages, 9 by 12 inches. Published by the Electrical Review Publishing Co., Chicago, Ill. Price $2.

The sixth edition of the "Electrical Blue Book" represents an improvement on previous editions, the aim of the publisher being to provide in the most compact form possible complete information regarding the rules of the National Electrical Code. The list of approved fittings as published by the Board of Fire Underwriters and illustrations of the products of the leading manufacturers of electrical material which have passed tests recommended by the National Fire Protection Association as conducted by the Underwriters' Laboratories are features. The National Electrical code is illustrated and explained. This code has grown out of the efforts on the part of the fire insurance organizations to prevent installation of defective electrical wiring. These rules were originally recommendations but they have been so clearly formulated and so promptly modified to meet changing conditions that they are now regarded as little less than mandatory laws, specifying the rules of safety for electric wiring apparatus. The electrician and electrical contractor will find the book not only a guide for the installation of apparatus but a directory of the electrical supply manufacturers furnishing approved apparatus.

Motion Study. By Frank B. Gilbreth. 116 pages, 5¼ by 7½ inches. Illustrated. Published by D. Van Nostrand Co., New York City. Price, $2.

This work describes the author's method for increasing the efficiency of workmen. It emphasizes the necessity of motion study in scientific management, the great field for such study and the variables involved. The variables of the worker include his anatomy, brawn, creed, earning power, experience, habits, health, mode of living, size, skill, temperament and training. Other factors which affect the worker's efficiency are his state of mind or contentment, his resistance to fatigue and his food or nutrition. Another set of variables designated as surroundings are appliances, clothes, color, entertainment, heating, lighting, quality of material, rewards and penalties, size of unit used, special fatigue-eliminating devices, surroundings, tools, union rules and weight of unit moved. A third set of variables are those of motion, being acceleration, automaticity, combination with other motions, cost, direction, effectiveness, foot-pounds of work accomplished, inertia and momentum overcome, length, necessity, path, play for position and speed. The author has taken bricklaying as a type of skilled labor to illustrate these principles of motion study. The book is one of much suggestive value to those interested in any phase of so-called efficiency engineering.

Questions and Answers on Automobile Design, Construction and Repair. By Victor W. Page. 622 pages, 5 by 7½ inches. 320 illustrations. Published by Norman W. Henley & Sons, New York City. Price $1.50.

This book embodies the general editorial experience of the writer while technical editor of an automobile journal. The endeavor was made to arrange the contents in logical, systematic order and to describe principles of construction with special reference to the requirements of the non-technical reader. The contents comprise the following chapters: Modern Gasoline Automobile and its Principal Parts; Action of Two- and Four-Stroke Cycle Motors; Parts of Gasoline Motors and their Functions; Fuels for Automobile Motors; Theory of Carburetion and its Application; Types of Carburetors and Their Action; How Gas is Exploded in Cylinder to Produce Power; Parts of Ignition Systems and their Purposes; Current Producers, Batteries, Dynamos and Magnetos; Low Tension Ignition Systems; High Tension Ignition Systems; Methods of Lubricating the Automobile Power Plant; Cooling the Gasoline Engine by Air; Typical Water Cooling Systems; Use of Clutch and Various Types Described; The Friction Transmission; Individual Clutch Change Speed Gear; Action of Sliding Gear Transmissions; Methods of Drive to Rear Wheels; Differential Gear Construction and Operation; Rear Axle Types; Automobile Frames and Springs; Steering Gear and Front Axle; Wheels, Rims and Tires; Automobile Bearings and their Care; How to Start and Control Automobile Power Plants; Methods of Speed Changing Outlined; Utility of Brakes and their Use; General Driving Instructions; Oiling the Automobile Chassis; Road Troubles and their Symptoms; Repairing Power Plant Group; Troubles with Power Transmission Parts; Chassis Troubles and their Elimination; Fixing Tire Defects; Equipment and Accessories.

Handbook for Machine Designers and Draftsmen. By F. A. Halsey. 494 pages, 8½ by 11 inches. Illustrated. Published by the McGraw-Hill Book Co., Inc., New York City. Price $5 net.

This work by Mr. Halsey, editor emeritus of the "American Machinist," was under consideration by him for years. Mr. Halsey had fifteen years experience in machine design before he became an editor eighteen years ago. His practical work showed him the weaknesses of existing handbooks, and in his editorial experience he had seen many valuable articles contributed to the technical press go into the "limbo of forgotten things" with much regret. The present work was compiled largely from the files of the "American Machinist," but other publications and the transactions of engineering societies were drawn from freely also. This matter has been condensed and rearranged where necessary to make it harmonize with the general plan. The page size, 8½ by 11 inches, was chosen because of the growing popularity of the standard typewriter sheet size and the fact that the book is not in any sense a pocketbook, but is intended for use on the draftsman's and mechanical engineer's desk. The large size page favors the use of diagrams and charts, which have been freely used. The contents comprise the following chapters: Mechanical Principles of Design; Plain or Sliding Bearings; Ball and Roller Bearings; Shafts and Keys; Belts and Pulleys; Flywheels; Cone Pulleys and Back Gears; Spur Gears; Bevel Gears; Friction Gears; Worm Gears; Helical Gears; Planetary Gears; Ropes; Chains; Brakes; Friction Clutches; Cams; Springs; Bolts, Nuts and Screws; Wire and Sheet Metal Gages; Hydraulics and Hydraulic Machinery; Pipe and Pipe Joints; Minor Machine Parts; Press and Running Fits; Balancing Machine Parts; Miscellaneous Mechanisms; Performance and Power Requirements of Tools; Cast Iron; Steel; Alloys; Steam Boilers; The Steam Engine; The Gas Engine; Compressed Air; Mechanics; Strength of Machine Parts; Weights and Measures; Mathematical Tables. The author's plan is to constantly revise the work, keeping it up to date by introducing new articles and excluding old matter pertaining to obsolete practice.

NEW CATALOGUES AND CIRCULARS

Eugene Dietzgen Co., 218 E. 23rd St., New York City. Circular of the Dietzgen electric blueprinting machine.

Rockwood Sprinkler Co., Worcester, Mass. Circular of the Rockwood pressed steel union with bronze seats.

Terrell Equipment Co., Grand Rapids, Mich. Circular of steel lockers, wardrobes, cupboards, shelving, etc.

New Departure Mfg. Co. (Hartford Division), Hartford, Conn. Catalogue of "New Departure" ball bearing shaft hangers.

Fort Wayne Electric Works of General Electric Co., Fort Wayne Ind. Instruction Book 3056 on Type A Form A oil transformers.

Sprague Electric Works of General Electric Co., 527-531 West 34th St., New York City. Bulletin 247 on round type direct-current motors.

Rich Tool Co., Chicago, Ill. Catalogue No. 15 of high-speed twist drills, reamers, track bits, flat drills, bonding drills, drill chucks, reamer chucks and rivet sets.

W. S. Rockwell Co., 50 Church St., New York City. Catalogue No. 20 of Rockwell furnaces, illustrating a large variety of furnaces adapted to all classes of service.

Betts Machine Co., Wilmington, Del. Catalogue of standard metal planing machines ranging in size from 36 by 36 inches to 150 by 144 inches, frog and switch planers, accessories, etc.

Wiley & Russell Mfg. Co., Greenfield, Mass. Pamphlet entitled "The Tale of the Lightning Tap" describing features of tap construction of interest to users of screw threading tools.

Mesta Machine Co., Pittsburg, Pa. Bulletin K of gears and rolling mill pinions, machine molded. A chart is included for determining the safe loads for molded gears and pinions of cast steel.

Putnam Machine Co., Fitchburg, Mass. (Manning, Maxwell & Moore, Inc., New York City, general sales agents.) Circular of the Putnam heavy pattern 42-inch coach and truck wheel lathe.

Fort Wayne Electric Works of General Electric Co., Fort Wayne, Ind. Bulletins 1145 on Type ML three-bearing belted direct-current generators with balance wheels, and 1147 on Fort Wayne transformers, Type A.

Kales-Haskel Co., Detroit, Mich. Circular of special washers, pipe and wire clips, cord holders, ratchet sectors, liners and shims, windshield hinge disks, screw machine products, etc., chiefly for automobile manufacturers.

Corbin Cabinet Lock Co., New Britain, Conn. Circular of the Corbin safety guard for presses and drops, providing an absolute preventative of injury to workmen without interfering with freedom of movement or the usual motion of hands and arms.

Herman Bacharach, 14 Wood St., Pittsburg, Pa. Pamphlet describing the Maihak indicator with Bottscher's power counter. This apparatus renders it possible to ascertain instantaneously the mean indicated horsepower of steam and gas engines.

American Tool Works Co., Cincinnati, Ohio. Circular of the "American" radial drilling machine built in 2, 2½, 3, 3½, 4, 5, 6 and 7-foot sizes, plain; 5, 6 and 7-foot sizes, full universal. The circular also contains data on drilling performed by the various sizes of the drills.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin No. 8107 on "Little David" pneumatic drills. This machine is of the piston type, having four single-acting pistons connected to a crankshaft by connecting-rods. The connecting-rods are fitted with Hyatt roller bearings.

Wheelock, Lovejoy & Co., 23 Cliff St., New York City. Catalogue of "Blue Chip" high-speed steel and high-grade tool steels made by the Firth-Sterling Steel Co., McKeesport, Pa. The catalogue contains valuable information for all steel users, with illustrations of hardening room equipment, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Safety calendar for 1913-14 illustrating in color a safety principle to be observed when crossing railroad tracks. Each page of the calendar bears a safety motto useful to superintendent, foreman and workman in shops, mills and factories. The motto of the calendar is "Safety Always."

Wells Bros. Co., Greenfield, Mass. Catalogue of the Wells self-opening threading dies, made in eight sizes ranging from ¼ inch to 3 inches capacity inclusive. The proper shapes of thread chasers for various metals are shown, and the construction details, making a catalogue of unusual interest to users of thread-cutting tools.

Joseph Dixon Crucible Co., Jersey City, N. J. Free to engineers, a limited number of booklets dealing with steam traps, unions for steam pipes, feeding graphite for lubricating purposes, etc. The booklets are treatises prepared by the well-known writer, W. H. Wakeman, who has contributed many articles on power engineering to the technical press.

Dodge Mfg. Co., Mishawaka, Ind. Catalogue 106A-14 of power transmission machinery, furnishing in condensed form information and price list of standard appliances embraced in the Dodge line. This condensed catalogue is offered as a more convenient form for ordinary uses than the company's complete catalogue containing about 600 pages.

McCrosky Reamer Co., Meadville, Pa. Catalogue of adjustable reamers, "Wizard" quick change chucks and collets, "Wizard" variable speed and reversing attachment for drilling machines, McCrosky expanding mandrels, "Searchlight" universal lamp brackets, "Nevastop" combination faceplate and dogs for facilitating rapid lathe work, etc.

Wanderer Works, Schoenau near Chemnitz, Germany. Catalogue of "Wanderer" milling machines of the knee, vertical spindle and planer types; automatic gear cutting machines; tool grinding machines; automatic dividing and engraving machines; tool accessories, etc. The catalogue is printed in English and illustrates a variety of interesting machine tools.

Ingersoll-Rand Co., 11 Broadway, N. Y. Pamphlet on steam, belt-driven and electric motor-driven air compressors Type 10. The pamphlet is unique in its typographical makeup, the text being a reproduction of typewriting with "thumb-nail"

MACHINERY

FEBRUARY, 1914

ADJUSTABLE AND MULTI-CUTTING TURNING TOOLS

DESIGN AND APPLICATION FOR THE TURRET LATHE AND BORING MILL

BY ALBERT A. DOWD*

THE cost of tool equipment for the manufacture of interchangeable work is an item which should be proportionate to the number of pieces to be machined. The saving in time which can be made by the use of special tools should also be carefully considered, as there are many cases where special equipments are designed for work which could be handled to advantage by the judicious use of standard tools. In order to obtain the greatest possible production from their machines, there have been instances where machine tool builders have sold tool equipments of expensive design, when a standard equipment would have done the work very nearly as well. Undoubtedly there was some gain in production, but it is doubtful whether the saving in time would pay for the special tools. The upkeep of special tools is also a factor which must be taken into consideration. It is interesting to note that the present aim of machine tool builders is to so design standard tool equipments that they can be adapted readily to a great variety of working conditions. A great deal of time is spent by manufacturers in devising and experimenting with various tools in order to perfect them to such an extent that they will conform to these conditions.

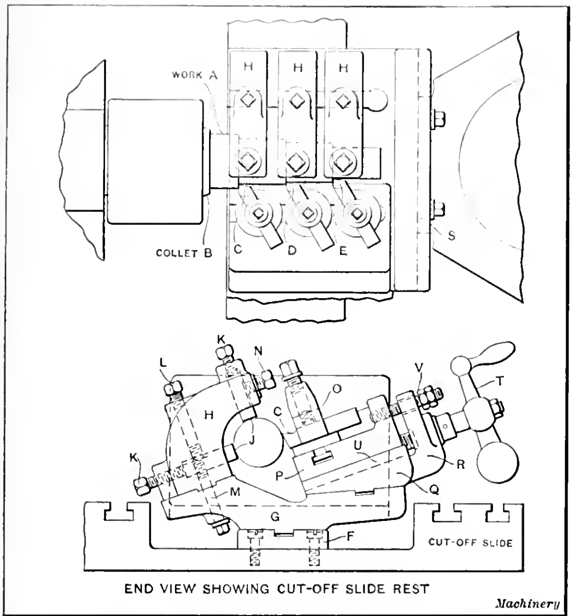


Fig. 1. Special Multi-turning Tool for Bar Work

The rapid growth of the automobile industry in the past ten years is largely responsible for the broader development of our machine tools. The enormous quantities of interchangeable parts which are required in this industry and the manufacturers' desire for increased production have brought into existence a great variety of multi-cutting tools. Tools of this kind may be designed for a variety of uses, and tool-holders capable of containing several tools can also be designed to handle a considerable range of work.

Adjustable tools and those having cutters for turning several diameters are sometimes combined with boring-bars, drills, or cutter heads, these being applied to some one of the various types of turret lathes. They are also occasionally designed for use on a vertical boring mill.

When used on the turret lathe, the cut-off slide is frequently equipped with a gang of tools so that the operations of turning, boring and facing can be carried on at the same time. Quite frequently the tools are so arranged that from nine to twelve are working at the same time, with the result that there is a considerable gain in production. There are a great many varieties of so-called "box-tools" on the market, and these are principally used for bar work on turret lathes or screw machines having a collet mechanism. Tools of this type are usually a part of the standard equipment furnished with screw machines adapted to bar work, and they will not be discussed in the present article.

The design of multi-cutting turning tools for castings and forgings which have several diameters to be machined, is a subject well worth considering, for it is safe to say that nearly any manufacturer who uses horizontal or vertical turret lathes can greatly increase the productive efficiency of his machines by the judicious use of multi-cutting tools. The several designs of turning tools illustrated in this article have been built for various purposes, and a careful study of the types shown may be of assistance in suggesting methods which can be used to perform some piece of work requiring tools of a similar kind. Some of the important points in the design of tools of this nature are given herewith.

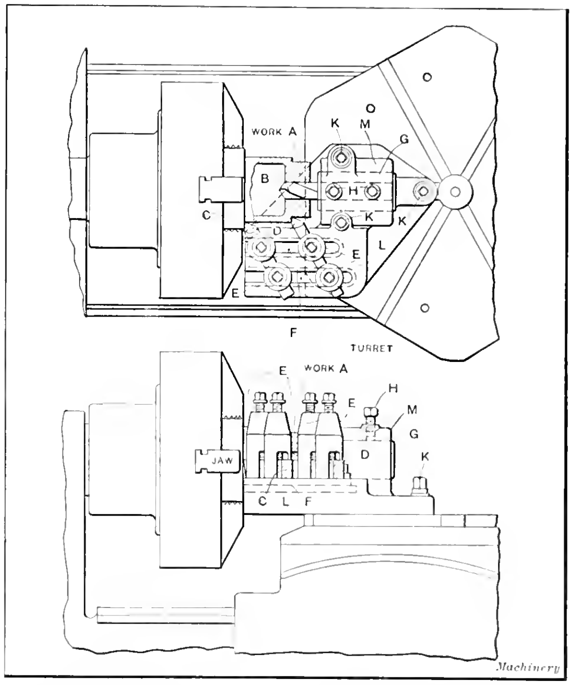


Fig. 2. Multiple Tool-holder for the Turntable Type of Lathe

General Points in Design

1. Rigidity: Avoid overhang as much as possible unless some sort of outboard support can be used. Pilot the tool if practicable.

2. Arrangement of tools: They should be perpendicular to the plane in which the turret rotates when indexing, be-

* Address: 84 Washington Terrace, Bridgeport, Conn.

cause variations in diameters are less likely to take place when tools are arranged in this way. Unequal indexing of the turret has very little effect on the radial position of the tools under these conditions, so that sizes can be held much closer than if they are placed in a plane parallel to the turret rotation. Use standard rectangular stock for the cutting tools so that the upkeep will be inexpensive and reforging be avoided.

3. Try to make the block containing the tools removable so that it can be replaced easily by another block with tools arranged differently to handle other work.

4. Make the tool-block adjustable if possible.

5. Back up the tools with adjusting screws.

6. See that provision is made so that cutting lubricant can be directed on the faces of the tools when forgings or steel castings are to be machined.

7. Arrange the tool-block in such a way that the thrust of the cut does not come against it; it is much better to have the thrust come on the body of the tool.

Multi-turning Tool for Electric Motor Shafts

One example shown in Fig. 1 is given of a multi-turning tool for bar work. This tool was designed for use on the

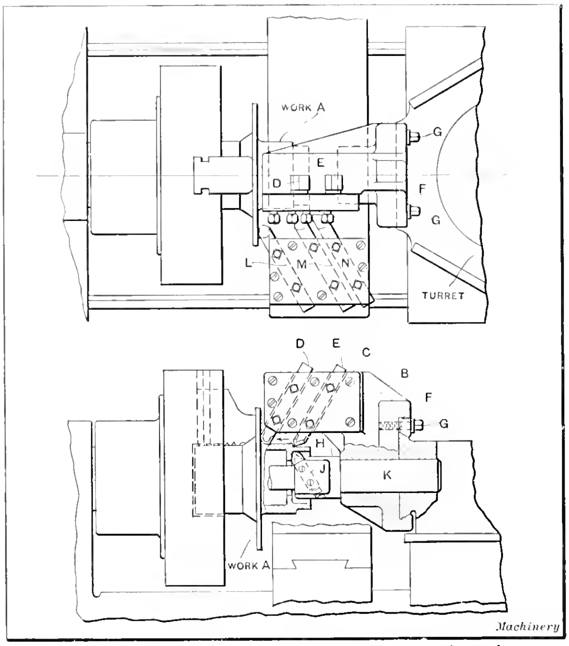


Fig. 3. Multiple Tool-holder for machining Automobile Hubs

electric motor shaft shown at *A* in the illustration. The work was handled in short lengths although the stock is a regular commercial product. Roughing and finishing operations were performed with the same type of tool. The work was held in collet jaws. Something like twenty varieties of shafts having different diameters and shoulder lengths were handled by these tools.

A Pratt & Whitney turret lathe with collet mechanism was used for this work; as this type of machine has a turret with dovetail faces, the body of the tool *G* was arranged to fit the dovetail and the gib *S* held it in place. The cut-off slide was planed off at the center and the hardened steel block *F* was secured to it. It will be noted that this block acts as a support for the tool, and the tongue assists in preventing lateral movement. The cast-iron block *Q* is fastened to the body of the tool and it is dovetailed at *U* to receive the tool-slide *P*. This is of steel and it is T-slotted so that standard toolposts *O* can be used. It will be seen that the tools *C*, *D*, and *E* are held in such a way that they can be adjusted readily both for different diameters and for shoulders of varying lengths. The slide is screw controlled and is operated by the handle *T*. A positive adjustable stop is provided by the check-nuts *V*. The back-rests *J* are of tool steel and are contained in the brackets *H*. The screws *K*, *L*, and *N*, are used for binding and adjusting, while those at *M* pass down through slots in the body of the tool and permit adjustment of the back-rests in a longitudinal direction.

Points worthy of notice in this tool are the method of supporting the body by means of the block on the cut-off slide, the flexibility of the tool adjustments, and the ease with which any tool may be replaced if broken or used up. The

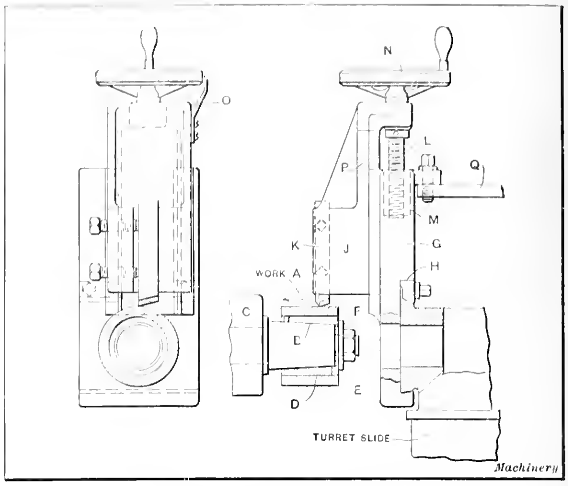


Fig. 4. Adjustable Turning Tool for finishing the Outside of Short Bushings

tools are of standard section and therefore require no machining except cutting off and grinding.

Multiple Tool-holder for the Turntable Type of Lathe

The bronze nut shown at *A* in Fig. 2 is an example of a piece of work which is to be drilled and turned on two diameters at the same time. There were six pieces of this kind varying slightly in size, which had to be machined in lots of twenty-five. Two tool-holders were used to do the work, one tool being arranged as shown in the illustration,

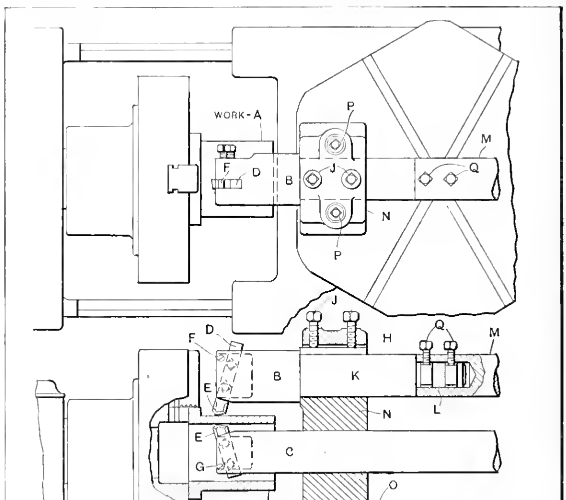


Fig. 5. Boring-bars for turning Concentric Packing Rings

while the other contained a boring tool in place of the drill *B*. The holder *L* was made of cast steel and was T-slotted in two places at *F*, so that tool-holders *E* of the standard type could be used. These carry the tools *C* and *D*, and attention is called to the way in which two posts are used for each

tool to insure the maximum rigidity. The body of the holder is fastened to the turret face by the screws *K*, and is tongued on its under side to fit the slot. A semi-cylindrical boss *M* contains the split bushing *G* which holds the drill *B*. Two screws *H* are employed to clamp the bushing. This holder is simple, easily made and quite adaptable for work within its capacity. There are likely to be slight variations in the diameters turned due to imperfect indexing of the turret, but for general commercial work these usually are not great enough to cause any serious trouble.

Multiple Tool-holder for an Automobile Hub

The piece of work shown at *A* in Fig. 3 is an automobile hub, and the tool-holder is arranged so that the operations of turning and boring can be carried on simultaneously with the facing. The tools *L*, *M* and *N* are secured in a special block on the cut-off slide. The tool-holder *B* is of cast iron and well ribbed; it fits the dovetailed face of the turret, being secured in position by the screws *G* and the gib *F*. The turning tools *D* and *E* are mounted vertically, and the steel cap-plate *C* contains the necessary holding screws. The boring-bar *H* is piloted in a chuck bushing at its forward end and contains the tool *J*, which stands in a vertical plane like the turning tools. The shank of the bar *K* is secured by the turret binding screw and an additional set-screw in the holder itself. A tool of this type will produce more accurate work than the type shown in the preceding illustration, on account of the position of the cutting tools with reference to the turret indexing. A feature of some importance is the piloting of the boring-bar, as this assists in the prevention of vibration. Care should be taken in the design of tool-holders of this type, that the overhang from the turret face is not too great, for if this is excessive, a certain amount of chatter is inevitable.

Adjustable Turning Tool for Short Bushings

A number of short bushings such as that shown at *A* in Fig. 4 were to be refinished on the outside. The bushings were of various diameters ranging from 2¼ to 4 inches, while the lengths varied from 1½ to 3 inches. The pieces were held on arbors *B*, in collet jaws *C*. A split sleeve *D* was expanded inside the work by the action of collar *E* and nut *F*. The body of the tool *G* was secured to the dovetailed face of the turret by gib *H*. The tool-slide *J* is a steel casting dovetailed at *P* and fitted with an adjustable taper gib to take up the wear. The cutting tool *K* is placed in a slot in the slide and is secured by the screws shown. The screw *L* is journaled in a lug at the upper end of the slide and enters a steel nut *M* in the body of the tool. Radial adjustment is obtained through this screw by means of the handwheel *N*. The rim of the wheel is graduated and the pointer *O* permits accurate readings to be made. This tool is very good indeed for light work, and accurate results can be obtained by its use. When two tools are used, a tie-rod *Q* assists in making the combination more rigid.

Holder for Adjustable Boring- and Turning-bars

The work shown at *A* in Fig. 5 is a cast-iron pot from which concentric packing rings are to be cut, and the boring and turning are done at the same time. Two cast-iron holders *N* are tongued at *O* and secured to opposite sides of the turret by the screws *P*. The turning- and boring-bars *B* and *C* pass through the holders and extend entirely across the turret. The boring-bar *C* is of the same diameter along its entire length, and it is secured in the holders by shoe binders similar to that shown at *H* but located in the sides of the holders. The boring tools *E* are of rectangular section and secured by set-screws in the slots at the ends of the bar. The screws *F* and *G* help to stiffen the ends of the bars where they are slotted. The upper or turning-bar is made in two sections *K* and *M* so that the tools may be swung radially to bring them into their proper position when the turret is set off center for turning larger diameters. The end of one bar is turned down at *L* to fit the hole in the other bar and the screws *Q* make a firm joint. A set of bars and holders of this kind is a very useful adjunct to a turret lathe equipment, and it may be adapted to a variety of uses. The double tie feature across the turret gives exceptional rigidity.

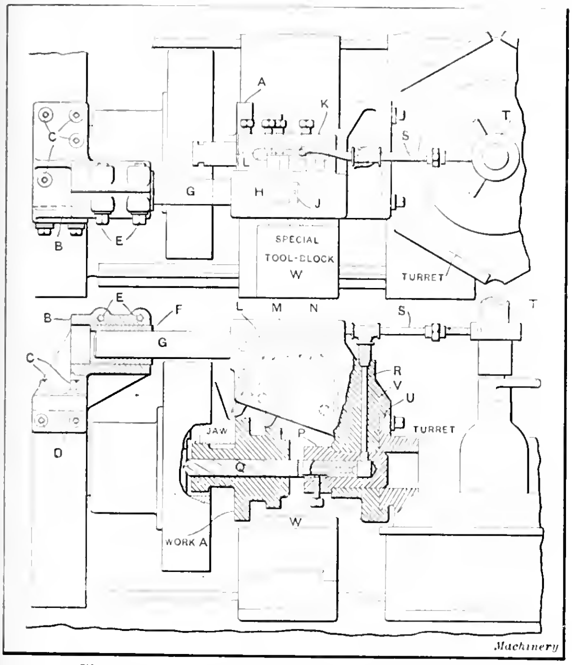


Fig. 6. Piloted Multiple Turning Tool for Gear Blanks

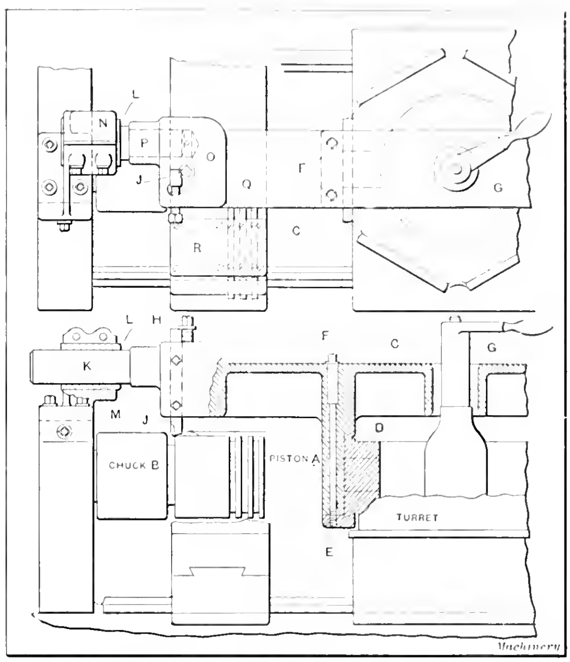


Fig. 7. Double-end Piloted Turning Tool for Pistons

Piloted Multiple Turning Tool for Steel Gear Blanks

The automobile jack-shaft gear blank shown at *A* in Fig. 6 is of alloy steel and it is held in special chuck jaws so that it can be drilled, turned and faced simultaneously. A special tool-block on the cut-off slide performs the latter operation, while the turning and drilling tools are carried by the turret. The body of the turning tool *V* is made of cast iron and is fastened to the dovetail turret face by the gib shown at *U*. The tool-block *K* is of steel and is slotted to receive tools *M* and *N*. An oil groove is cut at *L* along the top of the block and it is supplied with oil from the special piping system shown. The pipe *S* leads to the distributing collar *T* which, in turn, is connected with the cutting lubricant piping system on the machine. The slots in the tool-block are of sufficient width to permit an ample supply of fluid to run down and

reach the cutting ends of the tools, thus assisting greatly in prolonging the life of the tools and also allowing higher cutting speeds. The oil-drill *Q* is held in a steel supporting bushing *P* which fits the body of the tool-holder. It is supplied with lubricant through the hole *R* which is connected to the piping system. The steel pilot *G* is shouldered at *H* and is forced into the body of the holder. The small hole *J* is put in so that air pressure will not be generated when the pilot is pressed into place, as this would tend to deceive the fitter by making him think he had a good fit when, in reality, it was compressed air that made the pilot hard to force in. I have seen pilots fitted so that they were apparently all right at the time when the work was done, and yet when the time came for the tools to be used, it was found that they were loose enough to cause trouble. The air hole will prevent trouble of this kind.

A special bracket is shown at *B* and it is screwed to the spindle cap by the screws *C* and *D*. The bronze bushing *F* receives the end of pilot *G*, and it is clamped by the binding screws *E*. This method of supporting a turning tool is very successful and assists greatly in permitting heavy cutting without chatter. Another feature of this tool is the manner in which oil is conveyed to the cutting tools. Attention is also called to the position of the tool-block, this being at the rear of the body so that the thrust of the cut is brought directly against the heavier part of the casting. The method of mounting the tools is also a little out of the ordinary, in that the block and tools form a unit which can readily be removed, permitting the substitution of another block with tools arranged differently, to handle other work requiring different spacing. Two turning tools on opposite sides of the turret were used for this particular piece, one being used for roughing and the other for finishing.

Double-end Piloted Turning Tool for Pistons

The piston *A* shown in Fig. 7 is held by the inside on a special expanding pin chuck *B*. The arrangement of tools is that recommended by the Pratt & Whitney Co., for turning automobile pistons on their horizontal turret lathe. The turning tool-holder *C* is of cast iron and is double ended, reaching entirely across the turret, and the two ends are exactly the same. The body or arm is of U-section and it is cored out at the center so that the turret binder-lever can pass through it, as shown at *G*. A careful fit is made on the dovetail at *D*, and two special bolts *F* pass down through the body of the tool and pull up the gib *E* against the lower dovetail, thus clamping the tool securely. The tool *J* is backed up by the collar-head screw *H* and is secured by means of two screws. The steel pilot *K* fits the bushing *L* in the spindle cap bracket *M*, as in a previous instance. It will be noted that an air hole *O* is provided where the shank *P* enters the end of the tool body. In connection with the turning tools a special block on the cut-off slide is used to cut the ring groove in the piston. This block and tools are shown at *R* and *Q* in the upper view. This style of equipment is very well known and has given universal satisfaction.

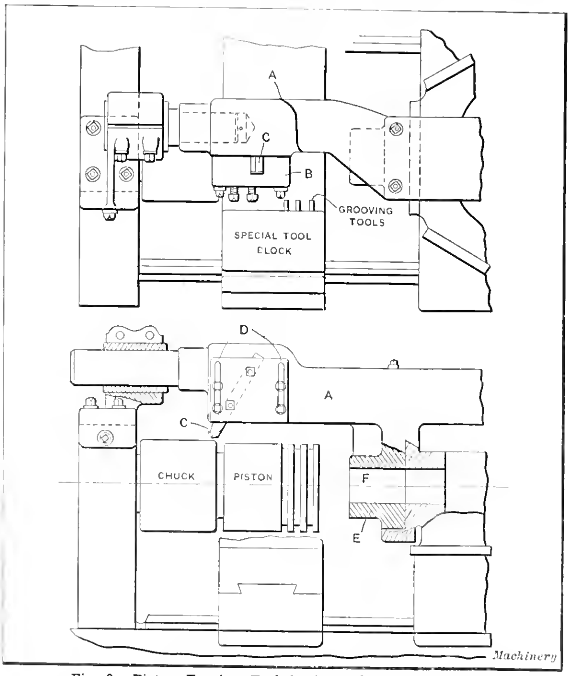


Fig. 8. Piston Turning Tool having Adjustable Tool-block

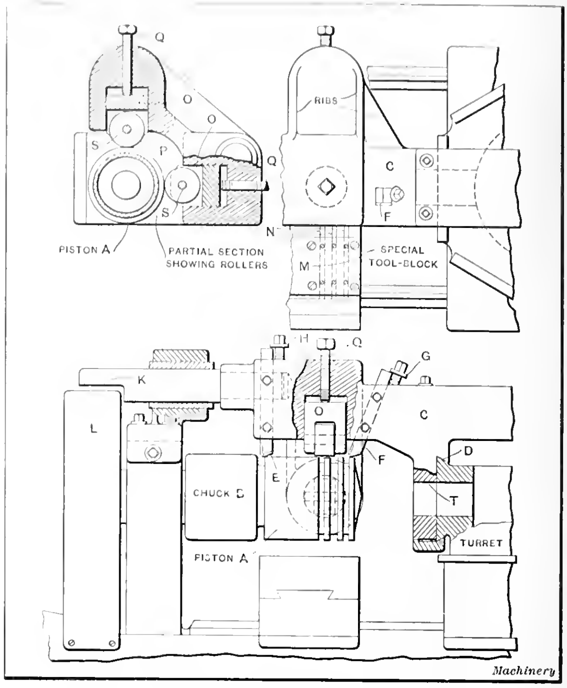


Fig. 9. Multiple Turning Tool equipped with Pilot and Roller Back-rest

Piston Turning Tool having Adjustable Tool-block

A development of the preceding tool is shown in Fig. 8. It will be noted that although the general construction is about the same, in this instance the tool-block is made separate so that other blocks may be substituted having more than one tool. Considerable adjustment is also permissible by means of slots shown at *D*. It is obvious that this method of construction requires the tool-block *B* to be of steel and somewhat heavy, so that it will properly resist the thrust of the cut. The screws which hold the block in position must also be of ample size. As this particular tool was designed for use in turning and boring ring pots, in addition to piston work, the boss *E* was supplied and bored at *F* to receive a boring-bar.

Special Multiple Turning Tool with Roller Back-rest

In a great many instances the design of an automobile piston is such that it is permissible to center the solid end, and this gives a chance to support the end by a conical rest. While the ring grooves are being cut some support is essential, and in the case of the piston shown in Fig. 9 the use of roller supports in place of a center rest was found necessary for the reason that centering was not permitted. The piston *A* is held on the special chuck *B* and the two tools *E* and *F* are held in a double-end tool-holder. Adjustment is obtained by means of the collar-head screws *H* and *G*. The turning tool body *C* fits the turret dovetail at *D* and it is clamped, as previously stated. The end of the pilot *K* is cut away on its under side in order to clear the gear guard *L*. The steel supports *O* are backed up by the screws *Q*, which are also used for adjusting purposes. The hardened and ground steel rollers *P* are hung on the pins *S*. (See detail view.) A special tool-block *M* contains the grooving tools *N*. This equipment also was very successful.

Adjustable Piloted Turning Tool for Large Diameters

A somewhat different type of tool is shown in Fig. 10, this being adjustable for various diameters from the 12-inch casting *A* down to a diameter of 6 inches or a trifle under that size if necessary. This tool was rather heavy and cumbersome and not entirely successful on heavy cuts. On the lighter variety of work, however, it proved satisfactory and adaptable. Two tools were used on opposite sides of the turret; the flat steel tie-bar *L* helped to prevent sagging.

The body of the holder *B* is of cast iron cored out so that the walls are ½ inch section, and it is tongued along its lower face to fit the turret at *M*. The forward end holds the steel pilot *C*, which is supported and guided by the bushing *D*. The bracket *E* is fastened to the head of the machine by the screws *F*, thus insuring a rigid support for the end of the pilot. The tool-slide *N* contains the tool *O* and it is securely gibbed by the two steel straps *P*. A taper gib (not shown) provides adjustment for wear on the sides. The bracket *K* is screwed to the top of the tool body and journals the operating screw *H*. A graduated collar permits accurate settings to be made without trouble. A bronze nut in the body of the slide at *J* receives the operating screw.

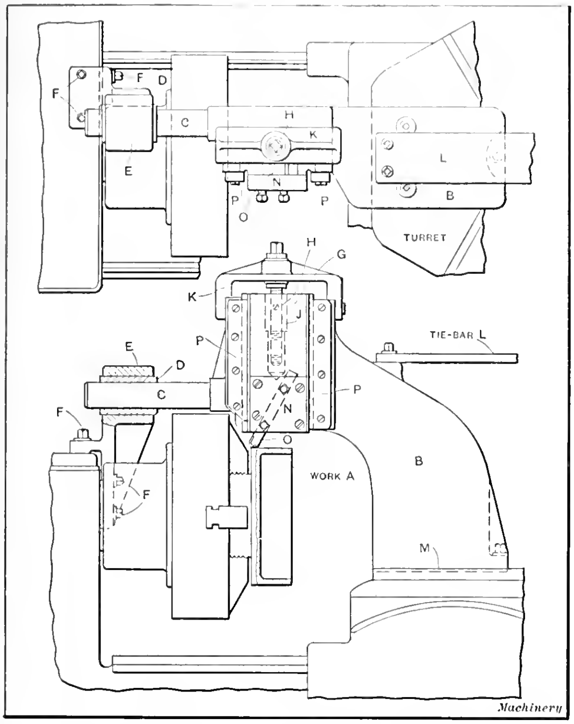


Fig. 10. Adjustable Piloted Turning Tool for Large Work

Multiple Turning Tool for the Vertical Turret Lathe

The vertical turret lathe is less frequently supplied with multiple tools than the horizontal type of machine, for the reason that the regular equipment supplied by the manufacturers is adapted to a wide range of conditions without very much special tooling, and, in addition, the class of work for which this machine is more likely to be used is of such a nature that multiple turning tools are less likely to be required. There are instances, however, when a considerable increase in production may be made by the use of the multiple type of tools. Take for example the special gear shown at *A* in Fig. 11. This piece of work is held by the inside of the rim in special jaws, and the tools in the side-head turret are used to face and turn the gear portion while the special multiple tools are at work on the hub. Before the operation illustrated takes place, the work has been bored, reamed and faced on the other side.

The body of the tool *H* is of cast iron and it is fastened to the turret face by the screws *J*, while the plug *K* centers it in the turret hole. The turning tools *E* and *F* are secured in the slots and a steel cover-plate *G* gives support for the set-screws which hold the tools in place. A steel shank *B* has a revolving roll *C* fastened to its lower end by the shouldered screw *D*; this roll acts as a pilot in the finished hole. The construction of this device is simple and the results obtained by its use are excellent

Piloted Multiple Turning Tool for Triple Gear Blank

A radical departure from regular methods is shown in Fig. 12. The work *A* for which the equipment was designed is a cast-iron triple gear blank. Attention is called to the fact

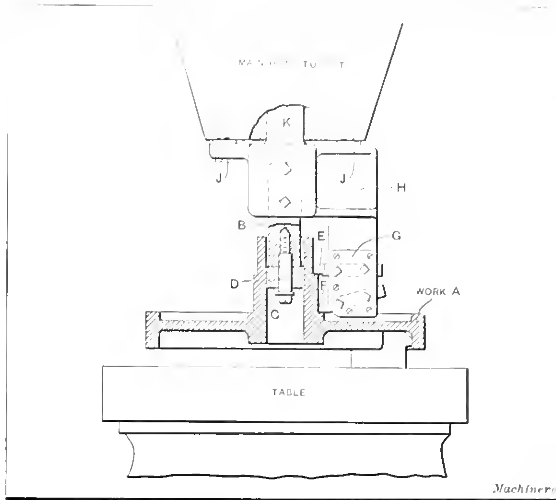


Fig. 11. Multiple Turning Tool for Vertical Turret Lathe

that in this illustration the side-head is shown in a false position in order to show the cutting action more clearly. The body *H* of the multiple turning tool is fitted to the turret and held in position by the screws *C*. A steel bushing *G* acts as an outboard support for the tool, and it is a sliding fit on the pilot *P* which is shouldered in the supporting bracket *N*. This bracket is heavily ribbed and is fastened to the bed of the machine. The adjustable washers at *M* are used to align the bracket properly. A tool-block *D* contains the two turning tools *E* and *F*, and the boring-bar *K* is held in the hub *J*. The arrangement of the side-head, in this instance, is a little out of the ordinary. A special tool-block *Q* contains the two facing tools *R* and *S*, and these work simultaneously with the turning tools, thereby making production very rapid.

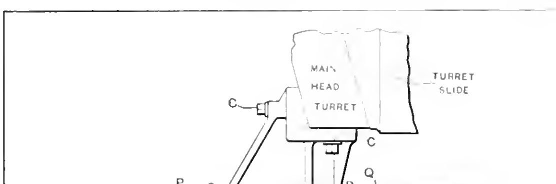


Fig. 12. Piloted Multiple Turning Tool for Triple Gear Blank

Multiple Toolpost Turret for the Side-head

The cone pulley shown at *A* in Fig. 13 was machined in one setting. The casting was held by the inside of the lower or largest step of the cone and a driver (not shown) was

placed against the interior ribbing, as the jaws were not sufficient to hold the work securely against the cutting action of the four turning tools. A special side-head turret toolholder was designed for this piece of work, and the facing and turning tools *D*, *E*, *F*, and *G* were held in it as shown in the illustration. One set of tools was used for roughing and a duplicate set on the other side of the turret post was used for finishing. The entire group of tools pivoted on the stud *H*. While these cutters were operating on the outside of the pulley, the boring-bar *B* (held in the main head turret

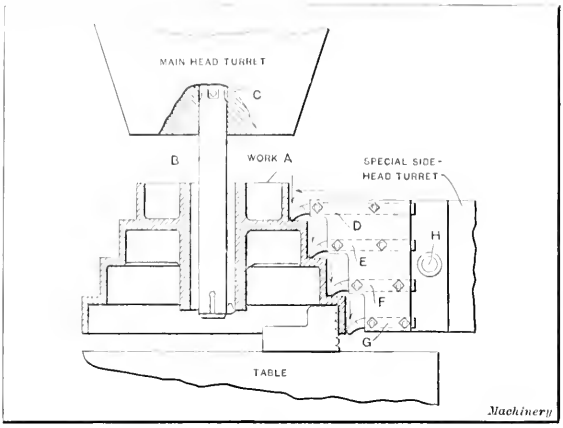


Fig. 13. Multiple Toolpost Turret for the Side-head

and driven by the pin *C*) was slowly boring out the hole. A forming plate was used to give the desired crown to the steps. The production could have been improved if a special turning tool had been used in the main head for turning the four steps of the cone, and the side-head used for facing only. These operations could have taken place at the same time, and the speeds would have been more nearly correct. The boring could have been done at a higher rate of speed. However, the

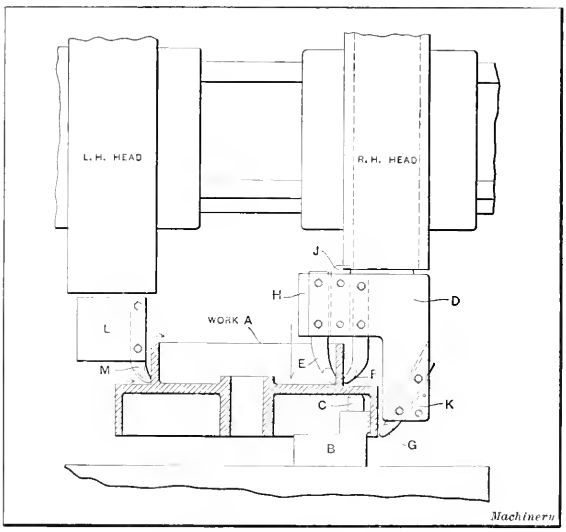


Fig. 14. Application of Multiple Turning Tool to Vertical Boring Mill

results obtained with the arrangement shown in the illustration were satisfactory.

Multiple Turning Tool for the Vertical Boring Mill

The vertical boring mill is seldom equipped with multiple turning tools, but there are cases where production can be increased considerably by their use. One example only is given of the use of an equipment of this kind. Fig. 14 shows a large pulley at *A*, and this is held by the inside of the larger step in the special jaws *B*. The buttons *C* give a three-point support to the work. A special tool-holder *D* is slotted out to receive the tools *E*, *F* and *G* which are used for the turning and boring. The plate *H* is fastened over one end of the tool-holder in order to tie it together, and the filler-block *J* gives additional strength while its upper end engages the right-hand ram and acts as a driver. Another block *K* ties the lower end of the tool-holder together. The left-hand head contains the toolpost *L* which supports the tool *M*. This tool is used for facing while the other tools are turning.

Other instances of multiple turning might be given, and illustrations shown, but these would be much on the same order as those which have been mentioned and would be of no particular value as representative types. Tools have been selected for this article which seem to best illustrate the principles of design required in the various types.

* * *

HARROUN KEROSENE CARBURETER*

The high price of gasoline and the rapidly increasing consumption have given great interest to the efforts of inventors to produce a practicable and efficient carbureter for automobile and other internal combustion engines using kerosene for fuel. The accompanying diagrammatic illustration shows the principle of the Harroun kerosene carbureter invented by Ray Harroun and now being marketed by the Harroun Co., of Indianapolis, Ind. Part of the exhaust gases are diverted

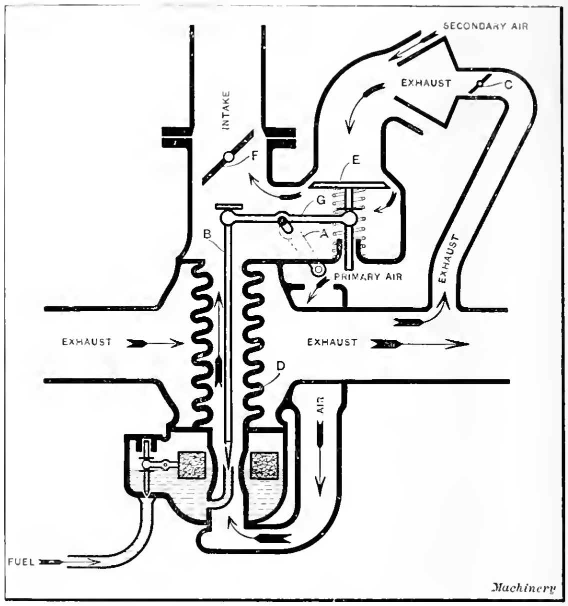


Diagram showing Principle of the Harroun Kerosene Carbureter

into a space surrounding a spirally corrugated chamber *D*. As the dense atomized fuel is drawn through this chamber by the suction of the motor, the heavier parts are thrown to the outside against the heated surface by centrifugal force and the more volatile portions of the fuel remain in the center. As the fuel is sprayed from the nozzle and comes into contact with the hot walls of the chamber it is turned into a vapor. This vapor is partially mixed with air coming in from the bottom of the chamber and is further diluted with cold air coming through the secondary air valve. The needle valve *B* in the opening of the fuel nozzle is automatically opened and closed by the action of the secondary air valve *E*. The carbureter requires but one adjustment, this being effected from the driver's seat through a suitable connection to the lever *A* on the side of the carbureter. This lever raises and lowers the fulcrum of the rocker arm *G* which is inside of the carbureter and raises and lowers the needle *B* as it is actuated by the air valve *E*.

One of the original features claimed for this carbureter is that of diverting a small portion of the exhaust gas back into the charge through the air valve opening. The discovery was made that a part of the exhaust gas mixed with the charge eliminates the disagreeable sounds which are always more

* For further information on kerosene carbureters see "Solving the Fuel Problem for the Motor Truck," October, 1913.

evident with kerosene than with gasoline fuel. Water has been used considerably to accomplish this result, but the use of water results in complications; a water supply is hard to regulate, besides being likely to freeze in cold weather. This gas mixing feature is claimed to be an advantage also with gasoline, as it eliminates "carbon knock" in any motor and also increases the efficiency of the fuel at variable speeds.

The butterfly valve *C* is provided as a means for regulating the amount of exhaust gas used. This may be worked from the dash. It provides regulation of the maximum expansion period in relation to the piston travel under varying running conditions. For example, it is a well-known fact among engineers that the fuel consumption ranges from one-half to three-quarters pound per horsepower hour when the motor is running at about 1000 feet per minute piston speed. The consumption increases rapidly, however, with either an increase or a decrease of the piston speed, sometimes being as much as one and one-half pound per horsepower hour at about 500 and 1600 feet per minute piston speed. This undesirable condition is due to the fact that the speed at which a correct mixture will burn most efficiently happens to be just right at 1000 feet per minute piston speed. A device that will retard the speed of combustion without retarding the spark timing at slow motor speeds will obviously increase the thermal efficiency. Under actual running conditions, an automobile motor is rarely pushed to its maximum or even its normal load.

The Harroun carbureter operates with either gasoline or kerosene without change of adjustment. In fact it is claimed to be a highly developed gasoline carbureter having the added feature of operating satisfactorily on cheap grocery store coal oil. The mileage obtained is ten per cent greater when using kerosene than when using gasoline. Recent tests have shown that with kerosene fuel fed to the engine through this carbureter, a motor will haul one ton one mile for one-third cent.

MACHINING ARMATURE SHAFTS*

TURNING AND GRINDING OPERATIONS WHICH ARE HANDLED AT A RAPID RATE

The method of machining armature shafts has been developed to a high degree of perfection in the plant of the Robbins & Myers Co., Springfield, Ohio, manufacturers of the "Standard" line of motors, generators and fans. The armature shafts are made from 0.30 carbon machine steel, and vary in length according to the motor, fan or generator in

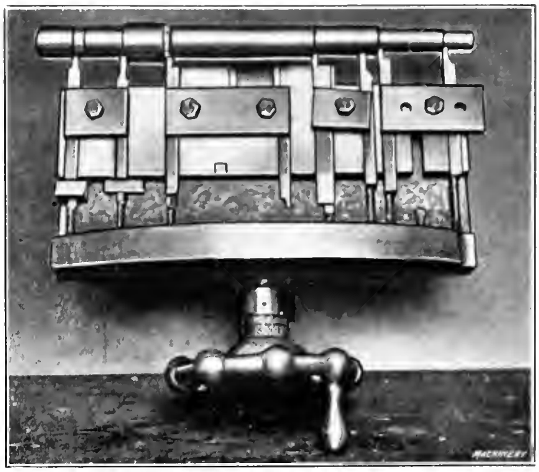


Fig. 2. Attachment used on the "Lo-swing" Lathe for necking Armature Shafts and facing the Shoulders to the Correct Length

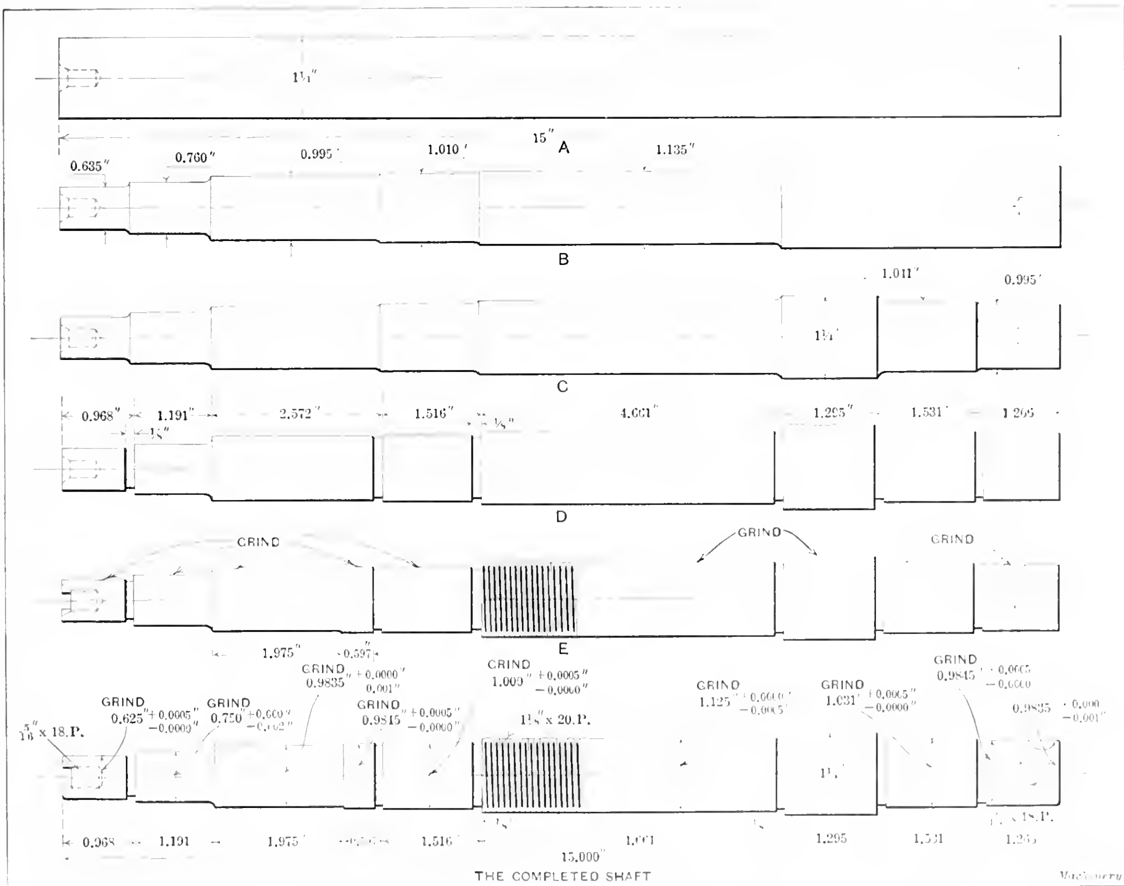


Fig. 1. Sequence of Operations on the Armature Shaft

* For articles on shaft turning previously published in MACHINERY, see "A Lo-swing Lathe Test on Motor Armature Shafts," April, 1913; "Multiple Shoulder Shaft Turning on the Cleveland Automatic," November, 1912, engineering edition; "Turning Shafts in the Cleveland Plain Automatic," April, 1911, engineering edition.

which they are used, the one illustrated being 15 inches long. They are carried through in lots of 500, special trucks being used to accommodate this number. The operations on the shafts are given in the order in which they are handled, only those that have interesting features being illustrated and described in detail.

Preliminary and Lathe Turning Operations

The first operation on the armature shaft is shown at *A* in Fig. 1. This consists in cutting it off to the desired length and drilling and centering both ends in a No. 4 Warner & Swasey hand screw machine. Following this operation, the shaft is rough-turned in the "Lo-swing" lathe as illustrated in Fig. 3. Five different diameters are turned in one setting with multiple tools. This operation completes one-half the shaft in a setting, as shown at *B*, and when the operator has finished the entire lot the machine is reset and the other end of the shaft machined. Handling the work in this manner has proved very satisfactory and enables a production of 100 shafts in ten hours to be obtained. The bar, to start with, is 1¼ inch in diameter, rough stock, and is reduced to the dimensions shown at *B* and *C*. The operations following the rough-turning consist in squaring the shoulders to accurate lengths and under-cutting for grinding, as shown at *D*. These operations are also accomplished in the "Lo-swing" lathe, which is equipped with a special tool-holder as illustrated in Fig. 2. This tool-holder, or slide, carries seven parting or under-cutting tools that reduce or neck the shaft for grinding, and at the same time finish the different shoulders to their exact lengths. The time for necking is included in the product of 100 shafts per day.

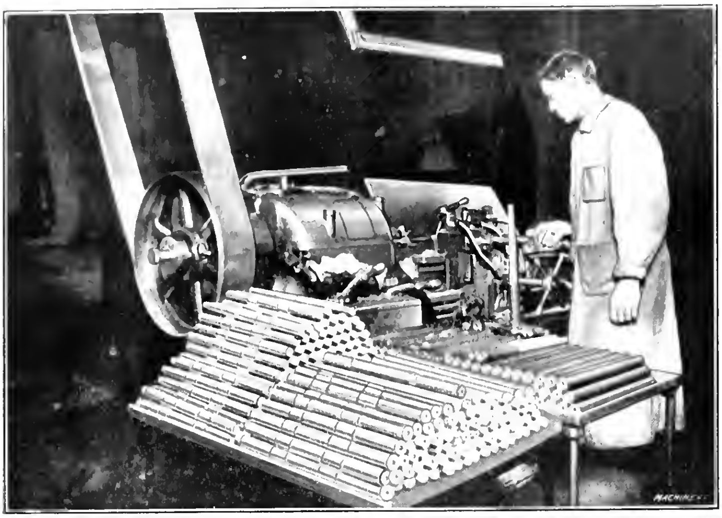


Fig. 3. Rough-turning Armature Shafts in a "Lo-swing" Lathe

Following the necking operation, the holes in the ends of the shaft are tapped in a Cincinnati drill press, and the keyway in one end and the slot in the other end are cut in a Whitney hand miller. One end of the shaft, as shown at *E* in Fig. 1, is threaded and this operation is accomplished in the hand screw machine, using a self-opening die.

Finishing Operations on Armature Shafts

The final operation on the armature shaft is grinding the different shoulders to the exact diameters, which is accomplished in the 6 by 32 Norton plain grinder shown in Fig. 4. The operator, instead of finishing one shaft at a time, puts through the entire lot by grinding only one diameter at a setting and by using a 2¼-inch wheel and feeding it directly in to the work instead of traversing the table. This procedure is followed except in cases where the bearing on the shaft is longer than the width of the wheel used, which would necessitate traversing the table. By referring to Fig. 1 it will be be seen that all but one bearing can be ground without traversing the table. It will also be noticed that the bearing on the extreme right end of the shaft is tapered an amount equal to 0.001 inch in its length. This is accomplished by truing the wheel with a diamond, the table being set over the required amount. In operation, the wheel is fed directly in to the work—not traversed.

On an average of 0.010 inch is left on the diameter of the shaft for grinding, except on the 1¼-inch diameter where it is necessary to remove about 1/32 inch. As shown at *E* in Fig. 1, there are eight bearings or shoulders on the shaft that can be ground in the manner previously described; that is, by feeding the wheel directly in to the work—not traversing the work longitudinally. As each shoulder on the lot of shafts is ground at a setting, it is not necessary for the operator to change the position of the table in relation to the wheel, any slight variation in the depth of the centers being taken care of by the nicks in the shafts. As soon as the wheel becomes slightly glazed or clogged, it is trued up with a diamond and straightened so that the bearing produced is accurate as regards diameter and straight from one end to the other. The automatic cross-feed and knock-out on the machine are used, and when one shaft is being ground the operator is placing a dog on the other, so that the only time lost is that required to remove and replace the shafts on the centers of the grinding machine. When all the bearings less than 2¼ inches in length have been ground, the machine is reset to grind the remaining long bearing, thus completing the grinding operations. The limits on the grinding operations are in many cases only 0.0005 inch. The grinding of only one bearing at a time has been found to be highly economical and efficient, as a production of 105 completed shafts in ten hours proves.—D. T. H.

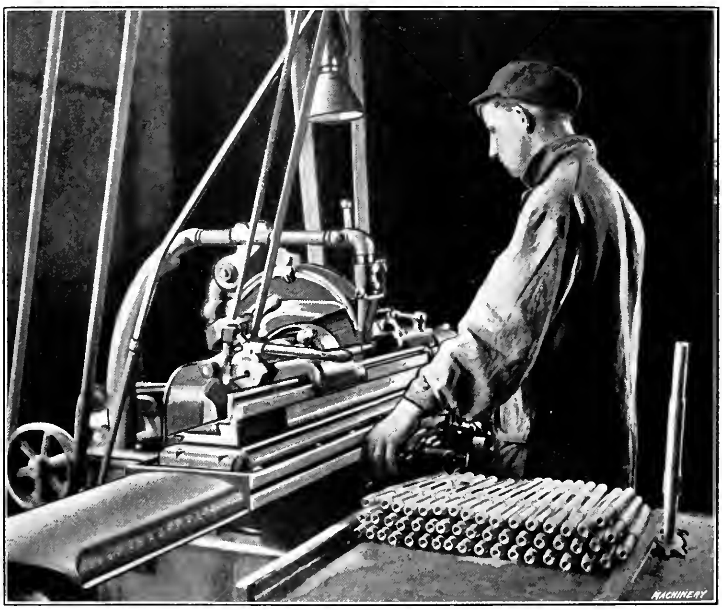


Fig. 4. Grinding Armature Shafts on a Norton Plain Grinding Machine

* * *

It is very unsafe to say that a thing cannot be done or that it must prove a failure. It is by far the safer course, at least in things mechanical, to admit that while it does not seem probable—you never can tell.

FOUR-SPINDLE REAMING ATTACHMENT FOR MOTOR CAR CYLINDERS

BY C. BOELLA*

In order to increase the production of cylinders for small motor cars, cast *en bloc*, the attachment shown in Fig. 1 was designed for application to a regular drilling machine to avoid buying an expensive machine. These cylinders were required in large quantities and high-grade machine work was necessary. A large Niles vertical drilling machine which was already used to ream cylinders, was fitted with the special attachment.

The attachment has a heavy cast-iron base firmly bolted to the machine table. This base has two perpendicular side walls provided with finished surfaces at the ends which are exactly square with the base. The base of the cylinder which, previous to the reaming operation is planed to the exact size, is placed in the fixture between the vertical sides. The latter are fitted at the back with suitable stops, against which the cylinder base bears. The cylinder is held to the fixture by four pivoted clamps which are inserted through suitable square

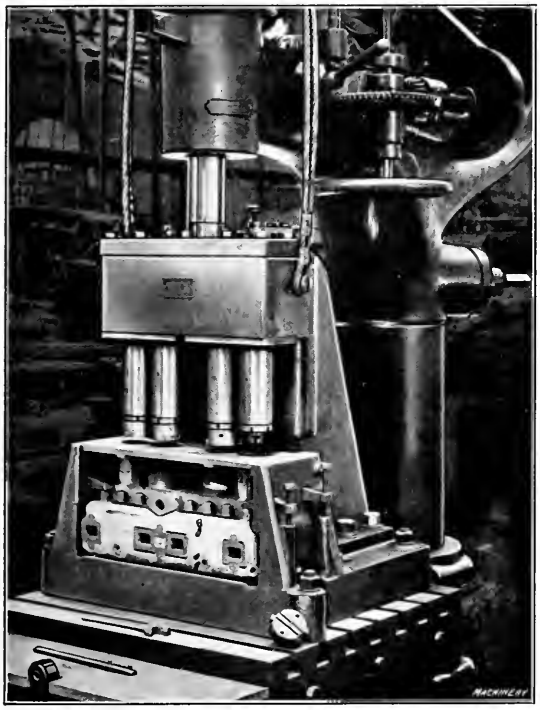


Fig. 1. Four-spindle Reaming Attachment and Fixture with Cylinder in Place

holes in the uprights. These clamps are tightened by screws in the ends which engage projecting lugs, as shown. A large channel at the base of the fixture just under the casting, provides room for chips and makes it easy to remove them.

The four tool spindles are mounted in a slide which is carried by a strong, heavily ribbed column that is bolted to the base of the fixture. Fig. 2 shows a plan view of the spindles and slide. In order to insure exact alignment of the slide during its traverse, it has been fitted with a central dovetailed guide *A*, which being narrow relative to its length, insures accurate movement of the slide. The taper gib *B* is adjustable endwise for taking up wear, the holes for the bolts being made oval to provide play for the taper gib adjustment. The gear *D* fitted to the spindle drives gears *E* and *F* which, in turn, drive gears *H* and *G*, these four gears being fitted to the tool spindles.

Fig. 3 is a vertical section through the tool-slide. A shaft D_1 is screwed to the lower end of the spindle *J* of the machine, and gear *D* drives the tool spindles, as previously explained. A ball bearing *K* is provided to take the vertical thrust of the tools, and plugs *L* screwed in the slide cover are used for vertical adjustment of the spindles. Each tool spindle is surrounded by a heavy steel tube *M*. This tube is fitted with a bushing *N* at its upper end and a smaller bushing *O* at its lower end. The latter is tapered externally and is adjusted by screwed ring *P*. The lower bearing is very close to the tool so that the spindle is rigidly supported.

The tools are fixed to the spindles in a peculiar way, each spindle being tapered to an angle of 20 degrees and fitted with a bayonet clutch. This clutch is engaged by a pivot that is

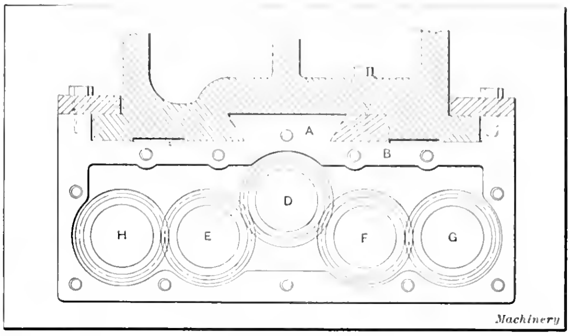


Fig. 2. Plan View showing Arrangement of Spindles of Reaming Attachment

integral with the tool-holder, thus holding the latter onto the taper part of the spindle. With this arrangement, the tools are centered accurately and are held rigidly even after long use; it also allows cutters to be easily removed. Fig. 4 shows the tool which is used both for roughing and finishing. It has a cylindrical body bored tapering to fit the conical end of the spindle. The lower face has a large dovetailed groove in which the two tools are held. These tools are of simple form and are fixed in position by tapering gibs. These tools permit heavy cuts to be taken with heavy feeds and high speeds without chattering.

Experience has proved that multiple cutters are not suitable for this kind of work because of the difficulty of setting them

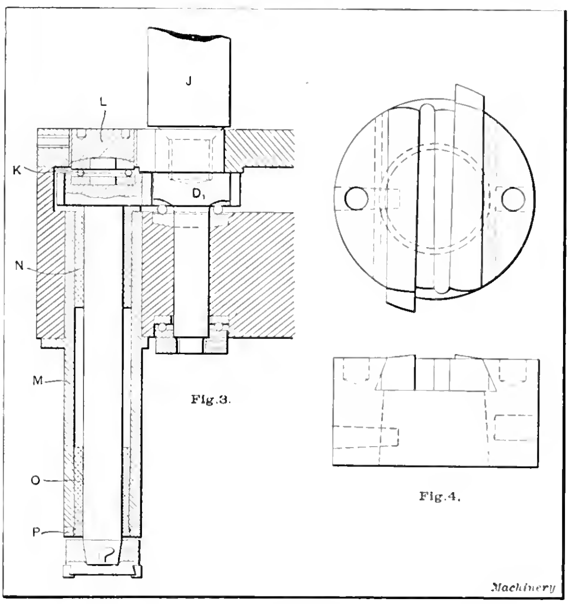


Fig. 3. Vertical Section of Spindle. Fig. 4. Cutter-holder and Cutters

up and fixing them rigidly enough to resist the strain of such hard usage. With the tools described, remarkable results have been obtained. A cylinder of 3- by 9-inch size is rough-bored in twenty minutes and finished in twelve minutes. Better results could be obtained were it not for the excessive heat generated, which is liable to impair the accuracy of the work. The depth of the cut during the roughing operation is about 1/8 inch and the finishing cut about 1/64 inch. The holes are

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quite smooth, straight and parallel and are located exactly with relation to the base.

As the slide with its spindles is heavy, it is necessary to counterbalance it. It was not convenient to increase the counterbalance weight of the machine spindle, so the slide was counterbalanced separately. Two wire ropes were attached to the sides of the slide, as shown, and these pass over grooved pulleys attached to the ceiling and connecting with suitable counterbalancing weights. As changing the cylinders is easier than changing the tools, for repetition work, it is better to rough a quantity of cylinders and finish them afterward.

* * *

BROACHING VS. REAMING

BY FRANK J. LAPOINTE*

The broaching of round holes has been adopted within the last few years by many manufacturers on certain classes of work in preference to reaming. This change is due to two reasons: The cost of the operation is less and the finish on the particular work referred to later is superior to that of reaming. It might be of interest to the readers of MACHINERY to know some of the conditions connected with broaching round holes, and the comparative time between broaching and reaming them.

It is an acknowledged fact that the boring and reaming of seamless steel tubing, especially when the walls are light, is not a very satisfactory operation; in fact, the pieces are usually distorted, due to the method of holding them. One of the principal objections to reaming, and one reason why it is so hard to obtain a well reamed hole in steel tubing, is that the reamer tears or "bites in" at some point on the surface. This is due to the fact that the fibers of the steel are drawn lengthwise or at right angles to the cutting edges of the reamer, which is one of the reasons why it is so hard to obtain a good clean finish in steel tubing by reaming.

On the other hand, when broaching the hole in a tube, a very nice finish can be obtained because the fibers lie or are drawn in the same direction as the broach is operated. The ordinary seamless steel tubing is about 0.008 to 0.030 inch under standard size, which is just a nice amount to broach out. For broaching this material, with diameters up to 2 inches, we broach on the high speed of our broaching machine, or with the cutting tool traveling at about six feet per minute. There is no clamping of the work for this operation and the shell is not distorted anywhere nearly as much as it would be by boring or reaming. Six or seven pieces can be broached while one is being reamed.

The writer recently had the pleasure of visiting one of the largest automobile gear manufacturers in the country and was pleased with the results they are obtaining in broaching round holes. The operation is on sliding gears and differential gears. The method of machining these pieces has been changed from the ordinary way to the following: The work is placed on a drill press, in a suitable fixture, and the holes, which vary from 1 1/16 to 1 1/2 inch in diameter, are drilled in one operation with a drill 1/32 inch smaller than the finished size of the hole. On the spindle of the drill press a facing head is arranged so that after the hole is drilled, the spindle is fed down and the gear faced off by this facing head; this forms a flat surface which is square with the hole and is used for locating the work while broaching. The old method was to drill these gears, then follow with a light boring chip, and then a reamer. I was informed that the reduction in price on this work was 1½ cent per hole, which is quite an item when we consider that the original cost of machining the holes was very low, and to reduce it 1½ cent per gear was well worth changing the operation.

The results obtained by broaching are that a well finished hole is obtained in addition to greater production; moreover, the life of a broach is eight to twelve times that of a reamer. Another operation of broaching round holes that may be of interest is carried on in our own plant. All bearings of bronze under 2½ inches diameter, are broached instead of being reamed. This is done for several reasons:

First, broaching is our business; second, it is the most profitable way for us to handle the work; third, there is less waste of material; fourth, the production is eight times as great; and fifth, we always have plenty of broaching machines on the floor to be tested out. Take, for instance, the broaching of a 2-inch round hole in bronze castings 4½ inches long. We allow 1/8 inch of stock to be removed or 1/16 inch on each side, the hole being cored ⅛ inch smaller than the finished diameter. When we were boring and reaming these holes to size, ¼ inch was allowed and the average time was ten minutes per piece. They are now broached at the rate of one in 1¼ minute and the pieces are not clamped and do not lose their shape. The finish of the broached holes is better than was obtained by reaming. The trouble when reaming hard bronze is to overcome the chattering and waving of the reamer in the hole; this has been done by broaching.

The results when broaching round holes depend on the tool itself. The broaches are ground all over after hardening and are backed off at the proper angle to give them a nice cutting edge. The teeth are nicked to break the chips on the heavy cutting part of the broach, but the last six or eight teeth that do the sizing are not nicked. Following the last six or eight sizing teeth is a short pilot which supports and guides the broach. One very important thing in broaching round holes is the proper spacing of the broach teeth. At no time must there be less than three teeth in the work, in order to properly support the broach; if the teeth were so coarse that only one tooth was cutting while another was entering, it would give the broach a slight movement, causing waves in the work. The broach must always be made up with differential spacing of the teeth. If the teeth are all evenly spaced, as a rule very unsatisfactory results will be obtained.

When making broaches a number of things must be taken into consideration, *viz.*, material to be cut, length of work, amount of stock to be removed on the outside, and the shape of the work, so that the proper support can be provided. The length of the broach depends entirely on the metal to be removed. Of course in cases where the broaching operation is for sizing, a short broach is used, usually having about 10 inches of cutting edge. If the broach is to remove ⅛ inch of stock, the length may vary from 28 to 40 inches, depending on the length of the work.

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In a discussion of the value of graphite as a lubricant at the December meeting of the metropolitan section of the Society of Automobile Engineers, Marcus A. Smith, lubrication engineer of the International Acheson Graphite Co., described some of the peculiarities of deflocculated graphite. The subdivision of graphite particles has been carried to such a point that they permeate the pores of the metal and in that way build up a surface layer in which the carbon particles are intimately associated with the metal. Such a surface is termed a "graphoid" surface. By adding one-quarter per cent of deflocculated graphite to lubricating oil it is possible to carry to all surfaces a material that is finer than the most minute pores of the metal and which will gradually saturate the metal with a lubricant that heat does not destroy. The minute size of these particles is indicated by the fact that 339,000 particles of deflocculated graphite, placed side by side, extend one inch. The claim is made that the benefits derived from deflocculated graphite diffused in oil are accumulative, for by continued use all the bearings, cylinder walls and piston rings are protected by a lubricant which impregnates the metal, and if at any time the supply of lubricant is shut off, the coefficient of friction remains practically unchanged for many hours of use.

* * *

The Bureau of Foreign and Domestic Commerce suggests in a recent consular report that all communications to the United States consular officers be addressed "The American Consul, at ——," the name of the officer not being given. Any communications so addressed will be opened and attended to by the person who happens to be in charge of the consular office at the time the communication is received. If addressed to the consul by name, it is likely to be forwarded to him unopened, should he be absent, and unnecessary delay would thus result.

REBUILDING A PIPE THREADER

BY A. P. CONNOR*

We were recently called upon to rebuild an old style manually operated Saunders pipe threader in order to take advantage of the increased facility with which a power driven machine could be operated. The provision of suitable gearing would evidently make it possible to change or reverse the speed at which the machine was driven; at the same time it was desired to retain the features of portability, adjustability and a degree of stability which would adapt it for rough usage. The machine had been in operation for a number of years but was still in good condition, so that the problem of rebuilding was limited to the change from hand to motor drive.

In order to have the machine as light as possible, it was decided to do away with the shelves that were located under the bed of the original machine. The lower shelf was replaced by a platform mounted on connecting stays secured to the legs. A ½ horsepower motor was mounted on this platform and means for adjusting the alignment of the motor spindle was provided by four bolts. It will be seen that two nuts are provided on each of these bolts, one nut being above the base of the motor and the other below it. By regulating these nuts, the alignment of the motor spindle can be adjusted to insure having the belt run properly. The arrangement is clearly shown in the illustrations, where it will also be noticed that the motor is located under the machine where it is out of the way.

The headstock housing was reversed in order to locate the driving mechanism at the opposite side of the machine from the position where the operator stands, and the whole machine was set over on the base a distance of 2½ inches toward the operating side in order to balance properly and avoid too much

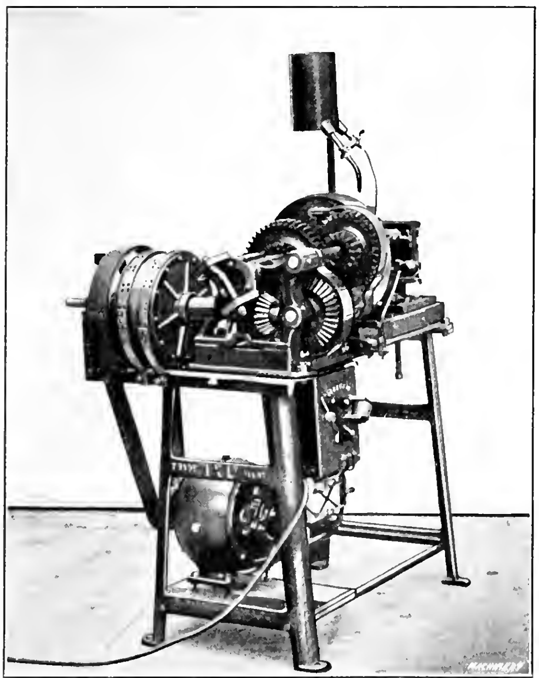

Fig. 1. Operating Side of the Rebuilt Pipe Threader

overhang on the driving side. The familiar form of planetary transmission used on automobiles was adopted, the gear reduction obtained in this way being one to three on the forward and slow reverse speeds. A high-speed reverse was also provided. All speed changes are obtained by a single operating lever. This lever is shifted to the right or toward the die carriage for threading; in order to reverse the direction of rotation of the stock for backing out the work, the operating lever is thrown into the left-hand position; and to stop the machine, the lever is moved to the middle. In order to obtain the high reverse speed, the operating lever is shifted a slight distance off center to the left. From the preceding description it will be noted that the motor connections are not touched in operating the machine and that it is unnecessary to alter the resistance of the electric circuit in order to obtain any of the results referred to.

A friction clutch mechanism is used in connection with the operating lever, which gives a very smooth action and avoids the possibility of breaking gears or otherwise damaging the machine or motor through sudden shocks. The full horsepower of the motor is available all the time that the machine

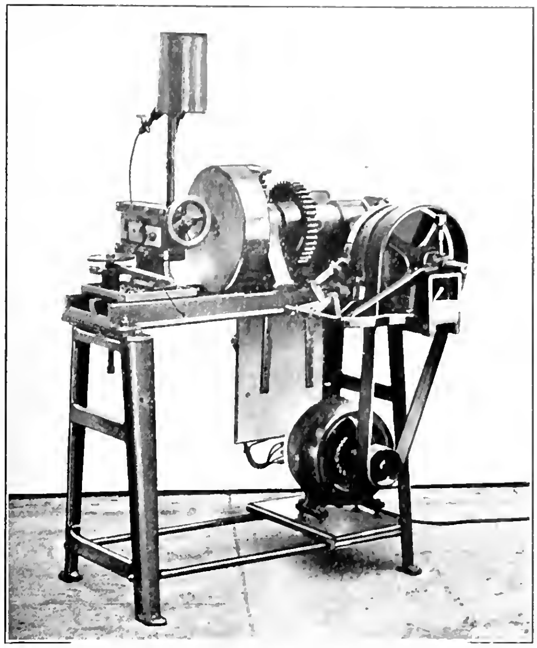

Fig. 2. Rear View of the Rebuilt Pipe Threader

is running. The belt speed must necessarily be high, owing to the type of motor used, and this would ordinarily entail the use of a large driving pulley on the machine. This objectionable feature was done away with by the use of the planetary gear reduction in connection with the regular gearing on the machine. It will be seen from Fig. 1 that the rheostat for the motor is mounted under the bed of the machine so that it is convenient for the operator and at the same time assists in counterbalancing the weight of the motor. The main circuit switch is placed under the rheostat. As the motor only develops ½ horsepower, it can be connected to an ordinary lamp socket with the usual form of attachment plug. The weight of the machine was held within a limit which enables it to be moved about from one job to another, and it is unnecessary to bolt it down to the floor. Solid dies are used, as they have been found most desirable for the class of work for which this machine is intended. The oiling arrangement is essentially the same as that used on the original machine.

* * *

MAKING COPPER WIRE BY ELECTRO-DEPOSITION

A process has been devised for the manufacture of copper wire by electro-deposition. According to the *Brass World*, previous attempts to manufacture wire by this process have been unsuccessful. A fine copper wire is used as a core and the additional copper is deposited on it while moving through a tank containing the solution. The fine copper wire is made endless and passes through a regular plating solution containing sulphate of copper and a little sulphuric acid. After leaving the tank, the wire passes through a small rinsing tank to remove the solution, and then, after making a number of turns around a reel, it returns to the plating tank. The plating is thus continued until a wire of the required diameter is obtained.

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PRESS TOOLS FOR CLIPPING AND PIERCING BRASS SHELLS

BY JOHN F. FORBES

The illustrations show several interesting forms of press tools for performing clipping and piercing operations on brass shells. Fig. 1 shows the shell *A* which is to be clipped along the dotted line, and at *B* and *C* two views of the completed shell are shown. The die used for this clipping operation is illustrated in Fig. 2. The die *A*, over which the shell slips is a hardened steel collar which is made to fit the shell accurately. This die is driven onto the stud *B* and held in place by means of the dowel pin *C*. The stud *B* is a press fit in the die-bed and is prevented from turning by means of the key *D* which serves the additional purpose of locating the stud in the desired position.

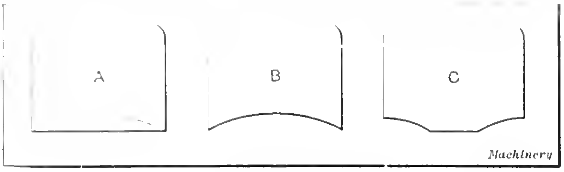

Fig. 1. Shell A to be clipped along Dotted Line and Two Views of Clipped Shell

The clipping punches *E* are mounted on two dovetailed slides in the die-bed. This construction will be readily understood by referring to the cross-sectional view of the die-bed along the line *X-X*. Allowance is made for any adjustment of the punches that may be necessary on account of grinding by the provision of elongated holes for the screws which secure the punches to the slides. In case any adjustment is made, a shim of sheet steel of the required thickness is placed between the back of the punch and the slide; this gives the punch a bearing on the slide and relieves the screws from the pressure of the cut. The punches are made to conform accurately to the cutting edge of the clipping die, the contour of this cutting edge being clearly shown by the dotted lines in the two views of the die which are shown in Fig. 2. The faces of the clipping punches conform to the circumference of the shell and the points *E* cut a little in advance of the remainder of the punch in order to insure having the shell clipped without leaving a fin or burr of any kind.

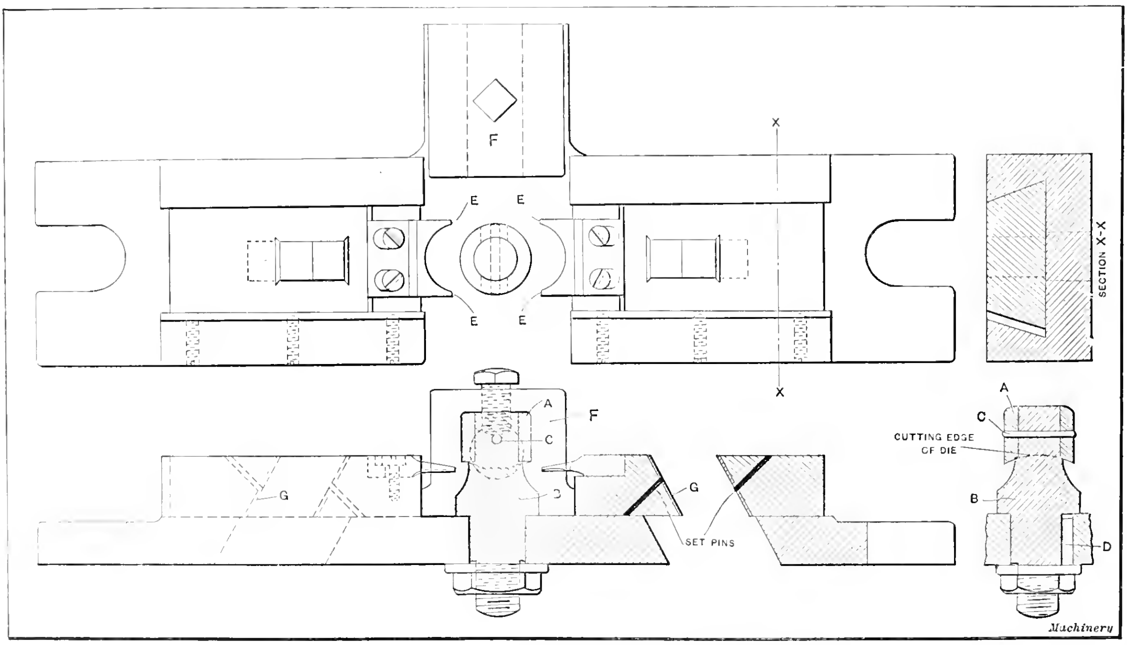

Fig. 2. Die-bed equipped with Tools for clipping Shell shown in Fig. 1

Operation of the Tools and Die-bed

In order to clip a shell with this set of tools, the work is placed over the die and the press is then tripped. The punch shown in Fig. 3 is held in the ram by means of the shank *A*. When the ram descends, the inner surfaces *B* of the arms which are inclined at 30 degrees, come in contact with the steel pads *G*, Fig. 2, in the slides that carry the clipping punches and move them in toward the die. This brings the clipping punches into action and causes the shell to be clipped. When the ram starts its return stroke, the outer surfaces *C* of the arms on the punch cause the slides which carry the clipping punches to be returned to their original positions. It will be obvious that this method of actuating the slides is positive in action and does away with the use of springs for returning the slides. It will be seen that the punch-holder *D*, shown in Fig. 3, has a small piercing punch *E* mounted in it.

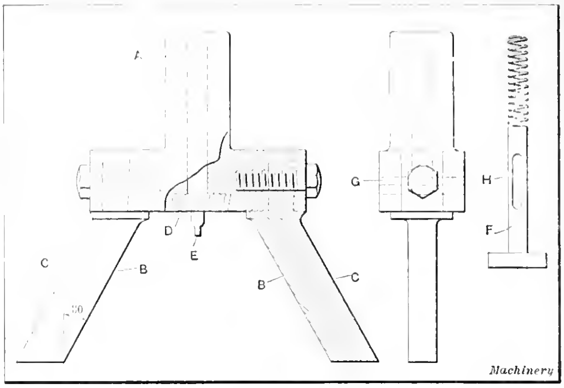

Fig. 3. Punch-holder with 30-degree Angle Arms to control the Movement of the Slides

This piercing punch is used in an operation that will be described in a subsequent paragraph. When the tool is used for the clipping operation, the piercing punch *E* and the punch-holder *D* are removed from the punch and the "hold-down" *F* is mounted in their place. This hold-down is held in place by means of a pin *G* which fits in the slot *H*, the length of the slot being sufficient to allow the hold-down the necessary amount of movement. This hold-down moves a little ahead of the clipping punches and thus comes into contact with the top of the shell and holds it securely in place

so that it cannot be raised off the die when the clipping punches begin to cut.

Construction of the Die-bed

The shells that are clipped or pierced on this die-bed are ordered in lots of not over 25,000. This fact made it desirable to make a die-bed that could be used for both clipping and piercing operations, and this advantage is obtained by the design shown in Fig. 2. This would not be of much advantage, however, if the work had been ordered in large quantities which would require the same set of tools to work day after day in order to get it out. In some cases, it was found desirable to provide special slides for a given set of punches and the clipping punches shown in place on the die-bed in Fig. 2 are an example of this kind. When these punches are removed, the slides are taken off with them and the regular slides can then be put in place on the die-bed in order to allow other tools to be set up. It will be seen that gibs are provided to enable any wear which may develop in the slides to be taken up.

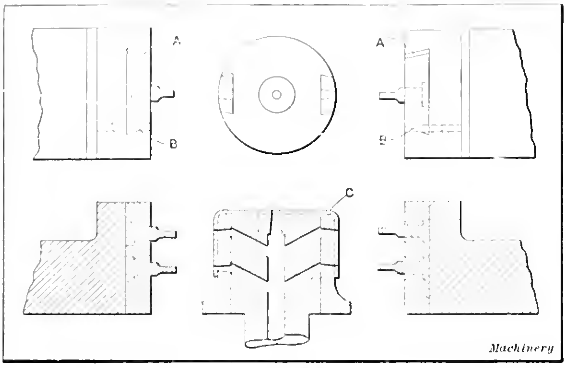

Fig. 4. Die set up for piercing Shell held in Vertical Position

The construction of the die-bed is such that shells can be held in either a horizontal or vertical position. This will be better understood by referring to Figs. 4 and 5 which show shells mounted in the vertical and horizontal positions. The shell *C* which is shown in position on the die in Fig. 4, has five holes pierced in it. Two of these holes are pierced in either side of the shell by means of piercing punches carried in the slides of the die-bed, while the fifth hole is pierced in the top of the shell by means of the piercing punch *E*, which is shown in position in the punch-holder in Fig. 3. The piercing punches for working on the sides of the shell are mounted in regular slides of the die-bed shown in Fig. 2. Referring to the top view in Fig. 4, it will be seen that these punches are mounted in dovetail holders which are held in the desired position by means of keys *A*. The pins *B* locate the punches in their proper positions and are particularly convenient in obtaining the desired alignment when setting up the tools after they have been removed for sharpening.

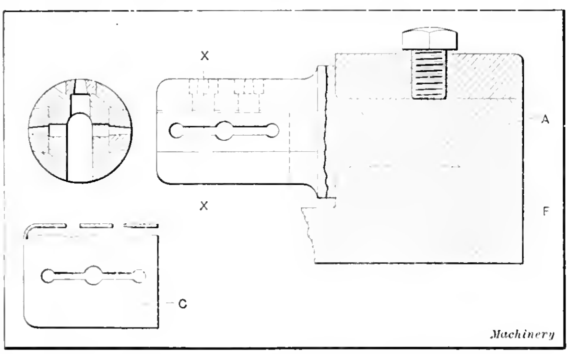

Fig. 5. Die set up for piercing Shell held in Horizontal Position

Fig. 5 not only shows the construction of the piercing die for piercing the shell *C*, shown at the left-hand side of the illustration, but also illustrates the way in which the work is held in a horizontal position in the same die-bed that is used for holding work in a vertical position. Referring again to the illustration Fig. 2, it will be seen that the part *F* at the back of the die-bed has a hole in it to receive the shank *A* of the piercing die-holder which is held in place by means of a set-screw. The shell *C* which is pierced on this die, could be pierced in a vertical position but this would necessitate a three-slide die-bed. Where the present method is used, the slot at either side of the shell is pierced by punches carried in the slides of the die-bed and the two small holes at the top of the shell are pierced by two punches carried in the punch-holder mounted in the ram of the press. In the case of the die used for piercing this shell, and all of the other dies referred to, it will be seen that a space is provided to allow the scrap and dirt to drop out at the bottom of the die.

* * *

HE DID NOT BELIEVE IN OIL

BY A. P. PRESS

Our friend Bill blew in the other day. He was the same old Bill that came in a year ago. The cigar with the gold band that he handed out was a little fatter, and it smelt a little more as though it came from Havana; his waist line had increased two inches—otherwise he was the same good fellow that we had always known.

"Well Bill, what are you doing?" was our question after he had settled down in the best chair in the office, pulled up his pants, and got his cigar to going.

"Well boss, I'll tell you. I am 'trouble man' for the Easy Car Co., and I am down this way to straighten out a little trouble. The trouble was so darned mean that I couldn't rest until I told someone about it, and so I came in to see you.

"About three months ago, we sold a big six-cylinder car to a dentist down here. The car was tested out. I took a ride in it myself, and it was shipped down to him in the usual way. The 'toothache man' took the car and paid for it, and wrote us a nice letter about how well pleased he was; then a week later, the trouble started in, and from that day until I came down a week ago, there has been nothing but kicks, complaints and cuss words.

"The 'Super' called me in his office last week, and said, 'Bill, go down there and fix that thing somehow. We don't know what's the matter, and we don't think the dentist does either, so find out.'

"Well, I came down, went over to the garage, and there my friend was waiting for me. I went all over the car, and I got down on my back and went under it; took off the crank-case, then took off one cylinder, and Mr. Press, what do you think? That darned fool—excuse my French—had been running that car for three months without a drop of oil in use anywhere. Transmission, engine, rear axle, in fact, the whole car, had never made the acquaintance of an oil-can. When I crawled out from underneath the car, I was mad clean through. There is no society for the prevention of cruelty to automobiles—if there was, I would like to be both secretary and president.

"When the dentist commenced to lamb it into me, I could not hold in a minute. 'Mr. Dentist,' says I, I said the words just as slowly and softly as I could, so as not to make a break, 'if I could buy you for what you really know about a car and then sell you for what you think you know, it would be the greatest gold brick proposition I know of. A man that would take a car like that, and run it three months without a drop of oil hadn't ought to be allowed to have a car. If you can't afford the oil, you should not have bought the car; and if you can afford the oil and don't know enough to put it in, you should not be allowed to drive a car.'

"What did he say? He turned red and yellow, and at last turned white and said that he supposed the garage man, or the errand boy, or the typewriter had always filled it up. I straightened the matter out. I told him before I started that it would cost $1 for every hour I spent on the car. He paid the bill like a man and gave me a dozen of these cigars, and I think you will agree that they are good ones too. So long." Then Bill went out.

FIXTURE FOR PLANING CLUTCHES IN THE SHAPER

BY C. BOELLA*

We had to manufacture a large number of four-tooth clutches for motor car starting handles. Formerly the teeth of these clutches were machined roughly with a milling cutter and finished by hand, but this method, besides being too expensive, was not giving uniform results. To avoid this defect and increase the production, a special fixture was designed.

This fixture is shown in Fig. 1 applied to a Hendey shaper. It consists of a cast-iron bracket bolted to the table of the

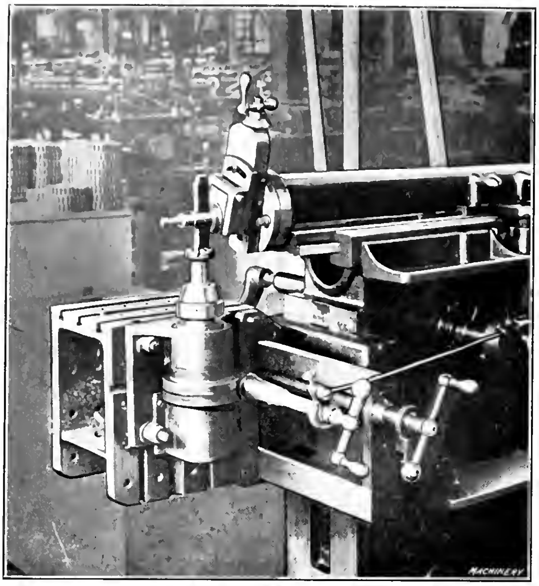

Fig. 1. Shaper equipped with Fixture for generating Helical Clutch Teeth

shaper, which has at its lower end, a hardened four-tooth half-clutch B_1 (Fig. 2) similar in form to the clutch to be made. The other half B of the clutch is also made of hardened steel and is fixed to the end of a spindle which both revolves and moves vertically. On the upper end of the spindle the work is held by means of a split collet. The spindle receives its rotary motion by a revolving sleeve driven by worm and worm-wheel A. The worm is rotated either by the handle shown at the end of the worm shaft in Fig. 1, or automatically by means of a ratchet and pawl which is similar to the device used for feeding the table. This automatic feed derives its motion from the regular feeding mechanism of the machine. A spiral spring keeps the rotating half of clutch B in contact with the lower clutch B_1 which is attached to the bracket.

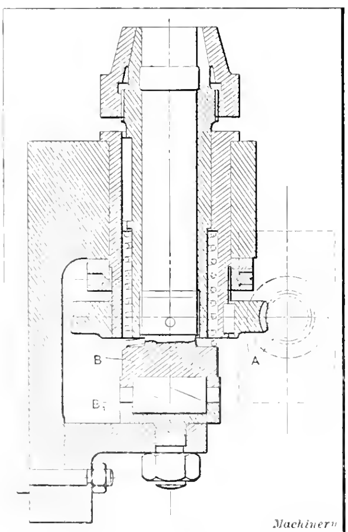

Fig. 2. Vertical Section of Fixture shown in Fig. 1

The fixture operates as follows: When the worm-wheel is revolved by means of the handle, the sleeve rotates driving with it the spindle carrying the work. This spindle, on account of the hardened four-tooth clutch fixed to its lower end, receives besides the rotary motion, an upward movement which lasts for a quarter of a turn; it then drops to its lower position and, as the rotary movement continues, it again rises, and so on for each succeeding quarter turn.

Prior to forming the clutch teeth, the tool-slide is inclined to a suitable angle and four slots are cut at points corresponding to the faces of the teeth and to a depth represented by the lowest position of the arbor carrying the clutch. The slotting tool is then replaced by a forming tool set as illustrated. As previously mentioned, the arbor turns and rises simultaneously for a quarter turn so that the planing tool generates a helical or spiral tooth. When the arbor drops to its initial position, the tool starts forming the second tooth, and so on until the whole clutch is finished. Good results as regards both output and accuracy are obtained with this simple fixture. The clutches are well machined and can be used without further finishing.

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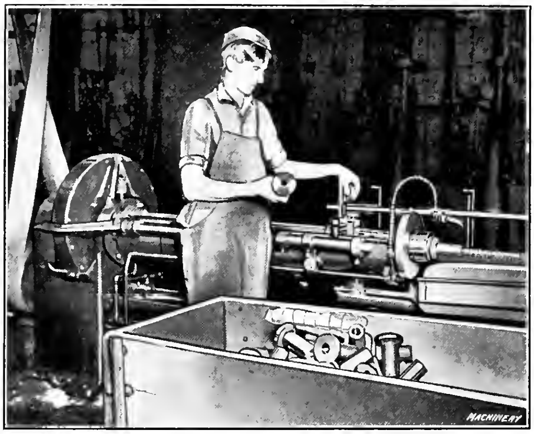
* * *

BROACHING VS. REAMING

Broaching, as generally understood, has been considered to be applicable only to the economical production of holes that are not round, such as square, hexagon, etc., but it has been found that round holes can be effectively broached for two reasons. First, the work can be much more quickly accomplished by broaching than by reaming; and second, the hole produced is smoother, free from objectionable "rings," and accurate as to size. An excellent example of the broaching of round holes was secured in Dodge Bros. plant in Detroit, where vanadium steel forgings used in the manufacture of the Ford automobile were being broached in a machine made by



Broaching 1 3/16-inch Round Holes 5½ Inches Long in Vanadium Steel Drop-forgings

the Lapointe Machine Tool Co., Hudson, Mass. The forging, which is 5½ inches long, is first rough-drilled in a high powered vertical drilling machine, from 0.005 to 0.010 inch being left on the diameter of the hole to be removed by the broach. The forgings are brought directly from the drilling machine to the broaching machine and the hole, which is 1 3/16 inch in diameter, is completed in one pass of the broach, a production of 750 being obtained in ten hours.

The fixture used is of very simple construction, consisting simply of a cast-iron ring fastened to the faceplate of the machine, against which the forging is held by the broach as it is drawn through. The spacing or pitch of the teeth in the broach is about equal to the diameter, and a small straight portion about 1¼ inch in length is provided on the end of the broach, which passes through the hole and gives it a burnished appearance. The hole produced by a broach is superior as a bearing surface to that produced by a reamer. This is because when the reamer is working in alloy steel, especially that containing a percentage of nickel, it usually tears rings around the hole, producing a rough surface. The broach, on the other hand, if it produces scratches or tears at all, makes these in a line parallel with the axis of the work, which is less detrimental to a bearing surface than annular grooves.

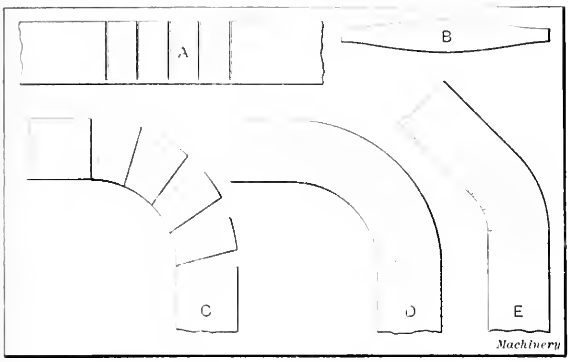
D. T. H.

MAKING BENDS FROM STRAIGHT SHEET METAL PIPES

BY FOREMAN PLATER

In large engineering works and factories, light sheet metal piping is used for various purposes such as ducts from ventilating fans, dust exhausting pipes from grinding and polishing machines and a number of similar uses. Wherever piping is used, right-, obtuse- or acute-angle bends play an important part, and it may be mentioned in this connection that the ordinary stove pipe bend or elbow cannot be used in a system of piping used in connection with a fan. The resistance produced by the sudden change in direction of the air moving at high velocity always has a serious impeding effect upon its movement. In order to reduce resistance as far as possible, right-angle bends should have the radius of curvature at the inside of the bend equal to at least the diameter of the pipe. Right- and obtuse-angle bends in sheet metal piping are generally produced by machinery, and most large firms carry a stock of the different diameters which they use. The machine-made bends are naturally cheaper than hand-made ones. However, in handling small jobs of sheet metal pipe work it is not always advantageous or advisable to use the ready-made bends.

It has often been the writer's experience to be called upon to make ventilating or dust collecting ducts that require bends



Method of making Bends from Sheet Metal Pipes

other than the standard forms which may be bought in the open market. There are several methods of making bends by hand in addition to those for producing them by machinery. The method generally adopted consists of laying out a development of the bend. The different segments are then cut from this development, sufficient allowance being made for joining, and connected by one of the usual methods followed in sheet metal work. These methods are adequately treated in many textbooks on sheet metal pattern drafting. In the majority of engineering work shops, however, such books are not always available when they are needed and many a mechanic has been at a loss to know how to proceed to lay out an accurate pattern for a bend of the radius and angle desired. It is for the use of such men that the present article has been prepared, illustrating a simple method of making sheet metal bends—either single or double and of any radius—from sheet metal pipes, without the necessity of laying out the developments to obtain the patterns.

Bends are more easily made from pipes of thicker gage, as the stouter metal lends itself more readily to bending. Special machines are generally used in marine and locomotive engine shops, but where the number of bends is limited, simple methods are generally employed. In bending pipes, two preliminary steps are necessary, *i. e.*, filling the pipe with lead or rosin to prevent the formation of wrinkles and irregularities, and annealing the pipe at the point where it has to be bent. The lead or rosin is melted out of the pipe after the bending has been completed. Fine sand is sometimes used as a substitute for the rosin, the sand being confined in the pipe by wooden plugs during the bending operation.

Before entering upon a discussion of the production of bends from sheet metal pipe, it may not be out of place to outline briefly the method of producing such pipe. When the diameter of the pipe is known, the circumference is obtained by multiplying the given diameter by 3.1416 or $\frac{22}{7}$, additional allowance being made for the lap. The sheet metal may be most satisfactorily bent between bending rollers, but if such rollers are not available, a round iron bar will answer the purpose. The seam or joint is either soldered or grooved, according to the requirements of individual cases. Where the sheet metal is to be bent by hand, an iron bar is generally used, around which the metal is formed with a box-wood mallet, or an ordinary plumber's dresser can be used with equally good results. The dresser covers a larger area at each blow and is not so likely to make indendations in the work.

A complete right-angle bend is illustrated at *D* in the accompanying illustration. In starting to make a bend of this type, the pipe is marked at the point corresponding to the center of the bend at the side of the pipe that will be at the outside of the bend. Equal distances are then marked on each side of this point so that a total of five marks has been made over the section of pipe to be bent. These marks are drawn almost all the way around the pipe. A hacksaw or chisel is then used to cut along these lines, care being taken not to cut completely through the pipe but to leave small portions to hold it together at the inner side of the bend. The method of procedure will be readily understood by referring to the diagram shown at *A*. The pipe is then bent to the form shown at *C* and the openings are closed up by pieces of sheet metal of the shape shown at *B*. Sufficient allowance is made in the size of these pieces so that they lap over on both sides to allow for soldering them in place. As previously stated, five such pieces will be required in making a right-angle bend. After these pieces have been cut out, they are slightly hollowed or peened by hammering them on a concave wooden block. After this peening operation has been completed, the pieces are bent around the pipe and secured in place, thus forming the complete bend shown at *D*.

Obtuse, acute or reverse bends are made in exactly the same way. An obtuse-angle bend is shown at *E*, where it will be evident that the construction is exactly the same as previously described, except that it was only necessary to make three cuts in the pipe instead of five. In the case of acute-angle bends it will be necessary to make more than five cuts, the number varying according to the bend. Reverse bends are made in the same way except that the cuts for the reverse bend are made on the opposite side of the pipe from those for the first bend. An ordinary mechanic will be able to make very satisfactory bends by this method without having had any extensive experience in sheet metal work.

* * *

LUBRICATION OF AIR COMPRESSOR CYLINDERS

The following information relating to the lubrication of air compressor cylinders is given in a pamphlet issued by the Fidelity & Casualty Co. Recent disastrous explosions in air compressor systems indicate the danger existing from the use of ordinary engine oil in air cylinders. Only a pure mineral oil with a flash point as high as good lubricating qualities will permit, should be used. An excess amount of lubricant should be avoided. As air receivers are liable to explosion from accumulated oil deposits, every receiver should be equipped with a pressure gage, safety valve and proper drains. All reservoirs and pockets in the air line where there might be deposits, should be drained frequently and cleaned. It is bad practice to have the air compressor inlet in a hot or dusty room. The air should be as cool and clean as possible. The practice of throwing kerosene oil into the compressor inlet to clean it is extremely dangerous. Lubrication of the air cylinder with soapsuds (preferably made of one part soft soap to fifteen parts water) for a few hours each week or less frequently if the load is light, will aid materially in keeping the cylinder clean. To prevent rust, discard the soap and feed oil into the cylinder about an hour before shutting down. The receiver blow-off should then be opened and the accumulation of oil and water drained off.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

FEBRUARY, 1914

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"INVOLUTE" GEARS AND CUTTERS

The report of the American Society of Mechanical Engineers committee on involute gears rendered at the last spring meeting was disappointing, but the fact that the data of tooth shapes produced by the so-called "involute" gear cutters made by the various cutter manufacturers are held a close secret caused an indefinite report by the committee to be almost a foregone conclusion.

The fact that true involute curves are not produced by commercial cutters of the rotary type was not generally known until a very few years ago, and the knowledge is by no means widespread now. Gears cut by true involute cutters of the rotary type, made in sets of eight to cover all numbers of gear teeth from a twelve-tooth pinion to a rack, will not run together satisfactorily. In order to make the rotary cutter a commercial proposition it was necessary to limit the number of cutters required for a given pitch, but to do this, theoretical considerations had to be sacrificed in order to secure satisfactory interchangeability. Hence, the involute cutter is involute in name only. The real tooth shapes are empirical and were reached by experimentation.

The data of "standard" cutter shapes comprising the radii of the curves, positions of centers, points of intersection, and so forth, have been offered to MACHINERY for publication twice within a few years, but could not be accepted because they were submitted without authority. The contributors were not authorized to publish the matter by the concerns that had developed the shapes at heavy cost. But this scrupulous policy of MACHINERY has not been a bar to the dissemination of the data. Probably none of the rotary gear cutter makers need make their cutters by copying B. & S. cutters if they have been willing to "pay the price."

The situation is unfortunate in several respects. A premium has been placed on the dishonesty of trusted employes, the mechanical public has been misled and true interchangeability of gears cut with the cutters made by different manufacturers has not been realized. We believe that mechanical progress would have been fostered if the policy of secrecy as to the exact shapes produced had not been so rigidly adhered to. The correctness of the theory of involute gearing has been seriously questioned by mechanical men because of a misunderstanding of the situation. That the theory is correct, however, has been proved by the success of the generated involute teeth on spur, spiral and bevel gears.

In the interests of mechanical progress we suggest that the well-known "involute" gear cutter makers publish the data of tooth shapes used and thus bring about an agreement which will make for true interchangeability of milled tooth gearing and eliminate a mystery that is hardly creditable to American manufacturing policy.

* * *

RECORD OF PRESSED FITS

The paper presented before the American Society of Mechanical Engineers contributing the record of over two hundred pressed fits is of interest and value to machinists. No feature of machine shop practice, within narrow limits, of course, has been attended with more uncertainty than the over-size allowances to be made on shafts and crank-pins assembled with hubs by pressure. The length and thickness of the hub and the material affect the over-size allowance to be made. Many mechanics who never saw a micrometer were able to make pressed fits with no guide but "judgment" which, of course, was the result of experience, but most of them made excessive allowances compared with those recorded by Mr. MacGill. The result was often overstrained hubs that cracked in service.

Little is gained in tightness of fit by exceeding the elastic limit of the solid metal composing the hub, and serious damage will result if the overstrain is carried far. Rough turning and boring, however, permit of considerable apparent variation in practice. The ridges of metal on the parts are crushed in pressing together, and in crushing require much more pressure to assemble than to press apart. This is the test. The pressed fit which shows the least difference between the pressure required to assemble and to force apart, other things being equal, is the best.

* * *

"SAFETY ALWAYS"

The National Tube Co. is distributing a safety calendar which should serve a useful purpose in promoting the principles of safety in the operation of shops, mills, factories and in the ordinary affairs of life. No one needs to be told of the importance now attached to safety considerations nor how rapid the growth of the sentiment has been. Every general manager, superintendent and other responsible officer of concerns in states where compensation laws have been enacted is familiar with the new aspect of the safety movement and should feel that he is now his brother's keeper. The calendar mentioned bears twelve mottos of special application in steel mills, and of general application in manufacturing plants. Following are examples:

> Every danger sign posted in the mill means that the danger pointed out is real. Men must ascertain what is on these signs around places where they work and give heed to the warnings. The red ball on a sign means danger.
>
> It is better to be careful a thousand times than to be injured once. Get the safety habit. If you see a man acting carelessly tell him about it, and don't be afraid of hurting his feelings by doing so.
>
> Neglect of slight injuries often results in blood poisoning and serious trouble. The company has provided an emergency hospital, where employes injured in the mill can receive the best of attention. Don't neglect small injuries.
>
> Your eyes are valuable to you. Wear goggles when working where chips or sparks may fly. They may be awkward at first, but you will soon get used to them and then you wouldn't work without them.
>
> A dirty mill means accidents. Do not leave waste material or refuse lying around. Places are provided for keeping it. Do your part toward keeping the mill clean.

The mottos "Safety Always" and "Safety First" have become industrial slogans which must have some influence on the methods of older men and much on those of the younger ones. In the course of twenty years there will be an entirely changed attitude on the part of workmen generally in regard to accidents and accident prevention. A preventable accident will then be looked upon as little less than a crime on the part of the one responsible, and the intelligent employers of labor will have contributed greatly to the spread of the idea by enforcing rules for safe conduct of their employes similar to the foregoing.

WORK-HOLDING DEVICES AND TOOLS

The articles by Albert A. Dowd now running on work-holding devices, tools and tool-guides, for lathes and boring mills are unusual if not unique. So far as we know, nothing comparable with them has been published before. The importance of the subject is indicated by the large number and variety of means provided for holding work and performing circular machining processes.

The first and principal accessories for holding work for turning were, and still are, pointed centers. These and a driver constitute a perfect means for holding parts for cylindrical or taper turning or grinding. But they can be applied only when the work is of a shape that permits it to be mounted securely on conical points fitting into it. A narrow, thin ring cannot be held thus, and the primitive means provided was either a mandrel or a faceplate. The mandrel has its limitations as has also the faceplate. The latter fitted with bolts, clamps, straps and finally with movable jaws actuated by screws, became a chuck.

The lathe center, mandrel, faceplate or chuck appear in some shape or other in all forms of work-holders; but the variety of designs possible and necessary for efficient mounting and driving work in modern manufacturing plants is almost endless. To work out efficient designs independently requires wide experience and good judgment on the part of the tool designer.

It is not too much to say that no factor of production is more important than the mandrels and chucks provided for machines. The best machine tool must be inefficient if not provided with these in the variety and form required for the work to be done on it. Although so important, they have been neglected in many plants that outwardly present the appearance of being well equipped. A machine is only the mechanism for applying power to a tool for cutting or shaping. It is useless unless the tool and the holders for the work are provided. Thus three elements are necessary—the machine, the cutting or shaping tool and the work-holding device.

* * *

NEW MACHINERY AND TOOLS

Every period of business depression is marked by activity in the development of improved means of production. The reasons are not far to seek. First, there is an insistent demand for machines, tools and methods which will produce more cheaply. Manufacturers strive harder in dull times to produce goods at lower prices than when the demand for their products is heavy. Second, the builders of machinery have more time to improve their products and they take the opportunity to simplify and improve methods of production and to introduce new practices that cannot be given the necessary attention when the shop is running at top notch production.

The January number of MACHINERY contained twenty-eight pages of descriptions of thirty-two improved products in the machine shop and closely related fields. This showing is gratifying. It not only indicates that American machine tool builders possess great enterprise, but that they fully appreciate the advantages of showing their new products in a journal that maintains a liberal policy in regard to the publication of matters of news to the mechanical world. That this liberal policy means much to American machine tool manufacturers is becoming generally appreciated. In no case is exclusive publication required or even suggested. On the other hand, the editorial policy has always been to encourage simultaneous publication in all the mechanical journals. The new developments made by manufacturers in a given field are matters of news interest to the readers of the journals in that field. Manufacturers who support the technical press by their advertising patronage merit this recognition of new developments which they bring forth from time to time. The policy of exclusive publication of new developments in one journal only is selfish and even dangerous to the welfare of the industry both as regards readers and advertisers. It gives that journal a false standing and would permit monopoly in technical journalism to be established if carried to its logical conclusion.

FILING YOUR OWN PATENT*

BY FORD W. HARRIS†

It is an economical man who tries to cut his own hair, but it is probable that any of us marooned on a desert island and given a pair of shears would take an occasional "whack" at it. Similarly, an inventor ought not to be his own patent lawyer, but there are occasions, when stern necessity drives, on which any inventor is justified in trying it. This condition is often due to the fact that the inventor is unable to find the $65 demanded by a reputable attorney for securing a patent but can find the $15 fee charged by the government.

Before outlining just how an inventor goes about prosecuting his own case, it might be well to say a word or two about patent attorneys. It is a notorious fact that there are a great many incompetent patent lawyers. It is also a well-known fact that the average patent is valueless. The two conditions go together, being cause and effect. Some patents—in fact, most patents—are valueless because there is no real invention behind them. They are mere adaptations or improvements upon which no patent should have been allowed. The line between mechanical skill and invention is so indefinite, however, that our patent office has no choice but to grant a patent upon an application that discloses a novel structure or results and which can by any stretch of the imagination be considered an invention. Such a patent, however, has generally very limited claims and is of little value to anyone. The "shyster" lawyer is generally responsible for the existence of such a patent, as he has led the inventor to think he has a meritorious invention when he is morally certain that the invention is valueless. It is probable that some legislation looking to a tightening of the lines and excluding such trivial patents would drive many of the poorer patent lawyers out of business and save the inventors of the country a great deal of expense and many a disappointment. It is also probable that anything that would decrease the number and increase the professional honesty of patent lawyers as a class would have the same effect. Both of these reforms are urgently needed and no doubt will come.

Many patents are valueless, not because the inventor did not have a meritorious invention, but because he allowed a poor lawyer to give away his rights. There is nothing more pathetic than a good invention poorly protected. The inventor has disclosed his invention to the public, he has fully explained and illustrated it as required by law, and he has obtained in exchange a claim or collection of claims which is easily avoided or which will be declared invalid by the first court called upon to pass on it. This is almost always due to the laziness or incompetence of the attorney who handled the case. The patent office is generally fair, but it will not give an inventor any more than he asks for, and if his attorney is satisfied with poor claims, that is what he will get. It is, of course, sometimes possible to surrender such a poor patent and take a re-issue that adequately protects the invention; but the proceeding is difficult, involves additional expense, and must be done promptly. It is probable that raising the standard among the patent office examiners and the cultivation of a fairer viewpoint among them might assist in this matter, but the real remedy is fewer and better attorneys. Our patent system is the foundation upon which a great deal of our industrial prosperity rests, and the American people should make an earnest effort to correct the manifest abuses and graft that have sprung up in the patent soliciting business.

Any man having a real invention should exercise great care in committing it to the tender mercies of the average patent lawyer. The good lawyers are not hard to find. They generally have built up a reputation over a long period of years and are known to prominent attorneys, bankers and business men. Only such men should be employed on real inventions, and they charge little if any more than the

* For additional information on patent prosecuting and kindred subjects published in MACHINERY, see also: "Patent Experting—A New Field for Engineers," January, 1913; "A Patent Office Paradox," November, 1912; "Life and Cost of Patents," December, 1912; "Actual and Constructive Patent Infringement," April and May, 1912; "Proposed Changes in Patent Laws," July, 1912; "Patent Laws and the Cost of Manufacture," June, 1909; "Forfeiture of Patent Rights," December, 1908; "The State of the Patent Office," March, 1908; "Patents and Inventors," June, 1908.

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shysters. It often happens, however, that an inventor does not have the money to employ such a man and must abandon his invention or make a start at prosecuting it himself. Or it may happen that he has some experience in patent cases and does not value his invention highly enough to warrant employing an attorney. He can deal directly with the patent office, and though the old saying that "the man who doctors himself has a fool for a patient" is somewhat applicable, nevertheless it is probable that the average mechanic or business man could prosecute a case before the patent office with as good or better results than the shyster lawyer. In any case the following hints can do no inventor any harm, even if he has a lawyer.

In the first place, it should be recognized that the United States Patent Office gives an inventor a lot of latitude. It will send him, free of charge, a copy of the Rules of Practice governing the general conduct of its business and the inventor's relations to it. This book looks formidable, but really only the first twenty-eight pages and some of the forms interest an inventor on an ordinary application. If you cannot prosecute an application on this information you will find that the difficulties you meet with are unusual ones. In addition, every library has Walker, Robinson or Hopkins on Patents, and a few evenings spent in reading the opening chapters will give you an insight into patent theory that is well worth while.

Having mastered the general theory you can prepare your application. The first thing is the drawings. The Rules of Practice are very specific as to size, etc., and should be followed closely. Here again, the general spirit of fairness to an inventor is shown. The patent office will accept for examination any sort of a drawing that is plain, and will examine and act upon any application that contains such a drawing. Before the patent issues and is printed, however, drawings of the style specified in the Rules of Practice must be furnished by the inventor or he must pay the patent office for making them. But he can prosecute his patent to final allowance or rejection on drawings that are decidedly not in accordance with the rules.

Having made the drawings, the inventor must write his specification. A sample drawing faces page 68 of the Rules of Practice and the specification for it is given on pages 70, 71 and 72. Pages 12, 13 and 14 explain this specification and the general structure thereof, and it is not hard to prepare a reasonably good one. The petition and oath are given as Form 1 to 10 and Forms 18 and 19; they are plain and can be copied and filled in directly from the Rules of Practice. The inventor should be careful to fully show and clearly describe his invention, as new matter can not ordinarily be added to either the body of the specification or the drawing after it is once filed.

The specification ordinarily ends with one or more claims which to the ordinary mortal look like a mere jumble of words. They are a general, concise and exact description of the invention. In all the books on patents and patent law, there has been very little written about the form of claims that will assist an ordinary man in writing them. They are the patent, and it is in writing and changing them to make them allowable that the attorney earns his fee. Years ago, when the writer was an inventor and had never attempted to handle cases, he conceived a great awe for claims. They appeared to be wonderful examples of verbal gymnastics. After having prosecuted many cases for himself and others, the conviction grows upon him that they are mostly a trick. They are simply fundamental ideas wrapped up in verbiage. Some men apparently never learn to write them, others take to it naturally. The best advice I can give a prospective prosecutor is to go to the nearest public library and get a late copy of the Official Gazette of the United States Patent Office. Look through the single views and appended claims therein and pick out five or six patents that have a number of claims that you can understand. Preferably, pick those that are very short, for the fewer the words the better the claim. Send five cents in coin or money order for each patent to the Commissioner of Patents, Washington, specifying the number, date and name of the inventor of each, and you will get a complete copy of the drawings, specification and claims. Study the form and the way the claims are expressed.

If you have read Walker carefully you will know that you cannot claim a mode of operation, but only the means by which the mode of operation is carried out. You cannot use as an element in your claim "a shaft moving up and down," but you may say "a shaft, means for moving said shaft up and down," etc. Writing claims is a trick and the main thing to remember is that the more different things a claim may be imagined as describing the better it is. Avoid being definite. Say "means for fastening said pulley to said shaft," instead of saying "a tapered key." One way you may limit yourself to a simple tapered key and the other way you cover any means that may be used to fasten the parts together; for example, a set-screw or a tapered pin. Believe one who has tried it with good success that claims are not as hard to write as they look. The main thing is to claim enough. Ask broadly for everything in sight and say it as many ways as you can. A dozen claims are not too many.

Now wrap up your drawings, petition, oath, specification, claims and filing fee of $15 and send it to the Commissioner of Patents. Take your drawings to a blueprinter and get copies or the patent office will make them for you for 15 cents each. Then sit down and wait for from one to nine months for the patent office to act. The examiner may reject all your claims; he may object to your drawings as informal and tell you that before the patent is printed you must have others made; but he must give you reasons and he will tell you how to fix them. And when he does act, you have one year in which to answer him. And if you materially amend your claims by a letter to him you have another year after he answers you to answer him. And so long as you put in broad claims and stand by them, your rights cannot suffer. Patents may be kept pending for years in this way. The patent office is full of them. You have a year to answer the examiner every time and so long as you keep claiming the earth you cannot lose. But before you let the patent issue and as soon as you possibly can, get a good lawyer in on your patent and let him fix it up for you. Just consider how your hair would look if you cut it yourself and how you would miss an ear if your shears slipped.

* * *

Native copper is found extensively in the Lake Superior region, and with the exception of a few mines that produce arsenical copper, the "lake copper" is of remarkable purity. It is seldom found on the market at the present time, as most of it is contracted for by the makers of wire, sheet copper, etc. Most of the copper production of the United States does not come from "native copper" but from the ores of Montana and Arizona, which consist of copper and sulphur, or copper, iron and sulphur. These ores are usually roasted to remove a portion of the sulphur, arsenic and other volatile impurities. They are then smelted with coke in a vertical furnace, producing a matte or compound of sulphur, copper, and iron that may contain thirty per cent copper. This matte may be given a higher copper content in various ways, or it may be run into a Bessemer converter, the iron and sulphur burned off and the resulting coarse or crude copper, which may be 99 per cent pure, cast into anode plates and electrolytically refined. The resulting electrolytic copper is often superior in purity to lake copper. The less pure grades of electrolytic copper are known as "casting copper" and are sold for making brass castings and for uses where a high conductivity is not required.—*Mechanical World.*

* * *

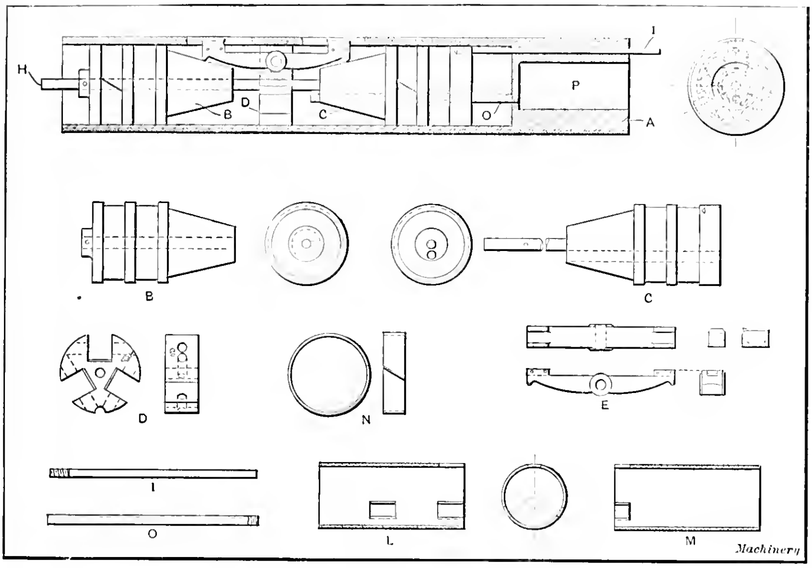
Machine tool builders suffer in some cases from the effects of jealousy or false pride which prevents them using the machine tools of competitors for work on which they are manifestly superior. If a special design of machine will do a certain class of work better and cheaper than the ordinary standard machine tools, the manufacturer—whatever his product may be—should be of a sufficiently liberal mind to adopt and use it in his shop. Of course, there may be honest disbelief in the value of a given machine for its express purpose, but in nine cases out of ten the disbelief is simply prejudice that will not be overcome.

RIFLING HEAD FOR RIFLING RECOIL VALVES AND GUNS

BY RUDOLPH R. GUENTHER*

The improved form of rifling head illustrated herewith has been used very successfully by a large eastern corporation for rifling recoil valves and guns. The outside diameter of the rifling head is about 0.002 or 0.003 inch less than the finished bore of the gun barrel, or recoil valve, and, as it is fed through the finished bore, three spiral grooves are cut, the finished depth of the grooves being 0.189 inch. The rifling head is connected at *P* to the bar of the rifling machine, and it is held in place by a steel pin. The machine used for this class of work is especially designed for the purpose, and measures about 60 feet in length. The bar to which the rifling head is attached has a travel of about 20 feet and is operated by means of a long worm screw which runs in a tail-head to which the rifling bar is attached.

The gun barrel or recoil valve to be rifled is held by means of a headstock and tailstock, which are geared so as to revolve the work at the proper ratio in order to generate the helical rifling grooves. The rifling head is equipped with a double set of tools, so that it cuts both the forward and return strokes. At each end of the machine there is a feeding mechanism which automatically withdraws the three cutters which have just completed a stroke, and moves the other set of three cutters outward for the return stroke. Each of these feeding mechanisms is composed of a worm, worm-wheel and ratchet wheel, to which a stop is attached; this stop engages the rifling head and is caused to move outward a certain distance for each stroke of the head, the movement depending upon the depth of the cut to be taken.



Rifling Head for rifling Recoil Valves and Guns

The construction of this rifling head is shown by the assembled and detailed views of the illustration. The casing *A* is made from a solid steel forging in order to secure a true bore and a perfect working fit. On the outside of this steel casing there are two sleeves *L* and *M*. These sleeves are made of bronze and forced on but are also held by small set-screws. Inside the steel casing *A*, two expansion heads *B* and *C* are located. Expansion head *C* has an extension rod which passes through a hole in the head *B* and the latter is attached to it by a small pin, thus locking the two expansion heads together.

The cutters are held in cutter-holders *E* which are pivoted in the center to a pivot bearing *D* which is slotted at three places 120 degrees apart, as shown by the detailed view. This pivot bearing is held in position by set-screws, and the outer ends of the cutter-holders are supported by conical surfaces on the expansion heads. Expansion head *C* has a hole directly under the central rod, which is provided for pipe *O*, through which oil is supplied to the center of the rifling head for washing out the chips at the end of each stroke and for keeping the cutters well lubricated. The oil also flows through a small recess cut in the bottom of pivot bearing *D*, into the space adjacent to head *B*.

Head *C* is provided with a rod *I* which is engaged by the stop of the feeding mechanism previously referred to, when the head is at the right end of its stroke. Similarly, end *H* of the extension rod engages the corresponding stop at the opposite end of the machine. In this way the expansion heads are moved either to the right or left, thus expanding one set of cutters outward and withdrawing the opposite set. Each head is equipped with cast-iron expansion rings *N*, which, by reason of the friction between the ring and casing, cause the rifling head to stay in the position in which it is set by the feed stops at the end of each stroke. The feeding mechanism is designed so as to feed the cutters outward at the beginning of each stroke not more than 0.0035; in other words, successive cuts of 0.0035 are taken until the grooves are machined to within about 0.0045 or 0.005 inch of the finished depth. The mechanism is then adjusted to throw out the cutters only 0.0015 inch, in order to prevent the tools from gouging into the grooves on the finishing cuts.

The rocker arms or cutter holders are made of forged steel and the outer ends beneath the cutters are shaped concave to fit the cones of the expansion heads. These conical ends of the heads were hardened and then ground and polished to insure a true working surface. The bearing ends of the cutter holders were also hardened to insure a perfect working fit and to reduce wear to a minimum. This improved rifling head has made it possible to rifle the bore of a gun barrel or recoil valve in about 56 per cent of the time required with the old-style head. With the latter, which was only equipped with one set of cutters, the time for rifling a recoil valve was about 55 hours, whereas with the improved head the same operation is performed in about 30 hours.

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* * *

EXPERIMENT WITH FALLING BODIES IN A DEEP MINE SHAFT

The Michigan College of Mines, Houghton, Mich., has made some interesting tests of falling bodies in a deep vertical shaft of a copper mine at Calumet, Mich. Within a radius of a mile from Calumet are three of the deepest shafts in the world, one of them being 5300 feet deep. One of the experiments consisted in dropping a smooth metal ball two inches diameter from the center of the shaft and trying to catch it in a box of clay placed 4200 feet beneath. Another ball was dropped from the southwest corner of the shaft. The balls were dropped by burning the threads by which they were suspended so that they started to fall directly downward. The shaft is nine by thirty feet cross-section. The first of the balls was suspended four feet from the side of the shaft and the second from a point nine feet from the opposite corner. Neither of the balls reached the box of clay; one of them was never found and the other, presumably the one started from the center, was found by a workman lodged in the timbers on the east side of the shaft 800 feet from the surface.

Bodies dropped into the shaft invariably lodge somewhere in the east wall. This action takes place because the earth is rotating on its axis from west to east. At Calumet a particle at the surface is moving to the east at the rate of about 1000 feet a second; but a particle 5000 feet down the shaft,

having the same angular velocity as the particle on the surface, is moving eastward at a rate of four inches less than 1000 feet per second. The ball suspended at the top of the shaft had a thousand-feet-a-second velocity; it was not only moving eastward at that rate when it started to fall but continued moving eastward all the way down the shaft. Meanwhile it dropped to the bottom at a rate which would have taken 17½ seconds for the fall if there had been no air resistance to encounter. During the 17½ seconds, the particle at the surface and the ball falling at the same rate would have traveled 17½ times four inches or nearly six feet further eastward than the particle at the bottom of the shaft. The ball started from the center of the shaft, therefore, struck the east wall long before it reached the bottom. As a matter of fact, the resistance of the air at the high speed the ball acquired soon after starting, was sufficient to prevent any further acceleration and consequently the ball was much longer than 17½ seconds in falling. In fact, only 800 feet of fall was required for the ball to make the four feet from the center of the shaft to the east wall and the other ball must have lodged at some point not much further down.

If the walls of the shaft were smooth and free from obstructions, no doubt a falling body would rebound from side to side of the shaft and finally reach bottom, but the many timbers in the lining of the shaft and the levels all the way down furnish places where a body is sure to lodge, and so if a load of ore were to be spilled into the shaft near the top most of it would later be found clinging to the shaft or stranded on the levels east of the shaft.

* * *

ROLLER AND SILENT CHAINS

At a recent meeting of the Society of Automobile Engineers, John R. Cautley presented a paper on roller and silent chains. A few general hints and practical suggestions contained in this paper are given in the following:

Many engineers have a distinct misconception as to all forms of driving chains. No roller or silent chain can be compared directly with belting. A driving chain is a piece of fine and highly accurate mechanism and should be treated as such. It will stand an amazing amount of abuse, but if properly installed and cared for it has an efficiency throughout its life which is hard to equal. Two basic principles in the design of a "standard" roller chain are: first, maximum wearing surface for the minimum of weight consistent with reasonable strength; second, such a proportion between roller diameter and sprocket tooth gap as will allow the maximum of wear on both with proper gearing.

Never use a tightening device on the back of a silent chain. An idler sprocket may be used, but it must start with at least three teeth in engagement. This is owing to the difference in mesh when the chain runs as a rack and when it runs over sprockets. If the chain runs over three wheels for any purpose, adjustment must be provided. Accuracy of chain and sprockets and mounting is just as necessary with both silent and roller chains as with gears, but this is easier to obtain with chains.

Means for adjustment is advisable for both kinds of chain and is often imperative. Suitable dust-proof cases improve the running of chains. Silent chains have drawn the attention of automobile engineers to the advantages of chain drive, but they should not overlook the modern and highly accurate roller chain which has many uses. An odd number of teeth is advisable for the small sprocket. This is not "a hunting tooth" but has the same effect with regard to the chain, as it prevents the same combination of links coming into mesh each time. Avoid an odd number of links where possible, as offset links, no matter how well made, are inherently weak. Small sprockets should be made of steel and should preferably be hardened, though this practice is not universal. For many purposes, sprockets of over forty-two teeth may be made of cast iron. Even with poor installation, chains hold up to their remarkably high initial efficiency until practically worn out.

* * *

Friction wears out machinery, and worry—not work—uses up men

MAKING SHRAPNEL CASES ON THE CLEVELAND AUTOMATIC

An unusual example of automatic machine work is that of producing the shrapnel case shown in Fig. 1. This case is made from a bar of 3 1/16-inch chrome-nickel steel stock. The steel has a tensile strength varying from 125,000 to 135,000 pounds per square inch, and is extremely tough. The work

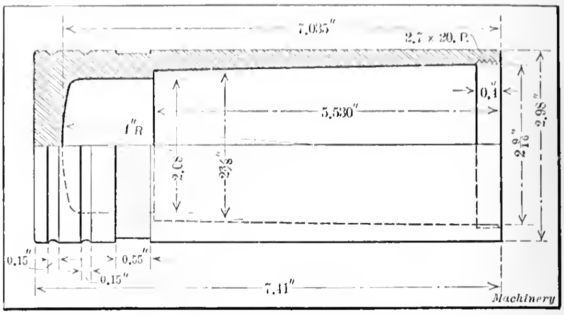

Fig. 1. Shrapnel Case made from Chrome-Nickel Steel having High Tensile Strength on a Cleveland Automatic Screw Machine, made by Cleveland Automatic Machine Company, Cleveland

is accomplished on a 3¼-inch Cleveland automatic, and the tooling equipment, as shown in Figs. 2, 3 and 4, is interesting. While the general operation of the Cleveland automatic is well understood by many mechanics, the production of this piece illustrates a number of points in the operation of this machine which are not so well known. Therefore it is

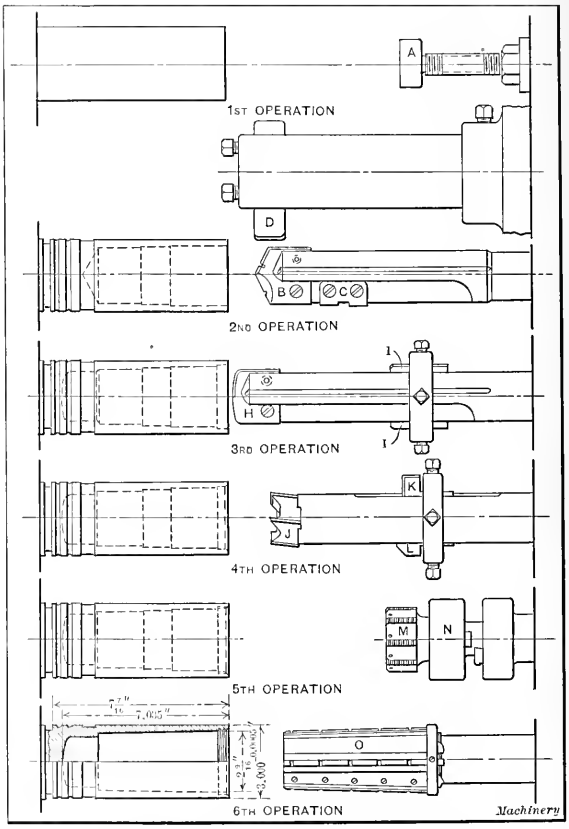

Fig. 2. Order of Operations on the Shrapnel Case

advisable to explain in detail just how this interesting job is handled.

The first operation, as the job was originally laid out, was to feed the stock out to the stop *A*, shown in Fig. 3, which is held on the cross-slide and operated by a lever on the base of the machine. This method, since the photograph shown in Fig. 3 was taken, has been improved upon and the time

cut from twenty-seven and one-half minutes to twenty-five minutes (see Fig. 2 for improved method). The second operation is to rough-drill the large hole with an inserted bit *B*, step the hole for the taper reamer with cutter *C* and rough-turn the external diameter with cutter *D* held in a special turning attachment. This attachment envelops the shanks of all six tools in the turret in order to obtain support. The cutters in the attachment shown in Fig. 3 work in advance of the under-cutting forming tool *E* shown in Fig.

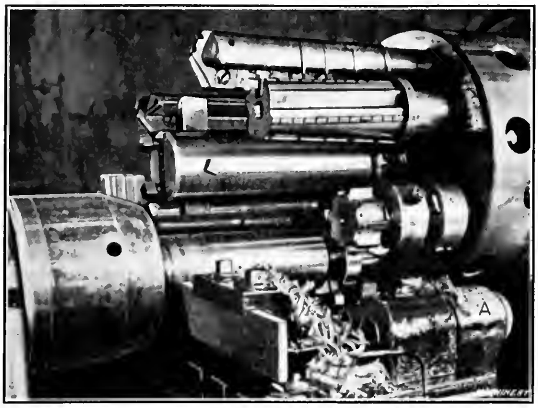

Fig. 3. Cleveland 3¼-inch Automatic Screw Machine set up for making a Shrapnel Case in Twenty-five Minutes

4, which is held on the rear cross-slide. The time required for the completion of the operations outlined is thirteen minutes.

In the third operation drill *H* finishes the powder pocket, and two cutters *I* counterbore for the tap—time required three minutes. The fourth operation consists in finishing the diaphragm seat with the counterbore *J*, finishing the face end with inserted cutter *K* and breaking the corner to facilitate tapping with inserted cutter *L*, the time required being forty-five seconds. In the fifth operation the thread is cut with a tap *M* held in the tap-holder *N* in forty-five seconds. Then the turret is indexed and for the sixth operation the hole is taper-reamed with reamer *O* provided with four inserted "Novo" steel blades, in ninety seconds. The last and seventh operation consists in knurling the band with a knurl *P* (see Fig. 4) mounted on the front cross-slide, and cutting the shell off with a cut-off blade *Q* retained in a holder on the rear cross-slide time six minutes. The total time required to produce this shrapnel case by the improved methods illustrated by the diagram in Fig. 2 is twenty-five minutes.

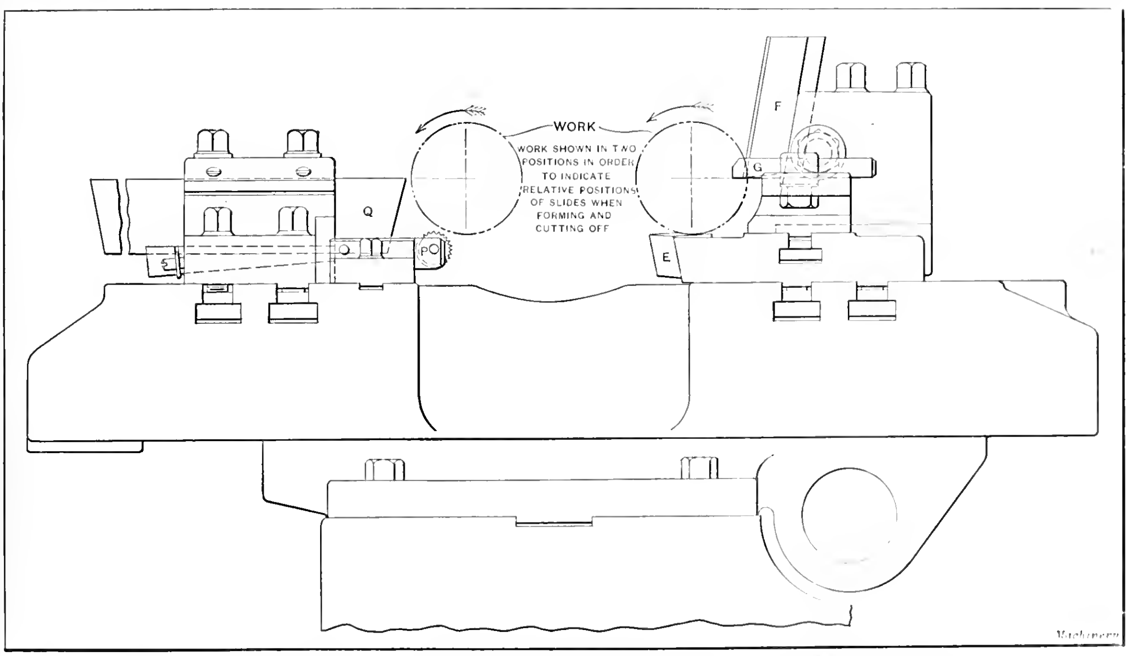

Fig. 4. Showing Tools held on the Front and Rear Cross-slides for performing the Knurling, Forming and Cutting-off Operations on the Shrapnel Case

There are several points of unusual interest in the production of this shrapnel case. One is the large amount of stock to be removed to form the hole; the second is the long taper-reaming operation difficult work to accomplish satisfactorily on an automatic screw machine—and the third is the long outside forming operation which must be held to a limit of 0.0005 inch on the diameter. In order to accomplish this last operation successfully, the external diameter of the piece is first turned with a cutter held in a separate turning attachment, leaving only 0.010 inch on the diameter to be removed by a wide under-cutting or shaving tool *E* held very rigidly on the rear cross-slide. Not only must the case be exact as regards diameter, but it must not vary from one end to the other nor at any point throughout its length. The large shaving tool held rigidly in the manner illustrated in Fig. 4 accomplishes this result satisfactorily.

The material from which the case is made is so tough that some difficulty was met with in selecting a tool steel that would stand up for a reasonable length of time under cut. The drills and counterbores are tipped with "Novo" cutters and all the forming tools, including the cut-off tool, are also made from the same steel. The only cutting tool in the entire tooling equipment not made of this steel is the tap. The bar is rotated at sixty-four revolutions per minute, giving a surface speed for the external cutting tools of approximately fifty-one surface feet per minute. The low cost of production of this shrapnel case is remarkable. Although the material is difficult to work, the labor cost for each piece is only 0.041 cent—almost negligible as compared with the cost when made by hand-operated machine methods. D. T. H.

* * *

The Russian torpedo-destroyer *Novik*, on the official trial run, reached a mean speed of 37 knots and a maximum speed of 37.3 knots. Several days afterward the vessel underwent the continuous six hours trial provided by contract. The speed of 36 knots prescribed for this trial was not only reached, but exceeded considerably, a mean speed of 36.2 knots throughout the six hours, and a mean speed of 36.8 knots during the last three hours being obtained. The *Novik* is a turbine-propelled vessel of 1280 tons displacement, and the boilers are fired with liquid fuel.

LUBRICATING SYSTEMS FOR CUTTING TOOLS—2

METHODS OF DRAWING LUBRICANT—DESIGNS OF DRAINAGE PANS AND TANKS—SEPARATION OF CHIPS AND LUBRICANT

BY JOSEPH G. HORNER*

The cutting tools which require a supply of lubricant through their hollow bodies include drills, reamers, counterbores, boring tools, and, less frequently, taps. Threading dies

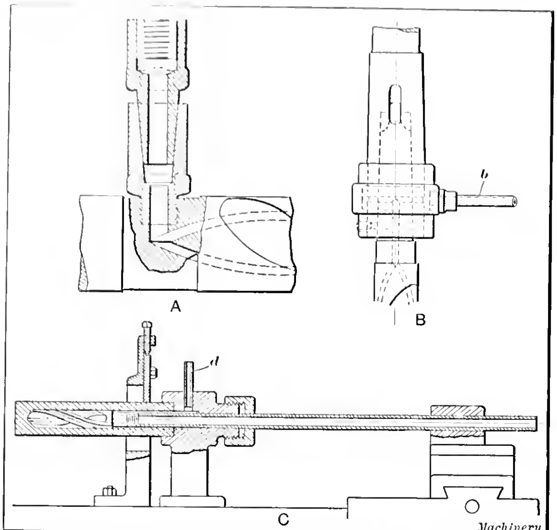

Fig. 11. A, Connection to Oil Passages of Stationary Drill; B, Connection to Oil Passages of Rotating Drill; C, Method of lubricating Hollow Drill for Deep Hole Work

are also fed by a pipe which floods their interior, or the threading machine may have a hollow spindle through which the oil is pumped. Long drills or their separate holders, not held

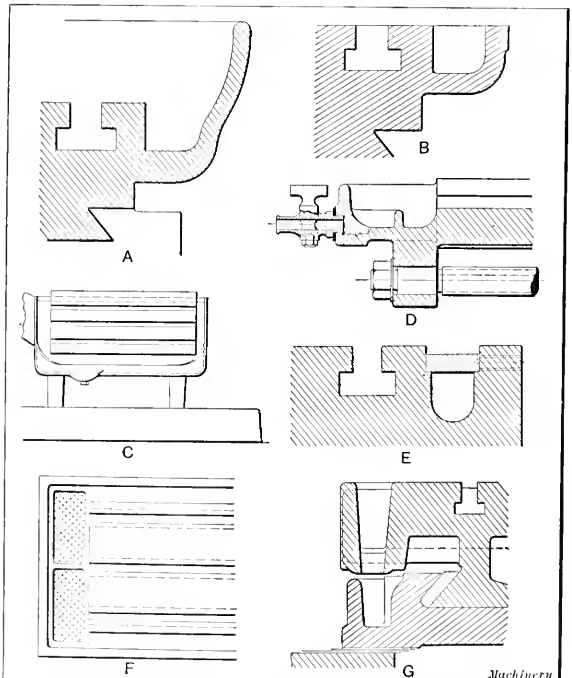

Fig. 12. Various Forms of Drainage Channels for Machine Tables

in a turret, usually have the supply pipe screwed in at the end and the oil goes to the cutting end by way of open grooves or grooves covered with strips soldered over; sometimes holes are drilled in the solid metal to the cutting point, or pipes are laid in recesses along the body of the tool. If the oil is not taken through the end of the drill it may be supplied as shown at *A*, Fig. 11. This method is suitable for any class of drilling machine or turret lathe in which the drill does not rotate. Connection to a flexible tube enables the drill to feed along to any desired extent.

A modification in the form of a loose collar, as at *B*, is necessary to permit a drill to revolve. The collar is held from revolving by the supply pipe *b*. The oil is sometimes fed by gravity but it should preferably be pumped through; it passes to the passages which communicate with the holes or tubes of the drill. A cup-shaped collar is sometimes used, the oil being poured in from the top. In all these tools, the chips find their way out of the hole by the flutes or spaces of the tool, but in the hollow drills used for deep holes, they have a special outlet. The oil is fed by way of the body grooves, and the cuttings escape through the flutes, the hollow shank and an extension tube (see sectional view *C*, Fig. 11). A stuffing-box surrounds the tube and the oil is pumped through pipe *d*, and goes along the outside of the tube and past the shallow flutes on the lands of the drill. The oil then forces the chips

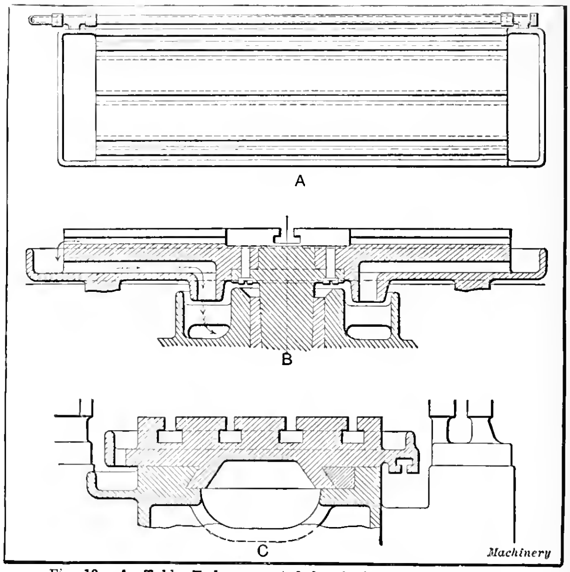

Fig. 13. A, Table Ends connected by Drain Pipe; B, Drainage leading to Annular Channel beneath; C, Drainage Channel for Reciprocating Table

back through the main flutes and out through the shank and the tube. The hole must be first drilled to a depth equal to the body length of the drill, before the latter can be used with

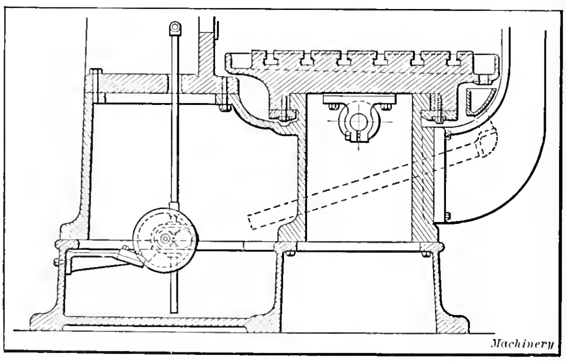

Fig. 14. Drain from Table into Tank in Base of Machine

oil, this preliminary operation being done with a short starting drill.

Methods of Recovering Used Lubricant

The methods of catching, draining and returning the oil are simple on some of the smaller machines, but more compli-

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cated on the larger ones, particularly on types which use lubricant very freely. The provision for lubricant often affects the design of the frame and many of the smaller details. The simplest catching device is a can hung underneath a table, this being emptied into the drip-can overhead at intervals. This is quite satisfactory when the quantity of lubricant used is very small, but like the drip-can, it fails to meet requirements when a flow of any magnitude is required, and a proper tank must be employed. The three principal means of receiving waste lubricant are, by a suspended tank, a tank on the floor or bolted to the machine base, or by using the hollow base of the machine to form a tank. The pans which surround the bases of so many machines come under the second category. The suspended tank is objectionable only on account of its limited capacity; the second class can be made of any desired dimensions; the tank in the base is a means of profitably utilizing the interior space, thus making it unnecessary to provide a separate receptacle.

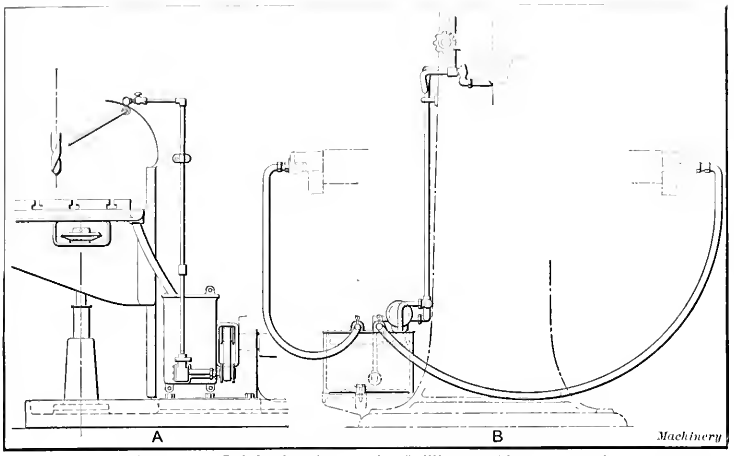


Fig. 15. A, Lubricating System for Drilling Machine; B, Supply and Return System of Vertical Milling Machine

The simplest method of dealing with the question of waste lubricant will be to follow the lubricant in its course, from the point where it leaves the work. It is also necessary to take into consideration the provisions for dealing with chips, since these affect the matter vitally.

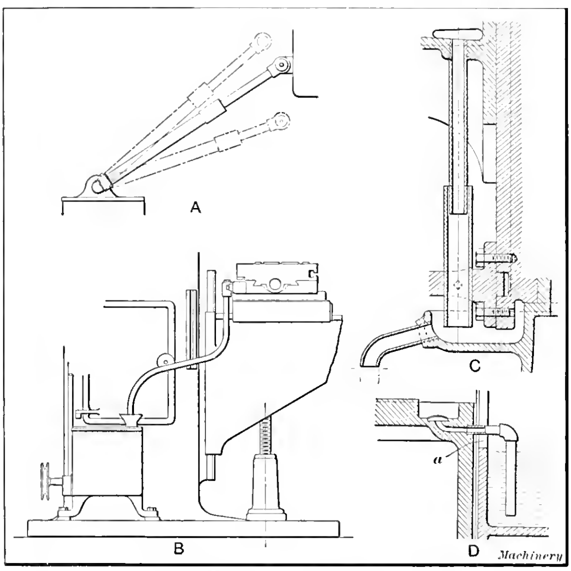


Fig. 16. Drainage Connections to permit Vertical Adjustment of Work Table

All work which is machined is held either on or over a table, or it may project beyond the bed or slide. In the first case, the table receives the waste oil, in the second, the oil either falls directly into a trough or is caught and diverted in various ways. Tables, when not intended for use with oil, simply have slots or tee-slots, and there is no rim or other provision to prevent a lubricant from falling onto the floor. The addition of a turned-up rim prevents the lubricant from escaping, excepting by the way of a spout or a hole, whence it drains into a can hung under the spout or tap, or falls through a rigid or flexible pipe, or by way of rims on subsidiary slides, to a tank below. The height of the rim is limited, in the majority of cases, by the level of the table, the rim being just below the table, but there are some exceptions. When it is known that the size of work or of jigs or fixtures will never exceed the bounds of the tee-slotted surface, then it is possible to raise the rim as shown at *A* in Fig. 12. This high rim is desirable when splashing is likely to occur. It is the practice now, with a great many milling machine manufacturers, to machine the oil rim flush with the table top as at *B*, in order that it may be utilized as a support and form part of the table surface. Large fixtures which hang over the working surface can thus be held, and dividing heads can also be set further apart than on a table with the rim set below. If a table having a vertical face, in addition to the horizontal top face, has to be drained, the oil rim is cast as shown at *C*, which is the table of a radial drill. The channel follows around the table and has a small well at the bottom, into which the waste collects and is drawn off by a tap or pipe.

Draining the Lubricant to the Supply Tank

The end of the table is the place most commonly selected for drawing off the lubricant, because it is more convenient to apply or attach a can, or to connect a pipe. The sectional view *D*, Fig. 12, shows the end of a milling machine table,

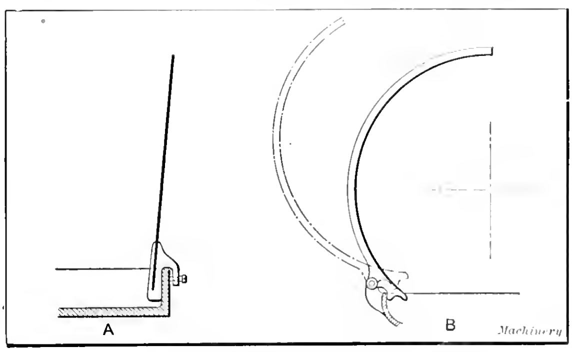


Fig. 17. Detachable and Pivoted Splash Guards or Plates

with a draw-off tap and an enclosure adjacent to the hole to prevent chips from blocking up the tap. Another device to prevent choking, which impedes the proper flow of the lubricant, is to fit guard strips to the channels, as at *E*, so that they cannot be quickly clogged with chips and thus cause table flooding. The filling up of the end pockets with chips is avoided on some tables by the use of removable strainer plates,

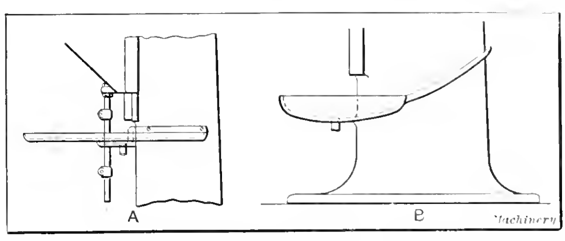


Fig. 18. A, Lubricant Tray attached to Column; B, Lubricant Tray cast integral with Column

as at *F*, which shows a plan view. These plates are set at about one-half the channel depth so that there is a clear space beneath for the liquid. In the milling machines made by

Messrs. D. & J. Tullis Ltd. of Clydebank (Scotland), the end pockets are connected by a pipe (A, Fig. 13), instead of having a deep channel on each side of the tee-slotted surface, comparatively shallow grooves being milled in the top to conduct the waste to the pockets.

When a square or a circular table has to make complete revolutions, the waste is preferably drained through the center into a tank or a hollow bed, the alternative to this being chutes leading to the main tank have to be used. If a table or slide has a limited range of travel in relation to some part below it, the part below can, in certain instances, be utilized as an intermediate drain. The section G, Fig. 12, of a milling machine table and slide, is an illustration. When, as in large plano-miller tables, there is no other moving part, arrangements have to be made to receive the oil at any longitudinal position. This is done by casting or bolting a trough

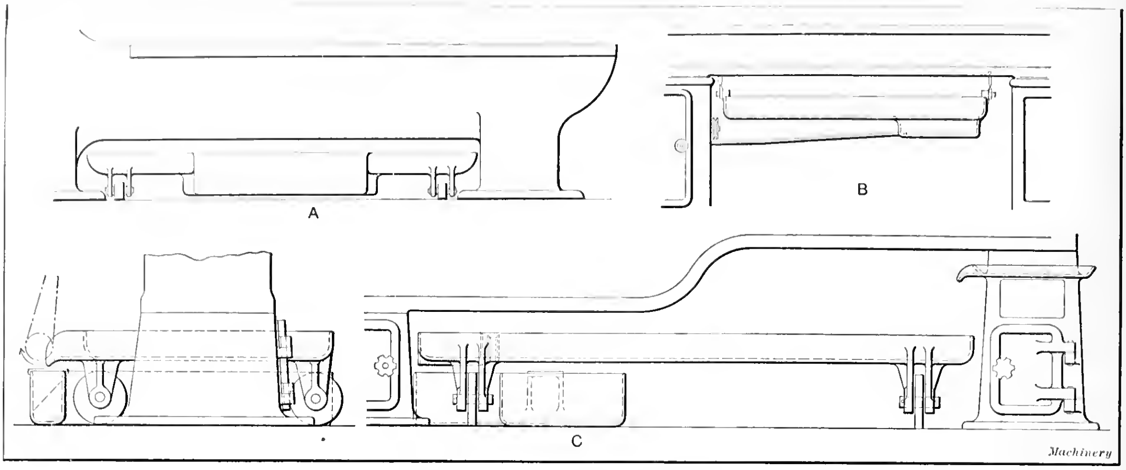


Fig. 19. Different Designs of Drainage Pans

to surround the table with a fixed pan into which the oil drips and is drained therefrom through a channel into a receptacle below. In the central drainage system, the precise course of the oil ducts depends on the manner in which the table is mounted. If there is no central spindle, but merely a hollow boss, the oil can flow down through this, but if a solid spindle occupies the center, the drainage takes place through passages situated some distance out, as at *B*, Fig. 13, to the side of the bed, just below the overhanging drain hole or spout of the table, and locating the drain hole in such a position that it will never run past the lower trough. The oil drains from the latter into a tank or hollow bed. A typical arrangement is shown at *C*, Fig. 13, and also in Fig. 14 (from a Walcott rack cutter), which includes the drain pipe from the trough into the hollow base and the pump and suction pipe.

Flexible tubing is employed very largely for drainage pur-

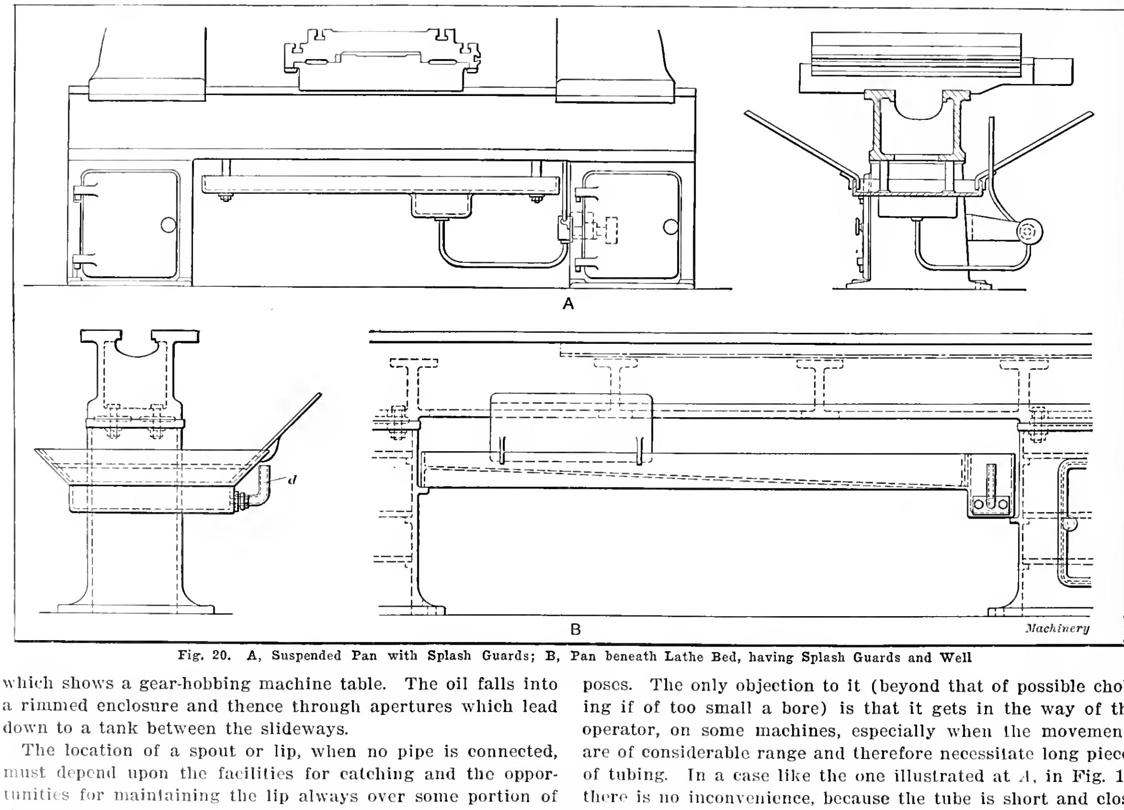


Fig. 20. A, Suspended Pan with Splash Guards; B, Pan beneath Lathe Bed, having Splash Guards and Well

which shows a gear-hobbing machine table. The oil falls into a rimmed enclosure and thence through apertures which lead down to a tank between the slideways.

The location of a spout or lip, when no pipe is connected, must depend upon the facilities for catching and the opportunities for maintaining the lip always over some portion of the pan or other receptacle. Frequently, it is impracticable to insure the latter condition, and then piping, or special poses. The only objection to it (beyond that of possible choking if of too small a bore) is that it gets in the way of the operator, on some machines, especially when the movements are of considerable range and therefore necessitate long pieces of tubing. In a case like the one illustrated at *A*, in Fig. 15, there is no inconvenience, because the tube is short and close to the frame, but at *B*, which shows an Alfred Herbert, Ltd., vertical milling machine the tubes are of necessity

long and somewhat cumbersome. Some of this firm's horizontal machines have a telescopic arrangement of piping extending from the cross-slide on the knee to the tank alongside the frame (as shown at *A*, Fig. 16), which accommodates itself to the vertical and horizontal positions of the slide, and takes the place of a flexible connection. The lower view *B* shows how a flexible drain tube is applied under similar circumstances, this example being from French practice. A slide with vertical movements can be drained by pipes, as represented at *C*. These pipes are telescoping and the lower one conducts the oil to a pan from which an outlet leads to the tank. Section *D* illustrates the drainage into the hollow frame of a drilling machine. There is a slot *a* of sufficient length to permit the pipe to travel up to the limit of the table adjustment.

Guards and Splash-plates

Two other details which are required for many types of machines are the guards and splash-plates which prevent the oil from flying beyond the limits of the machine or drainage pan. These devices are necessary chiefly for work rotating rapidly and comprise curved plates or castings around chucks

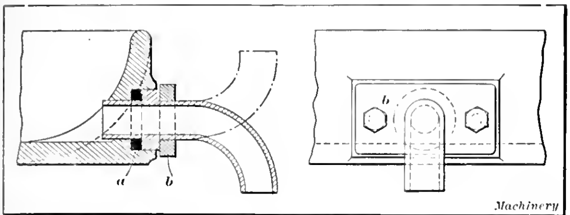


Fig. 21. Combined Drainage Pipe and Tap

and parts of spindles as well as around rotating work, and flat or curved plates held opposite the spindles or work, at some distance, so as to deflect the waste down into the pan. Sometimes drills are also encircled by sheet guards to catch the oil thrown off by the curling chips. All these types of guards are usually removable to facilitate the work of the operator, and are either clipped to convenient places or hinged to swing back. A clip for holding a flat guard is shown at *A*,

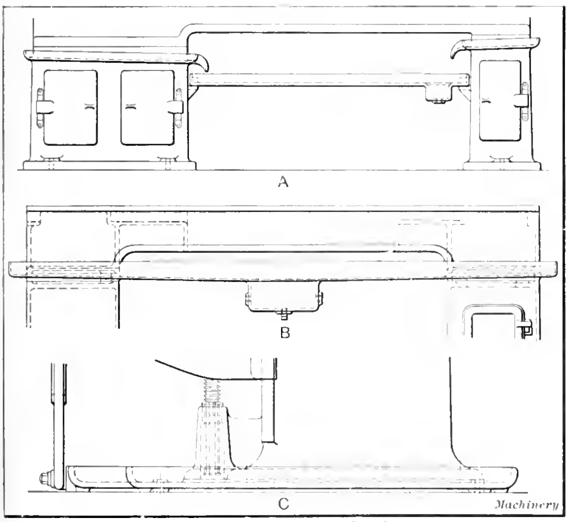


Fig. 22. Other Drainage Pan Developments

Fig. 17. This is also a convenient device for holding curved pieces to fit around the angles of a pan or base, instead of riveting the clips permanently to the splash-plate. At *B* is represented a hinged guard for protecting the whole of an automatic screw machine head, two of these being used. They can be swung down below the pan for inspecting the head. Hinged guards are also fitted around the tables of boring and turning mills, when lubricant must be used and the speed of rotation is rather high.

Drainage Pans for Cutting Lubricant

The nature and capacity of the drainage channels and drip-pans on any machine, depend both on the quantity of lubricant which is likely to be employed and the course which it takes after leaving the tools and work. Lubricant which does not escape from the bounds of a table and is caught immediately by a pipe, or other means, does not, of course, require channels or pans for collecting it; but if there is extensive splashing, catching-lips, trays, or regular pans become essential, until, in the final development, the whole machine stands in a large pan having deep sides. With a minimum of splash-

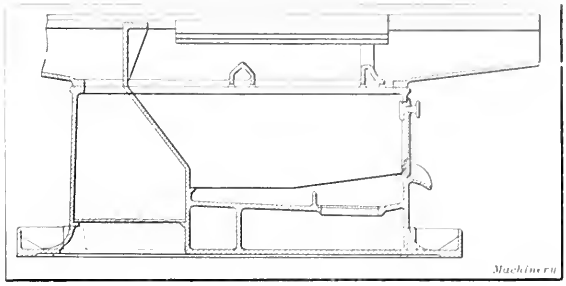
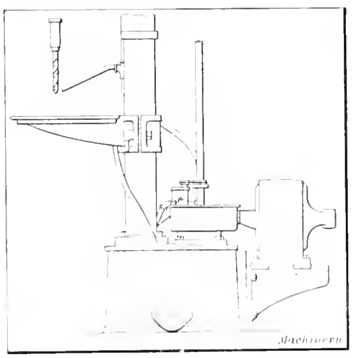


Fig. 23. Hollow Base of Turret Lathe used for receiving Chips and Lubricant—Tool Cupboard at Left

ing or dripping, which causes a small amount of oil or suds to trickle down the frame of a machine, a simple tray screwed on (as at *A*, Fig. 18) is sufficient, or the column may be completely encircled with a channel, as at *B*, the depth being increased at the front to hold a moderate quantity of oil.

A portable pan is often attached to a portion of a machine beneath the area of operation to receive the chips and lubricant, the latter draining through a pipe and away. Portable



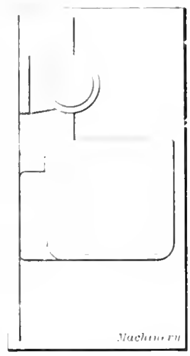


Fig. 24. Base of Drilling Machine used for Lubricant Tank
Fig. 25. Tank suspended on Lugs to permit Easy Removal for Cleaning

trays are also used on some boring and milling machines; these are placed under particular locations where lubricant drips down, and a flexible pipe connects the tray to the tank. A few examples of different arrangements of pans are given in succeeding illustrations. The detail *A*, Fig. 19, shows a portable pan with a well combined; illustration *C* shows another portable pan which has a separate tank that is fixed

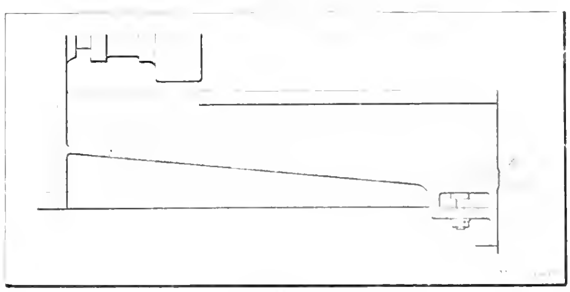


Fig. 26. Threading Machine with Tank Bed

and carries the pump. The portable pan has a lip, as shown in the end view, to drain into the tank beneath. The right-hand cabinet leg has a channel surrounding it which drains into the portable pan. For dealing with large quantities of chips, the pan on wheels is preferable to the fixed pan from which the chips have to be removed and transferred to some

other receptacle for disposal. At *B*, Fig. 19, is shown a fixed pan that is suspended beneath the machine. This practice is common in Germany because it enables pans to be added only when required, leaving the machine otherwise suitable for op-

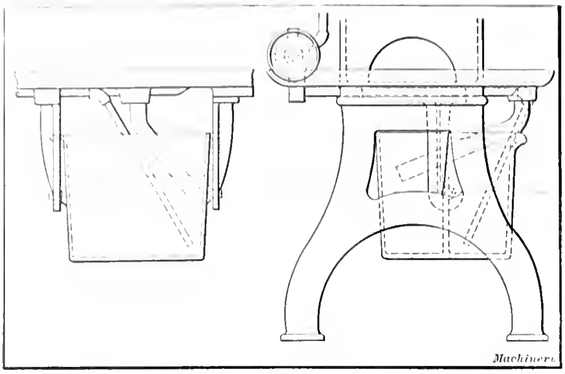


Fig. 27. Lubricant Tank suspended on Hooks for Tilting

eration without cutting lubricant. Another suspended pan (on a Greenwood & Batley special milling machine) is shown at *A*, in Fig. 20. This pan is hung on four bolts and has plates to catch the drip from the overhanging table. A pan with splash-plate attached is shown at *B*. This pan is supported on lugs cast on the cabinet legs and has a well and drainage

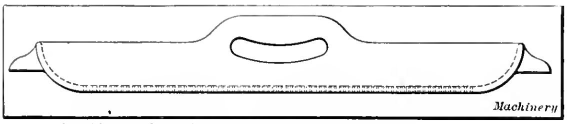


Fig. 28. Perforated Tray for separating Chips from Lubricant

pipe *d*. The method of fitting a pipe of this kind is shown in Fig. 21. It has a packing ring *a* which is clamped by the shoulder of the bent pipe; the latter is held in by the gland plate *b*. In the position indicated, the pipe drains off the contents of the pan, but when turned vertically, as shown by the dotted lines, it retains the lubricant in the pan, forming a simple tap or drainage cock.

A further development is shown at *A*, Fig. 22, the drainage system including channels around each leg, so that no oil can escape, excepting into the pan; in a more complete system, the whole bed stands in a pan interposed between it and the legs, as at *B*. This is common practice with some classes of small milling and other machines which rest upon a floor stand, and with the smaller automatic screw machines. The larger ones either have a turned-up foot all around the base, or the whole machine stands in a large tray which is partly filled with lubricant, the depth of the tray ranging from a few inches to a foot or more. Milling machines standing in a separate tray, as at *C*, do not require such a large oil capacity as "automatics," especially of the multi-spindle type. The latter often have a hollow cabinet leg which contains an extra oil supply. Supplementary sloping chutes overhang the edges of the trays of some automatics to receive drippings from projecting turret slides and spindle ends.

The practice of receiving all the chips and lubricant entirely within the bed is noticeable in the Pittler (German) turret lathes (Fig. 23). The interior has a plate and grid to catch and drain the chips and there is a door at the end for their removal. The vessel to contain the chips is placed under the drainage lip by the door. The remaining portion of the machine frame, to the left, forms a tool cupboard. This utilization of the interior of the machine base to hold the oil, in order to avoid the provision of an outside tank, is a practice becoming increasingly popular. The bases of drilling machines (see Fig. 24), milling machines, gear-cutters, etc., often form excellent tanks for the reception of cutting lubricant. The chief objection with some designs is the difficulty of cleaning the tank. If the chips cannot enter the hollow body, this objection is negligible, but if they are free to fall in with the oil (as in Fig. 26), the chips become a nuisance. For this reason, special facilities are afforded for cleaning the tanks from which pumps draw their supply, in

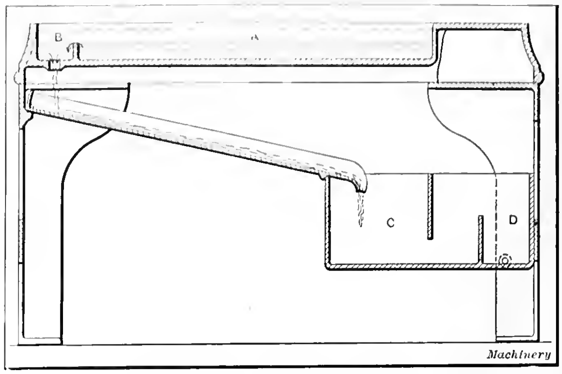


Fig. 29. Lubricant Tank with Partitions for separating Fine Chips from Lubricant

cases where the chips are fine and difficult to keep back. A tank, instead of being bolted down, may be hooked over a pin standing up from a lug (Fig. 25), without interfering with the pipes, or it may be tilted on lugs (Fig. 27). The tanks for Lincoln millers are often suspended in this way.

Separation of Chips and Lubricant

The separation of chips presents little difficulty, when they are large and cannot possibly pass through a small opening which admits the lubricant; but when they are fine, like the small chips from threading machines, etc., and particularly

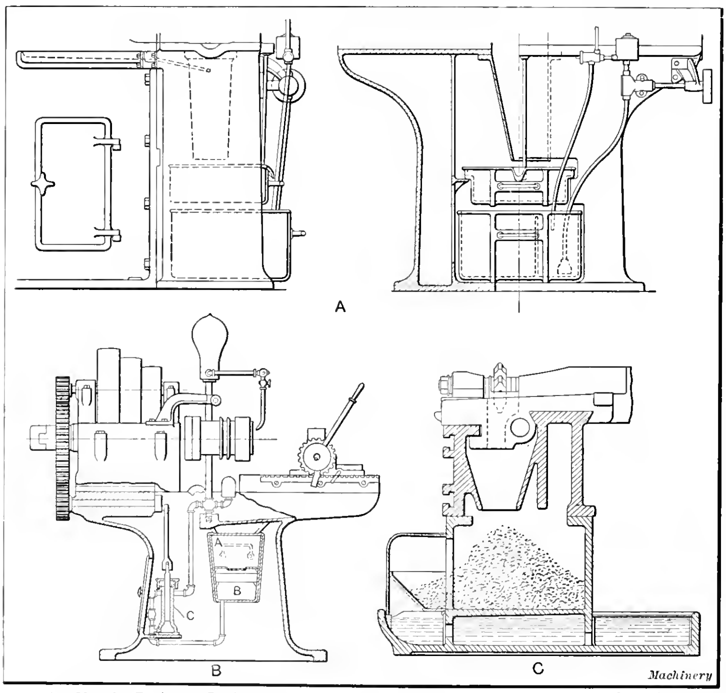


Fig. 30. A, Drainage Tank placed above Main Supply Tank; B, Common Lubricating Arrangement for Threading Machinery; C, Gear-cutting Machine with Provision for storing Oil in Base

those from hacksaws or cold saws, the greatest care has to be taken to prevent their entering the pump. This is done in two ways: By using strainers, and by fitting divisions or weirs so that two or three have to be passed before the liquid

reaches the pump chamber. An example is shown in Fig. 29, which illustrates the frame of a hacksaw machine built by Messrs. C. Wicksteed & Co., Ltd. of Kettering (England). Soap-water is used as a lubricant; this is first received in the recess *A* in the bed, and is drained at the front end *B*, which is farthest away from the falling swarth or chips as they are carried back by the blade on its return stroke. A sloping trough then conveys the lubricant to the tank *C*, which has two divisions, as shown. Light swarth which floats on top, cannot pass over the first division, and the clear liquid goes underneath to the pump chamber *D*.

If chips are produced in moderate quantities, it is well to have a separate perforated tray resting on the main pan, and empty this as required. One form is shown in Fig. 28. This tray should be deeper when larger quantities of material are handled, and is placed over the main tank, as shown at *A*, Fig. 30. It is drawn out when full, for getting rid of the chips. For threading machines, the usual arrangement is represented at *B*. This view shows the chip box *A*, with strainer and the settling tank *B*, with a division which prevents any sediment that might pass through the strainer from entering pump *C*. The latter is of the plunger type, and there is an air-vessel on the delivery pipe to insure a more constant flow of lubricant. In some designs, the interior, where the pump is located, forms an oil reservoir of larger capacity than the tank *B*.

Oil is contained only in the foot or base of some machines, corresponding in this respect to automatic screw machines, and the interior of the frame or the bed is used only to receive the chips. The sectional view *C* illustrates a large Brown & Sharpe automatic gear-cutting machine having this arrangement. The base stores the oil (from 25 to 30 gallons) and the chips fall from the cutter-slide to the position indicated, accumulating at the front eventually, and being removed through the opening for treatment in the oil separator.

* * *

ABOLISHING THE "CAN"

BY J. CROW TAYLOR*

It will be a surprise to some to hear that Germany, the country famous for beer and temperate drinking, is now showing a tendency, and a pretty general one at that, to discourage the use of beer by factory employes during working hours. There is what would be called in this country a pretty general disposition among German factory owners to abolish the "can."

As an example of how some handle this matter in Germany a consular report cites the methods used at the works of Ludwig Loewe & Co. of Berlin, where 3000 men are employed. Here they prohibit the beer can during working hours and offer in its place a drink of tea. The company has the tea prepared, puts it into pint bottles and sells it to the men for approximately three-quarter cent per bottle. Arrangements are made so that the tea may be had at any time any of the men desire it. Special trucks are used for distribution and boys wheel the tea about through the works, where bottles can be bought at any time by employes by a system of coupon tickets.

This tendency at present in Germany is in keeping with the attitude of factory owners in the United States. For a good many years now there has been a pretty general disposition to eliminate the use of beer during working hours. Many American mills and factories have long since put the ban on the beer can. Meantime Germany and the German element in this country has clung to it and pled the privilege of temperate drinking in extenuation. Temperate drinking is undoubtedly a great improvement on drunkenness, but it seems we are arriving at an age now which is not merely to be temperate but is to be prohibition so far as strong drink and even the milder drink of beer is concerned during working hours. It may be necessary to substitute tea and coffee in some instances, but as a general proposition it will likely be found eventually that water is a mighty good thing to drink during working hours, and that it will make for the good of the men as well as the employers and reduce accidents as well as increase efficiency.

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A RECORD OF PRESSED FITS*

BY C. F. MACGILL†

Articles on forced or pressed fits have been published in various technical journals of the country during the past ten or twelve years (one by Stanley H. Moore appearing in the transactions of the Society), but in only one of the papers noticed is there any reference to the diameter and length of the hub into which the shaft is forced or the material of which the hub is made—three very important elements in a forced fit. The great difference in allowances recommended, and in the pressures shown in the articles referred to, led me to have an exact record kept of each forced fit, from which were later calculated the tension stress, radial pressure and the coefficient of friction. The accompanying tables are the result.

In my experience, covering about twenty years in charge of shops where forced fits were made, I found that it was not necessary to increase the allowance with the diameter of the shaft, as the increased surface area of the fit added sufficient friction to bring the pressure up to the required tonnage, and that an allowance of from 0.002 inch to 0.004 inch on steel shafts pressed into steel hubs, and an allowance of from 0.003 inch to 0.005 inch on steel shafts pressed into cast-iron hubs of ordinary hardness, gave good results. I have yet to learn of one of these shafts coming loose.

There is no doubt in my mind that allowances greater than 0.006 inch on steel shafts pressed into cast-iron hubs, not only do not serve any useful purpose, but tend to set up strains that are injurious to the casting. One large plant with which I am familiar, issues an allowance table for pressed fits, the allowance gradually increasing with the shaft diameter. This is not followed in their shaft department, but instead a flat allowance of 0.003 inch is used without regard to the diameter of the shaft.

The allowances given by Mr. Moore, in his paper already referred to, are very much too great, while those given by Mr. Riddell in his discussion of the paper, are too low for sizes under 12 inches. According to Mr. Moore's formula $A = (2D + 0.5) \div 1000$. The allowance for an 8-inch shaft would be $(8 \times 2 + 0.5) \div 1000 = 0.0165$ inch, and on a 12-inch shaft $A = 0.0245$ inch. By referring to the accompanying tables of actual fits, it will be seen that an allowance of 0.002 inch on 8-inch shafts pressed into steel hubs, showed pressures of from 60 to 110 tons, and an allowance of 0.004 inch on a 12-inch shaft pressed into a cast-iron hub, showed 130 tons; hence it does not seem that greater allowances are either necessary or advisable.

The records in these tables cover 204 fits of diameters varying in size from 3.5 inches to 20 inches; sufficient in range and number to demonstrate the correctness and value of the practice followed. All of these measurements and gage readings were taken by the same inspector, and as he was a thoroughly reliable man, I am satisfied that they are correct. The records are all of fits made on electric generators and motors. The tables give the diameter of the shaft; the diameter of the bore; the length of the seat; the diameter of the hub; the material of which the hub is made; the allowance (the difference between the diameter of the shaft and the diameter of the bore of the hub into which the shaft is pressed); the pressure in tons required to force the shaft in; the maximum tension stress in the bore, in pounds per square inch; the radial pressure on the surface of the shaft, in pounds per square inch; and the coefficient of friction. The figures are given as a record of actual experience on sizes between the diameters shown. They are not claimed to represent correct practice beyond these dimensions.

The values in the last three columns were figured from formulas developed by Prof. A. Morley and published in *Engineering*, August 11, 1911. In these formulas

R_1 = outer radius of hub;

R_2 = inner radius of hub = radius of shaft after fitting;

$A = R_1 - R_2$ = thickness of hub wall;

$D = 2R_2$ = diameter of shaft;

p_2 = radial compressive stress in pounds per square inch at radius R_2;

* Paper presented before the American Society of Mechanical Engineers, December, 1913.

† Superintendent, Busch Sulzer Bros., Diesel Engine Co., Second and Utah Sts., St. Louis, Mo.

RECORD OF PRESSED FITS

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
1	3.504	3.500	6	5	Steel	0.004	30	25520	8680	0.105
2	3.504	3.500	6	5	Steel	0.004	45	25520	8680	0.157
3	3.504	3.500	6	5	Steel	0.004	45	25520	8680	0.157
4	3.503	3.500	6	5	Steel	0.003	50	19185	6525	0.233
5	3.504	3.500	6	4½	Steel	0.004	30	27360	6840	0.133
6	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
7	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
8	4.004	4.000	6	6¼	Steel	0.004	40	21125	8875	0.120
9	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
10	4.004	4.000	6	6¼	Steel	0.004	40	21125	8875	0.120
11	4.003	4.000	8	5½	Steel	0.003	30	17175	5325	0.112
12	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
13	4.004	4.060	6	6¼	Steel	0.004	35	21125	8875	0.104
14	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.134
15	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
16	4.004	4.000	6	6¼	Steel	0.004	33	21125	8875	0.0985
17	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
18	4.004	4.000	8	5½	Steel	0.004	40	22900	7100	0.112
19	4.004	4.000	6	7¼	Steel	0.004	50	19545	10456	0.127
20	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.103
21	4.004	4.000	6	6¼	Steel	0.004	50	21125	8875	0.149
22	4.004	4.000	6	6¼	Steel	0.004	50	21125	8875	0.149
23	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.103
24	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.103
25	4.054	4.051	6	6¼	Steel	0.003	40	15915	6286	0.153
26	4.054	4.051	6	6¼	Steel	0.003	40	15915	6286	0.153
27	4.505	4.500	8	6½	Steel	0.005	60	24665	8665	0.122
28	4.505	4.500	8	6½	Steel	0.005	50	24665	8665	0.102
29	4.5035	4.500	8	6½	Steel	0.0035	45	17285	6050	0.131
30	4.505	4.503	6½	5¾	Cast Iron	0.002	20	5750	1455	0.3
31	4.503	4.500	6	10	Cast Iron	0.003	30	7070	4690	0.151
32	4.503	4.500	6	10	Cast Iron	0.003	30	7070	4690	0.151
33	4.503	4.500	8	6½	Steel	0.003	40	14815	5185	0.136
34	4.503	4.500	8	6½	Steel	0.003	40	14815	5185	0.136
35	4.880	4.875	7	7½	Steel	0.005	48	21885	8865	0.101
36	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
37	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
38	4.880	4.875	7	7¼	Steel	0.005	60	22365	8385	0.143
39	4.880	4.875	7	7¼	Steel	0.005	45	22365	8385	0.107
40	4.880	4.874	6	7¼	Steel	0.006	67	26835	10064	0.145
41	4.880	4.875	7	8	Steel	0.005	40	21060	9690	0.077
42	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
43	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
44	4.880	4.876	7	7¼	Steel	0.004	40	17890	6710	0.111
45	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
46	4.880	4.875	7	8	Steel	0.005	55	21060	9690	0.106
47	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
48	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
49	4.880	4.875	6	7½	Steel	0.005	45	21885	8865	0.113
50	4.880	4.375	6	7½	Steel	0.005	45	21885	8865	0.113
51	4.880	4.375	6	7½	Steel	0.005	45	21885	8865	0.113
52	4.880	4.875	6	7½	Steel	0.005	45	21885	8865	0.113
53	4.880	4.875	7	8	Steel	0.005	55	21060	9690	0.106
54	4.880	4.875	6	7¼	Steel	0.005	40	22365	8385	0.104
55	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
56	4.880	4.875	7	8	Steel	0.005	50	21060	9690	0.096
57	5.003	5.000	7¾	10	Cast Iron	0.003	25	6545	3930	0.105
58	5.003	5.000	8	10	Cast Iron	0.003	20	6545	3930	0.081
59	5.002	5.000	5½	7¾	Steel	0.002	50	8500	3500	0.330
60	5.440	5.437	9	13 3/16	Cast Iron	0.003	25	5730	4055	0.0806
61	5.440	5.437	9	13 3/16	Cast Iron	0.003	25	5730	4055	0.0806
62	5.502	5.500	8	13	Cast Iron	0.002	22	3800	2650	0.120
63	5.502	5.500	8½	13	Cast Iron	0.002	25	3800	2650	0.128
64	5.630	5.625	7	13	Cast Iron	0.005	30	9340	6390	0.076
65	5.630	5.625	7½	8¼	Steel	0.005	40	19550	7115	0.085
66	5.629	5.625	8¼	8¼	Steel	0.004	65	15610	5695	0.207
67	5.630	5.625	7½	8½	Steel	0.005	65	19185	7480	0.131
68	5.630	5.625	7	8	Steel	0.005	45	19900	6765	0.1075
69	5.630	5.625	7	8¼	Steel	0.005	65	19550	7115	0.148
70	5.630	5.625	6½	8¼	Steel	0.005	65	19550	7115	0.159
71	5.630	5.625	7	8¼	Steel	0.005	65	19535	7115	0.147
72	5.630	5.625	7	8½	Steel	0.005	55	19185	7480	0.119
73	5.630	5.625	7	9¼	Steel	0.005	48	18260	8405	0.092
74	5.630	5.625	7½	8½	Steel	0.005	50	19185	9480	0.101
75	5.630	5.625	7	8¼	Steel	0.005	55	19535	7115	0.125
76	5.630	5.625	8	8	Steel	0.005	55	20000	6650	0.1185
77	5.7525	5.750	8	12¾	Cast Iron	0.0025	18	4610	3060	0.081
78	5.752	5.750	8	12¾	Cast Iron	0.002	20	3690	2375	0.117
79	6.005	6.000	8	9	Steel	0.005	70	18055	6945	0.134
80	6.002	6.000	8	9	Steel	0.002	55	7220	2780	0.262
81	6.003	6.000	7¾	13¾	Cast Iron	0.003	30	5265	3575	0.115
82	6.005	6.000	8	9	Cast Iron	0.005	30	10485	3225	0.123
83	6.003	6.000	8	14½	Cast Iron	0.003	40	5200	3680	0.144
84	6.0025	6.000	7	13¼	Cast Iron	0.0025	40	4425	2920	0.207
85	6.0025	6.000	8	14½	Cast Iron	0.0025	38	4425	2920	0.173
86	6.130	6.125	7	8¼	Steel	0.005	65	19065	5475	0.176
87	6.253	6.250	9	11½	Steel	0.003	60	19065	5475	0.134
88	6.253	6.250	9	11½	Steel	0.003	65	9320	5080	0.145
89	6.253	6.250	9	11¼	Steel	0.003	65	9320	5080	0.145
90	6.2735	6.273	9	11½	Steel	0.0005	15	1550	8401	0.20
91	6.5025	6.500	8	21¾	Cast Iron	0.0025	40	3790	3170	0.155
92	6.503	6.500	8	14¾	Cast Iron	0.003	40	4871	3280	0.149
93	6.502	6.500	8	14¾	Cast Iron	0.002	38	3245	2190	0.213
94	6.503	6.500	6	12	Cast Iron	0.003	40	5160	2835	0.23
95	6.503	6.500	8	13½	Cast Iron	0.003	35	4980	3110	0.134
96	6.502	6.500	8	13	Cast Iron	0.002	25	3355	2115	0.152
97	6.503	6.500	8	11¼	Steel	0.003	90	9220	4610	0.24
98	6.5025	6.500	8	14¾	Cast Iron	0.0025	25	4060	2735	0.112
99	6.503	6.500	8	14¾	Cast Iron	0.003	35	4800	3395	0.126
100	6.502	6.500	12	10	Cast Iron	0.002	50	3680	1495	0.275
101	6.610	6.605	11	14	Steel	0.003	60	8000	5620	0.094
102	6.939	6.937	7¾	13	Cast Iron	0.002	15	3210	1785	0.1

Machinery

RECORD OF PRESSED FITS

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
103	6.939	6.937	8	11	Cast Iron	0.002	17	3410	1465	0.133
104	7.002	7.000	10	12	Steel	0.002	75	5730	2820	0.242
105	7.002	7.000	10	12	Steel	0.002	80	5730	2820	0.268
106	7.003	7.000	10	12½	Steel	0.003	90	8325	4515	0.181
107	7.002	7.000	9	17	Cast Iron	0.002	50	2965	2110	0.24
108	7.003	7.000	10	13	Steel	0.003	85	8285	4615	0.168
109	7.003	7.000	10	13	Steel	0.003	80	8285	4615	0.158
110	7.003	7.000	9	16¾	Cast Iron	0.003	40	4465	3135	0.129
111	7.002	7.000	10	12	Steel	0.002	95	5730	2820	0.307
112	7.003	7.000	8	12¾	Cast Iron	0.003	35	4815	2600	0.153
113	7.003	7.000	10	13	Steel	0.003	50	8285	4615	0.0985
114	7.0035	7.000	8	14¾	Cast Iron	0.0035	45	5375	3400	0.12
115	7.003	7.000	9	17	Cast Iron	0.003	50	4450	3160	0.18
116	7.003	7.000	8	12	Steel	0.003	100	8605	4235	0.269
117	7.034	7.031	8	10½	Steel	0.003	75	9260	3520	0.262
118	7.034	7.031	8	10½	Steel	0.003	35	9260	3520	0.113
119	7.1895	7.187	7	13	Cast Iron	0.0025	25	3915	2085	0.152
120	7.2525	7.2495	9	16¾	Cast Iron	0.003	35	4350	2475	0.115
121	7.437	7.435	7½	11	Cast Iron	0.002	25	3275	1220	0.234
122	7.4395	7.437	8	13	Cast Iron	0.0025	25	3810	1970	0.136
123	7.502	7.499	8	12¾	Cast Iron	0.003	55	4605	2230	0.238
124	7.5025	7.500	8	13	Cast Iron	0.0025	35	3810	1905	0.194
125	7.5027	7.500	8	14½	Cast Iron	0.0027	20	3970	2290	0.0925
126	7.5029	7.501	8	25½	Cast Iron	0.0019	15	2460	2145	0.074
127	7.534	7.531	10	12	Steel	0.003	50	8320	3620	0.117
128	8.002	8.000	9½	13¾	Steel	0.002	60	5015	2485	0.202
129	8.002	8.000	9½	13¾	Steel	0.002	60	5015	2485	0.202
130	8.002	8.000	9½	13¾	Steel	0.002	60	5015	2485	0.202
131	8.002	8.000	16	14	Steel	0.002	110	4975	2525	0.217
132	8.002	8.000	9½	13¾	Steel	0.002	80	5015	2485	0.27
133	8.002	8.000	9½	13¾	Steel	0.002	85	5015	2485	0.286
134	8.002	8.000	9½	13¾	Steel	0.002	75	5015	2485	0.253
135	8.002	8.000	9½	13¾	Steel	0.002	80	5015	2485	0.27
136	8.002	8.000	9	13½	Steel	0.002	80	5065	2435	0.318
137	8.003	8.000	9	17	Cast Iron	0.003	50	4025	2565	0.173
138	8.4395	8.4375	7	11	Cast Iron	0.002	25	3060	795	0.34
139	8.4395	8.437	8	11	Cast Iron	0.0025	18	3820	833	0.205
140	8.440	8.4375	8	11	Cast Iron	0.0025	15	3820	833	0.17
141	8.503	8.500	8	14¾	Cast Iron	0.003	35	4035	2015	0.162
142	8.503	8.500	8	14½	Cast Iron	0.003	45	4055	1980	0.212
143	8.503	8.500	9	15	Cast Iron	0.003	40	3815	2370	0.141
144	8.503	8.500	8	14¾	Cast Iron	0.003	45	4435	2020	0.208
145	8.5025	8.500	6½	15	Cast Iron	0.0025	30	3000	2255	0.154
146	8.505	8.5015	8	15	Cast Iron	0.0045	45	6005	3085	0.136
147	8.507	8.504	9	11	Cast Iron	0.003	40	4565	1145	0.292
148	8.561	8.562	14	13½	Cast Iron	0.002	30	2765	848	0.1875
149	8.939	8.937	8	13	Cast Iron	0.002	18	2860	762	0.211
150	8.939	8.937	8	13	Cast Iron	0.002	20	2860	762	0.234
151	8.939	8.937	8	13	Cast Iron	0.002	22	2860	762	0.257
152	9.002	8.999	12	20½	Cast Iron	0.003	65	3515	2375	0.161
153	9.002	8.999	12	20½	Cast Iron	0.003	65	3515	2375	0.161

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
154	9.0025	8.999	12	20½	Cast Iron	0.0035	75	4100	2375	0.159
155	9.0025	8.999	12	20½	Cast Iron	0.0035	75	4100	2375	0.159
156	9.0015	8.9995	9	16¾	Cast Iron	0.002	22	2480	1370	0.126
157	9.002	9.000	10	14	Steel	0.002	80	4710	1955	0.29
158	9.002	9.000	10	14	Steel	0.002	75	4710	1955	0.272
159	9.003	9.000	12	20¾	Cast Iron	0.003	70	3500	2395	0.171
160	9.003	9.000	12	20¾	Cast Iron	0.003	70	3500	2395	0.171
161	9.003	9.000	12	21	Cast Iron	0.003	70	3495	2410	0.171
162	9.003	9.000	12	20¾	Cast Iron	0.003	70	3500	2395	0.171
163	9.002	9.000	13	20½	Cast Iron	0.002	75	2345	1585	0.257
164	9.003	9.000	12	20¾	Cast Iron	0.003	90	3500	2395	0.22
165	9.003	9.000	12	14¾	Cast Iron	0.003	85	3890	1775	0.298
166	9.003	9.000	10	18⅜	Steel	0.003	100	6200	3795	0.187
167	9.003	9.000	10	18⅜	Steel	0.003	80	6200	3795	0.149
168	9.003	9.000	9	17	Cast Iron	0.003	45	3700	2080	0.17
169	9.003	9.000	9	17	Cast Iron	0.003	50	3700	2080	0.189
170	9.939	9.937	7½	13	Cast Iron	0.002	25	2745	720	0.295
171	9.9998	9.996	9	16¾	Cast Iron	0.0038	60	4400	2080	0.204
172	10.003	10.000	9	16¾	Cast Iron	0.003	40	3495	1640	0.172
173	10.004	10.000	12	21	Cast Iron	0.004	90	4205	2715	0.176
174	10.0035	10.000	14	21	Cast Iron	0.0035	80	3765	2375	0.153
175	10.002	10.000	12	18	Steel	0.002	55	3925	2475	0.128
176	10.502	10.500	8	13	Cast Iron	0.002	16	2505	550	0.22
177	11.002	11.000	12⅝	18	Steel	0.002	70	3750	1705	0.189
178	11.002	11.000	12⅝	18	Steel	0.002	80	2750	1705	0.216
179	11.005	10.9997	14	20¾	Cast Iron	0.053	38	5350	3005	0.0525
180	11.002	11.000	12¾	18	Steel	0.002	85	3750	1705	0.24
181	11.002	11.000	13½	18	Steel	0.002	90	3750	1705	0.227
182	11.002	11.000	13	18	Steel	0.002	90	3750	1705	0.235
183	11.002	11.000	13	18	Steel	0.002	70	2750	1705	0.183
184	11.002	11.000	12¾	18	Steel	0.002	90	3750	1705	0.24
185	11.002	11.000	13	18	Steel	0.002	100	3750	1705	0.261
186	11.0025	11.000	10	17½	Cast Iron	0.0025	50	2680	1160	0.25
187	11.0035	11.000	10	17½	Cast Iron	0.0035	60	2755	1625	0.214
188	11.064	11.062	12	18¾	Cast Iron	0.002	48	2100	975	0.236
189	12.004	12.000	12	20¾	Cast Iron	0.004	130	3815	1895	0.302
190	12.003	12.000	13	20½	Cast Iron	0.003	70	2875	1405	0.204
191	12.004	12.000	13	21	Cast Iron	0.004	78	3795	1930	0.165
192	13.0045	13.002	13	21½	Cast Iron	0.0025	100	2235	1035	0.362
193	13.003	13.000	14	22	Cast Iron	0.003	85	2660	1265	0.235
194	13.0045	13.000	12	22	Cast Iron	0.0045	90	4000	1905	0.193
195	13.0045	13.000	12	22	Cast Iron	0.0045	100	4000	1905	0.213
196	13.003	13.000	12	25½	Cast Iron	0.003	70	2530	1470	0.195
197	13.004	13.000	13	26	Cast Iron	0.004	100	3355	2015	0.187
198	13.0035	13.000	13	22	Cast Iron	0.0035	110	3105	1490	0.252
199	13.003	13.000	12¾	21	Steel	0.003	125	4790	2130	0.225
200	14.033	14.031	14	21	Steel	0.003	150	4785	1845	0.264
201	14.033	14.031	14	21	Steel	0.002	100	3075	1185	0.274
202	14.5035	14.500	13	25½	Cast Iron	0.0035	100	2720	1430	0.235
203	16.004	16.000	14	25½	Cast Iron	0.004	120	2865	1415	0.241
204	20.002	20.000	20	28⅞	Steel	0.002	160	2220	780	0.327

Machinery

f_t = hoop tension per square inch at radius R_2;
J = excess in original diameter of shaft over that of bore of hub = allowance;
E = Young's modulus for shaft material, assumed, 30,000,000 } thus $E = 2E_1$;
E_1 = Young's modulus for hub material, assumed, 15,000,000
$\frac{1}{m}$ = Poisson's ratio for shaft material } assumed $m = m_1 = 4$
$\frac{1}{m_1}$ = Poisson's ratio for hub material

Total tension stress at bore of hub

$$f_t = \frac{\frac{J}{D} \times E}{\left(\frac{m-1}{m} + \frac{1}{m_1} \times \frac{E}{E_1}\right) \frac{R_1^2 - R_2^2}{R_1^2 + R_2^2} + \frac{E}{E_1}}$$

Radial pressure on shaft

$$p_2 = \frac{\frac{J}{D} - \frac{f_t}{E_1}}{\frac{m-1}{mE} + \frac{1}{m_1 E_1}}$$

Coefficient of friction

$$\mu = \frac{P}{P_2}$$

where

P_2 = total normal pressure in tons;

P = pressure in tons required to force shaft into hub.

Cast-iron hub on steel shaft $D = 6.0025$ inches, $J = 0.0025$ inch, length of hub $l = 7$ inches, thickness of hub $t = 3\frac{5}{8}$ inches. Assuming $m = m_1 = 4$ and $E = 2E_1 = 30{,}000{,}000$ then

$$\text{Max. tension stress } f_t = \frac{\frac{0.0025}{6} \times 30{,}000{,}000}{\left(\frac{3}{4} + \frac{1}{4} \times 2\right) \frac{44 - 9}{44 + 9} + 2} = 4425$$

pounds per square inch.

$$\text{Radial pressure } p_2 = \frac{\frac{0.0025}{6} - \frac{4425}{15{,}000{,}000}}{\frac{3}{4 \times 30{,}000{,}000} + \frac{1}{4 \times 15{,}000{,}000}} =$$

2920 pounds per square inch

$$\text{Coefficient of friction} = \frac{40}{\frac{\pi \times 6 \times 7 \times 2920}{2000}} = 0.207$$

* * *

PFAUTER PATENTS ON GEAR HOBBING MACHINES IN GERMANY

The German Pfauter patent No. 112,082 class 49a on spiral gear hobbing machine expired September 1, 1912. The patent for this invention by Mr. Pfauter was taken out by the Chemnitzer Strickmaschinenfabrik of Chemnitz in 1897 and expired at the end of fifteen years. As the patents have expired, anyone can build hobbing machines in Germany on the Pfauter system. When Pfauter applied for patents on his hobbing machine he made application for both spur and spiral gear machines but after making a thorough examination, the patent office discovered that the hobbing method as applied to cutting spiral gears only could be protected, inasmuch as the hobbing principle of cutting spur gears had been known for thirty or forty years. Up to September 1, 1912, only two makers were permitted to manufacture hobbing machines for cutting spiral gears, these being Mr. Pfauter, whose entire product was taken over by the Schuchardt & Schütte Co., and Biernatzki & Co., who had acquired the patent rights from the Chemnitzer Strickmaschinenfabrik.

LAMINATED SPUR GEARS

A new method of making spur gears to secure accuracy and silent operation which is being developed commercially by Laminated Gears, Ltd., Sedgley Road, Owlerton, Sheffield, England, was described in *Page's Engineering Weekly.* This new gear, which is the invention of Arthur E. Terry, consists of a number of thin disks in which teeth have been formed by dies. These disks, which may be of brass, mild steel, high-tensile steel, etc., are placed side by side and clamped together by rivets. In assembling the gear, successive disks are displaced a distance equal to one-half the circular pitch, so that the teeth are staggered as shown in Fig 1. These disks

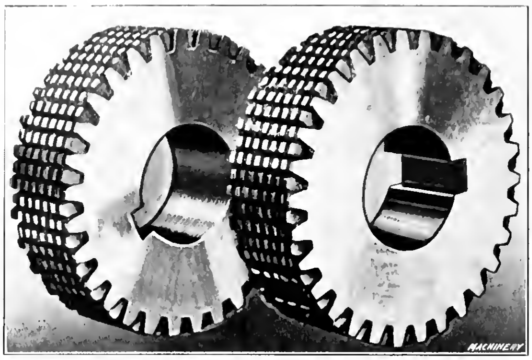

Fig. 1. Laminated Gears formed of Toothed Disks riveted together

are located on the tooth notching machine, by the bore and keyway, so that each disk has exactly the same pitch diameter. Between the plates of an assembled gear are metal washers varying from 0.001 to 0.012 inch thick, in accordance with requirements. These washers provide a slight clearance for the meshing teeth. The laminated gears are said to produce very little noise in operation, owing to the fact that the impact of the meshing teeth is halved, thus lessening the noise produced; moreover, as the gear is formed by a number of laminations, it cannot vibrate as a whole, and if one of these gears is suspended and struck by a hammer,

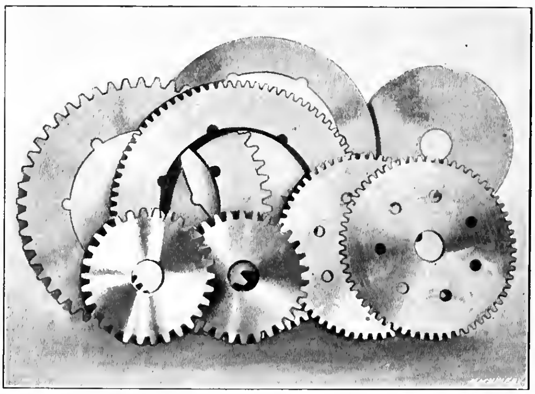

Fig. 2. Stampings and Blanks for Laminated Gears

the sound produced is about the same as would be obtained by striking a disk of lead; hence, the vibrations which produce a ringing sound in the case of a solid gear are entirely eliminated, owing to the laminated construction. It is claimed that when laminated gears are hardened there is no danger of distortion, because in the hardening processes the plates can be packed on a mandrel so as to form a long pinion with the teeth in line. When the plates thus assembled are casehardened, they will only be hard on the working faces of the teeth, and, consequently, the distortion of the plates will be slight; furthermore, when they are assembled, what little distortion there may be in each individual plate will be neutralized.

* * *

No one was ever lost on a straight road.

COMPARATIVE TESTS OF THREE TYPES OF LINESHAFT BEARINGS*

RELATIVE POWER CONSUMPTION AND COEFFICIENTS OF FRICTION FOR BALL, ROLLER AND BABBITT BEARINGS

These tests were made in order to ascertain definitely the relative and absolute amounts of power required to drive a specially constructed lineshaft carrying given loads at certain known speeds of revolution, when supported successively by three different types of shaft bearings, and to determine coefficients of friction for each type. The three types tested were ring-oiled babbitt bearings, roller bearings and ball bearings. Twenty bearings of each type were used in order that representative results might be obtained.

The design of the apparatus was made with the assistance of the manufacturers of the bearings to whom preliminary drawings were submitted, and during the four years of the tests representatives of these firms have visited the laboratory for the purpose of giving whatever advice and assistance was possible. The preliminary work, covering the first two years, showed the necessity of considering the temperature of the oil film in the babbitt and roller bearings, and it was only after careful study of the temperature question with regard to all three types that satisfactory results were finally obtained.

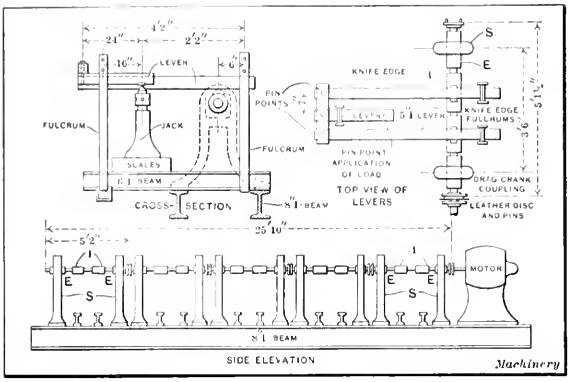

Fig. 1. Diagram of Apparatus for testing Lineshaft Bearings

Description of Testing Apparatus

The apparatus consists of 25 feet 10 inches of lineshafting in five equal sections, mounted in hangers *S* (see Fig. 1) which are inverted and used as floor stands. The hangers are bolted to two 8-inch I-beams which are leveled upon the floor. The shafts are of cold-rolled steel, 2 7/16 inches in diameter. Each section is 5 feet 2 inches long; the adjacent sections are coupled together by means of a flexible leather disk or two straps connecting the two flange couplings. The flexible couplings prevent transmitting any part of the load applied on one shaft, to either adjoining section, and also prevent binding between shafts and bearings due to possible lack of alignment.

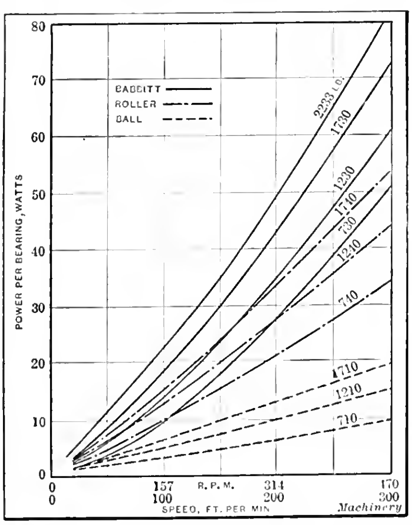

Fig. 2. Comparison of Power consumed by Friction in Babbitt, Roller and Ball Bearings at Various Speeds, with Loads per Bearing as indicated—Temperature of Bearing 100 Degrees F.

A direct-current Fort Wayne motor is directly connected to one end of the shafting by means of a flexible coupling. The motor is of the interpole type with the interpoles removed, making it a shunt motor. Its rating with the interpoles is 7½ horsepower, 28 amperes, 400/1600 revolution per minute, four pole, 230 volts. The power required to run the motor alone at all speeds, without load, was accurately ascertained, as well as the power required to run the motor and shafts together, at all loads and speeds. The relative amounts of power required to overcome the friction of the various types of bearings were therefore accurately determined.

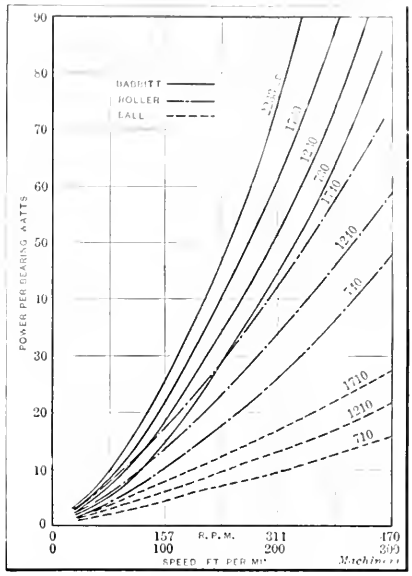

Fig. 3. Comparison of Power consumed by Friction in Babbitt, Roller and Ball Bearings—Temperature of Bearing 77 Degrees F.

The load was applied through levers having hardened knife edges and pin points as fulcrums. Across the top of the 8-inch I-beams and at right angles to them, are bolted short 6-inch I-beams to which the fulcrums are attached. Standard 1000-pound scales are set upon the 6-inch I-beams. A double system of leverage is used in order to get sufficient load upon the bearings with as short a length of lever as possible.

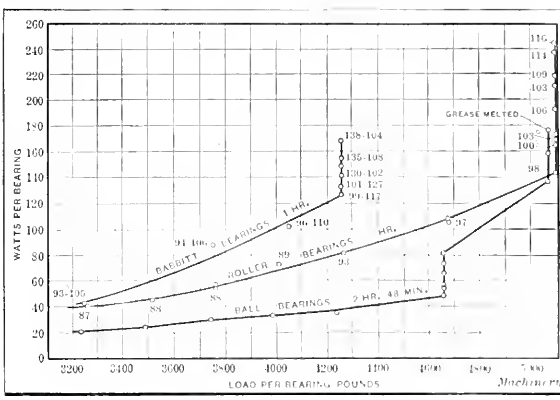

Fig. 4. Lubricant Breakdown Tests for Babbitt, Roller and Ball Bearings

This double system of levers also serves to steady the apparatus and prevent excessive vibration. A pressure ratio of 8.33 at each bearing to one at the scale was obtained. This was checked by an independent method of weighing the actual load resulting at the bearings, from a given load on the scales. The loads were applied to the shaft by two bearings between each pair of hangers. These bearings are identical with those in the hangers, and are supplied with knife edges which engage a V-shaped groove in the 5-inch I-beam levers. The bearings and hangers for each section are symmetrically placed with respect to the middle of the sec-

* Abstract of paper by Carl C. Thomas, E. R. Maurer and L. E. A. Kelso, presented before the American Society of Mechanical Engineers, December, 1913.

tion; therefore, equal loads on the intermediate bearings *I* produce equal pressures on the end bearings *E*. The reason for using twenty bearings was that the amount of power necessary for a single bearing was so small as to be difficult of measurement; moreover any single bearing might not truly represent results that would be obtained from that type of bearing in general.

The Bearings Tested

The three kinds of bearings tested were: the Hess-Bright ball bearing manufactured by the Hess-Bright Mfg. Co.; the ring-oiled bearing manufactured by the Dodge Mfg. Co., lined with babbitt metal made from their formula; and the Hyatt roller bearing manufactured by the Hyatt Roller Bearing Co. All bearings were for the same size shaft and the same pieces of shafting were used for all the tests, except that two sections bent during the tests were replaced. The babbitt bearings are 9 21/32 inches long and hence their projected area is 22.36 square inches.. These bearings were oiled by the well-known ring-oiler device, there being two rings in each bearing. Each roller bearing contains six right-hand and six left-hand rollers, 0.780 inch in diameter; six are 9 9/16 inches long and six are 9 3/16 inches long. The bearings are of the type in which a cage is used for holding one-half the rollers. Each ball bearing contains a single set of balls 9/16 inch in diameter. The diameter of the inner race across the ball groove is 3.4729 inches.

Mercury thermometers (two in each babbitt and roller bearing, and one in each ball bearing) were used for measuring the temperature of the oil or bearing. In order to avoid the endwise thrust of the shaft, when supported by the roller bearings, it was necessary to interpose two ball thrust collars. Before this was done, excessive vibration of the motor and of the apparatus resulted from the tendency of the shaft to move endwise. This was particularly troublesome at high loads and speeds.

Procedure when Making Tests

The power was measured by the ammeter voltmeter method. A second ammeter was used as a check on the first; and a watt-meter (arranged for direct and reverse readings) as a further check. The general order of taking data was as follows: Clean the commutator; adjust motor to speed; take all power readings; read all thermometers; adjust speed again and repeat power measurements. This gave the power both before and after the temperature was taken, the mean of which would give the mean power for the mean temperature very closely. In addition, the readings acted as a check on each other.

The manner of making a test or run was essentially as follows: Each night the plant was run from three to twelve hours under the load and speed to be used during the run of the following day, but without observation. The purpose of the preliminary night run was to allow the shaft and bearings to adjust themselves to the conditions of the run. Then on the following day the shaft was run from three to six hours and frequent observations of power and temperature were made during the run. The first few observations were made as often as practicable (about five minutes apart); the others, generally at fifteen-minute intervals, but toward the end of the run when the temperature was rising slowly observations were made at intervals generally of thirty minutes or more.

TABLE I. RELATIVE AMOUNTS OF POWER CONSUMED IN FRICTION

Bearings	100 Feet per Minute		300 Feet per Minute	
	77 Deg. F.	100 Deg. F	77 Deg. F.	100 Deg. F.
Ball	1	1	1	1
Roller	2.2	2.5	2.7	3
Babbitt	3	3.6	4.5	4

Machinery

The speeds used in the tests were between 150 and 450 revolutions per minute, corresponding, respectively, to about 100 and 300 feet per minute peripheral speed. Most of the loads used were between 700 and 1800 pounds per bearing, corresponding, respectively, to about 30 and 80 pounds per square inch for the babbitt bearings. All statements of results therefore are subject to the above limitations as to speed and loads. Two lubricants were used in all the tests: Atlantic red engine oil in the babbitt and roller bearings, and No. 2 Keystone grease in the ball bearings.

Relative Power Consumption

Figs. 2 and 3 show a comparison of the power consumed by friction in the babbitt, roller and ball bearings for bearing temperatures of 100 degrees and 77 degrees F., respectively. Each curve gives the power required per bearing of the kind indicated, to run the shaft under the load and speed given. The power required for the babbitt bearings is higher than for the other bearings, except perhaps at low loads and speed, and the power for roller bearings is higher than for ball bearings. The excess of power for babbitt over rollers, and rollers over balls, increases with increase of speed for all loads. Table I shows the relative amounts of power consumed in friction by the three kinds of bearings at the speeds and temperatures indicated; the relative numbers are based, in each case, on the average power for the three loads: 710, 1210, and 1710 pounds for balls; 740, 1240, and 1740 for rollers; and 730, 1230 and 1730 for babbitt.

TABLE II. COMPARISON OF COEFFICIENTS OF FRICTION

Type of Bearing	Coefficient of Friction					
	Load, 727 Pounds		Load, 1227 Pounds		Load, 1727 Pounds	
	77 Deg	100 Deg.	77 Deg.	100 Deg.	77 Deg.	100 Deg.
Ball	0.0025	0.0019	0.0022	0.0018	0.0020	0.0016
Roller	0.0069	0.0055	0.0055	0.0047	0.0049	0.0042
Babbitt	0.0112	0.0075	0.0082	0.0058	0.0070	0.0051

Machinery

The coefficients of friction for the three types of bearings, when subjected to average loads of 727, 1227 and 1727 pounds, respectively, and temperatures of 77 and 100 degrees F., are given in Table II. The peripheral speed was 150 feet per minute.

Lubricant Breakdown Tests

In order to observe the performance of the bearings under extraordinarily heavy loads, "breakdown tests" were run on each type of bearing with only one section of shafting on which were four bearings. This small number of bearings was used because it was impracticable to keep close watch of a larger number and avoid trouble during the excessively severe conditions. The maximum load was 600 pounds on the scales, or about 5000 pounds per bearing. The results are shown in Fig. 4. A speed of 200 revolutions per minute was chosen because it represents about the average lineshaft speed in practice. These tests began at about 3200 pounds per bearing. Failure occurred at about 4250 pounds per bearing in the case of the babbitt, 4650 pounds in the case of the ball bearings, and about 5100 pounds in the case of the roller bearings.

The quality and amount of lubricant used undoubtedly have an important effect upon the load that will cause a given bearing to fail. The bearings did not in any case fail structurally, as the power was cut off soon after distress was manifested, but the failure was simply that of the lubricant. Breaking down of the lubricant resulted in an immediate increase of the power required to maintain the original speed of rotation of the shaft in the bearings. In each case probably only one of the four bearings used in the breakdown tests showed distress at any one time. In the case of ball bearings, distress was manifested by disintegration of the grease which "melted" and ran out of the bearing. This was accompanied by the immediate increase in power requirement, as shown in Fig. 4. The temperatures given (99 degrees, 117 degrees, etc.) indicate the averages for the four bearings being tested. Similar behavior on the part of the babbitt and the roller bearings indicated that at least one of the four under test was suffering from an approach to "metal-to-metal" contact. The bearings were not injured by these endurance tests, and all were used in subsequent tests at the more usual speeds and pressures.

CENTRALIZED CONTROL SYSTEM FOR PANAMA CANAL LOCKS

ELECTRICAL CONTROL-BOARD WITH INDICATORS TO SHOW POSITIONS OF GATES, VALVES, ETC., AND MECHANICAL INTERLOCKING SYSTEM

In an article on the Panama Canal published in the April, 1913, number of MACHINERY, a general description of the electrical control system for operating the locks was given, and the ingenious mechanical interlocking system to prevent all dangerous combinations in the relative positions of gates, valves, etc., was also referred to. These control and interlocking systems constitute one of the most interesting features of the canal for the mechanical and electrical engineer, and now that they have been installed in the locks, we are able to present a more complete description. In order to clearly understand this control system, one must be familiar with the general arrangement of the locks, which were described in detail in the article referred to, published in the April number.

An electrically operated centralized control system was necessary owing to the size of the locks. For instance, the flight of locks at Gatun has a total length of approximately 6200 feet, and the principal operating machines are distributed over a distance of about 4000 feet, so that any form of mechanical transmission for controlling these machines would be almost impossible. The control-boards are installed in houses located on the middle lock walls at points which afford the best view of the locks. The position of the gates or other apparatus is shown by indicators on the control-board so that the operator does not need to actually see the various parts which he controls. The control-boards are, to some extent, miniatures of the locks themselves, and, with the exception of that machinery which only needs an "open" or "closed" indication, the indicating devices will act in synchronism with the movement of the lock machinery to which they are connected. One of these control-boards is shown in Fig. 1. It is a flat-top bench-board type, 32 inches high and 54 inches wide. The total length of these boards varies for different locks as follows: Gatun, 64 feet; Pedro Miguel, 36 feet; Miraflores, 52 feet. On top of the control-board, the side and center walls of the locks are represented by cast-iron plates and the water in the locks by blue Vermont marble slabs. The control switch handles are mounted above the surface of the board, as well as the various indicating devices.

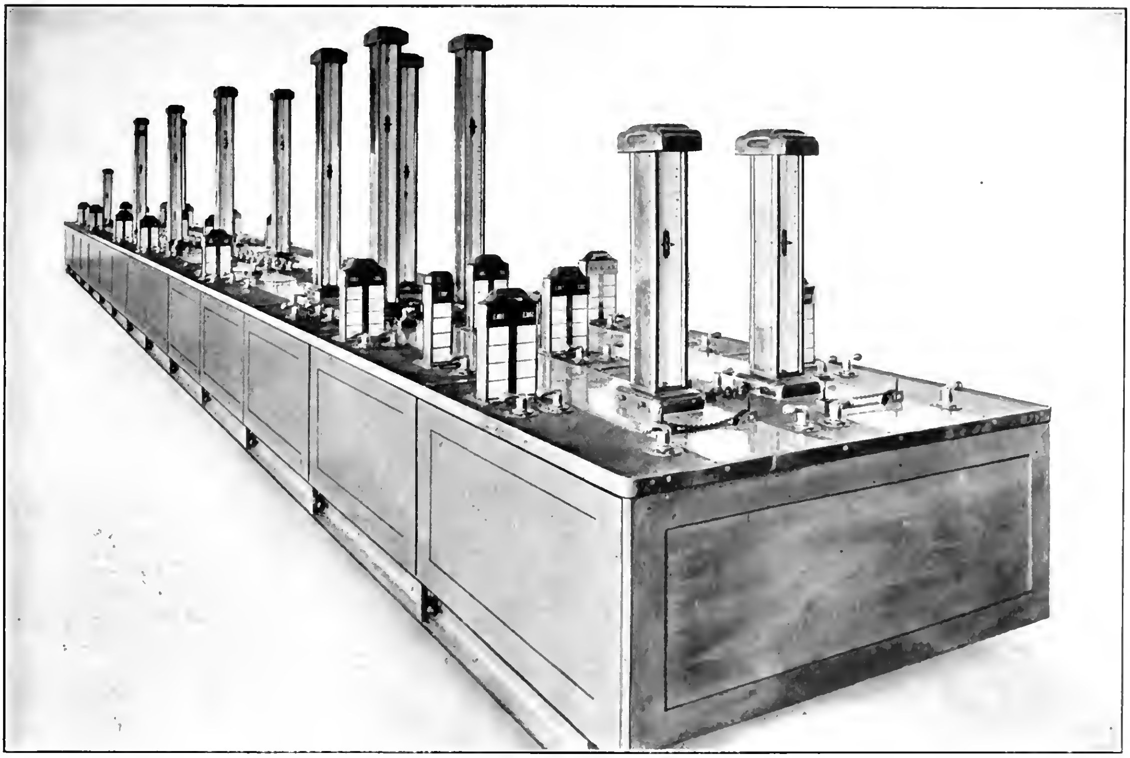

Fig. 1. Lock Control-board for Miraflores Locks of Panama Canal—The Water Levels in Different Chambers and Positions of Gates, Valves and Fender Chains are shown by the Indicators seen on Control-board

Operation of Control-board Indicators

A synchronous indicator for showing the movement of a lock member, has a transmitter located at and operated by the mechanism in the lock wall, and a receiver operating an indicator at the switchboard in the control house. Both transmitter and receiver have a stationary and a rotating part. The movement of the lock machinery and the connected transmitter rotor produces a field in the transmitter stator polarized in the direction of the rotor axis, which induces voltage in the stator coils. This voltage is transmitted by a three-phase connection to the receiver stator coils and duplicates in them, but in the reverse direction, the conditions of polarity and voltage in the transmitter. The rotor of the receiver being energized by the external source in the same direction as that of the transmitter, is reacted upon by the polarized receiver stator until the magnetic axes coincide and the rotors of both transmitter and receiver are in the same relative positions. Any difference in the position of the transmitter and receiver rotors causes a difference of potential between the stator windings, with a consequent flow of current, and resultant torque, which again moves the receiver rotor to the same relative position as that of the transmitter rotor. The receiver rotor follows closely and smoothly the movement of the transmitter rotor, and, consequently, imparts to the control-board indicator a movement identical with the movement of the lock machine, although on a reduced scale. A brief description of the different synchronous indicators follows:

Indicators for Lock Gates, Fender Chains and Valves

In the case of the lock gates, the vertical operating shaft is connected to a shaft which operates the transmitter machine. The latter shaft is threaded and carries a nut on which is mounted a rack. The rack engages a gear on the rotor shaft, and this turns the rotor as the gates operate. The mitering gate indicator (See Fig. 2) comprises a pair of aluminum leaves, shaped to correspond to a plan view of the gates. These leaves travel horizontally just above the top

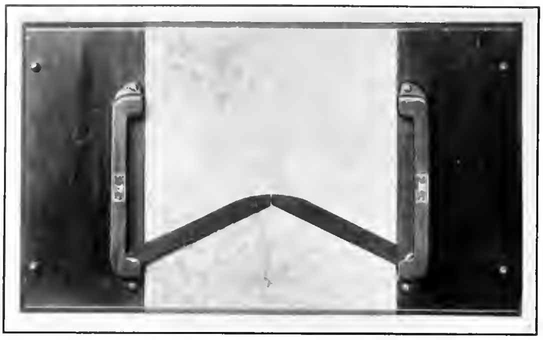

Fig. 2. Indicator used on Control-boards to show Positions of Lock Gates—The Indicator Leaves move in Synchronism with Lock Gates

of the board, the hinged ends being connected to shafts extending down through the board, where they are geared to the receivers by means of bevel gears.

For the chain fender, the position indicator transmitter is driven by the shaft operating the limit switch that controls the stroke of the piston for operating the chain. The indication on the board is given by a small aluminum chain, which, like the large chain, is raised and lowered, each end operating independently. Two of these chains may be seen near the right-hand end of the control-board in Fig. 1. The ends of the miniature chains are fastened to semaphore arms which are connected to segmental gears meshing with the driving gears on the receiver machines. As the receiver rotors turn, the chain is either lifted or lowered, the position of the large chain from the bottom of the lock being indicated by the angle of the semaphore arms.

As the gate valves which control the flow of water into the main feed culverts are in pairs to reduce the size of each valve, their position indicator machines are also in pairs. The transmitter rotor is driven by a shaft and gearing similar to that described for the lock gates. Each indicator is similar to a small elevator, a car being used to indicate the position of the gate valve. Both the front and back of the shaft is fitted with opaque glass marked with black lines for the one-quarter, one-half and three-quarter positions. A small aluminum cage moves up and down in each compartment. A drum for operating the cord which raises and lowers the cage is located underneath the control-board and is operated by the receiver through a suitable train of gears. To make the indications visible from points up and down the control-board, the elevator shaft under each car is always illuminated and the portion above is dark. These indicators are located on the cast-iron plates of the control-board, which, as previously mentioned, represent the side walls of the lock. (See Fig. 1.)

Water Level Indicators

The specifications for the water level indication required an accuracy of 1/20 foot in actual water level. In the transmitters and receivers for the machines described previously, the rotors turn less than 180 degrees with an inherent lag of 1½ per cent between transmitter and receiver rotors in this distance, which, obviously, prevents this arrangement from being employed to give the water level indication. The required accuracy was obtained by two sets of transmitters and receivers. One set is connected to a "fine" index in which the rotors make ten complete revolutions, and the other set is connected to a "coarse" index operating less than 180 degrees. The fine index is a hollow column carrying a pointer. The length of the column is such that when an aluminum ball representing the coarse index (which can be depended upon for coarse indication) is within the limits of the column, the reading of the fine index is correct within the limits specified. The scales are illuminated by lamps at the base and top of the indicator. These indicators, which may be seen in Fig. 1, are the tall column-shaped members mounted on the marble slabs. To operate the water level indicators there are wells 36 inches square in the lock walls, which communicate with the lock by a small opening at the bottom of the well. These wells contain steel box floats, 30 inches square by 9 inches deep. A non-slipping phosphor-bronze belt transmits the movement of the float to a sheave fitted with pins on the transmitter mechanism, the pins registering with holes punched in the belt.

The positions of the miter forcing machines (for locking the closed gates and forcing them together to make a good joint) are not indicated by synchronous indicators, but the open and closed positions are shown by red and green lights and a mechanical indicator on the control-board.

Mechanical Interlocking System

In order to make it necessary for the operator to manipulate the control-switch handles always in the proper order, corresponding to a predetermined sequence of operations of the lock machinery, and to prevent the operator in control of one channel from interfering with the machinery under the jurisdiction of the operator controlling the other channel, the control switches are provided with mechanical interlocks.

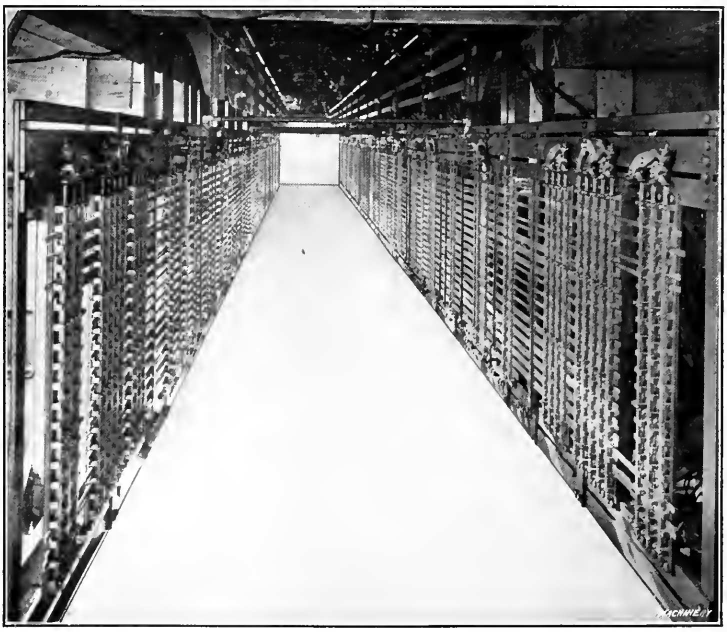

Fig. 3. Mechanical Interlocking Bars located beneath Control-board to prevent Dangerous Combinations in Relative Positions of Gates, Valves, etc.

The interlocks, which are shown in Fig. 3, are in two vertical racks under each edge of the board and some distance below, so that they may be inspected and oiled from a floor which is about seven feet below the floor on which the switchboard operator stands. Vertical shafts operated by connecting-rods from the control switch shafts extend downward past the electrical parts, for the operation of the interlocks. The interlock system is essentially a bell-crank mechanism, connecting the shaft of the control switch through a movable horizontal bar, to a vertical operating shaft which can or can-

not move, according to the relative positions of the interlocking bars and dogs. The interlocking system depends mainly on the action of engaging bevel dogs located on the horizontal and vertical bars, the movement of a horizontal bar tending to lift a vertical bar by bevels on the dogs. A horizontal bar cannot be moved without raising a vertical bar; thus, if at any time a dog on a horizontal bar rests against the upper end of a dog on a vertical bar, no movement of the horizontal bar where the dog engages with the vertical bar can take place, and the control handle connected to that particular horizontal bar is locked.

Interlocks prevent the chain fender from being lowered until adjacent lock gates have been opened, and also prevent the gates from being opened until the chain is in the raised position. In this way it is insured that the chain fender will always be in the up position to protect the gate when the gate is closed. After the lock gates are closed the miter forcing machine which locks the ends of the gates cannot be operated until the gates are closed.

The gate valves for the side wall culverts, next above or below a lock gate, must be closed while the miter forcing machine is open. As the miter forcing machine cannot be closed until the gates are closed, this means that the valves either above or below the gate must remain closed until the gate itself is closed, thus preventing the operator from creating a current of water around the gates while they are open, or are being opened or closed. This interlock is not included on the middle wall valves for the reason that they will be used with the locks on either side and must be free for that purpose.

The gate valves are not only installed in pairs, but each pair is in duplicate. One pair of duplicates is left open as a guard, or reserve pair, and the other is used for operating, so that in case of an obstruction in the culvert or accident to the machinery, the duplicate pair can be used. Either pair of gate valves may be opened first, at the choice of the operator, an interlock becoming effective when the first valve of the second pair of duplicates is opened. The control of these valves is interlocked so that if the valves are opened at one particular point, the valves a lock length upstream or downstream cannot be opened. Thus the operator is limited to equalizing the water between locks and cannot allow water to flow from the upper lock past the middle lock into the lower lock, which operation, if permitted, might flood the lower lock walls and the machinery chambers in them.

The cylindrical valves (which control the flow of water to the lateral feed culverts) are interlocked so that if those on one side are opened the ones on the other side are locked closed, and the opening of one switch on a side will lock the opposite ten. This prevents careless cross filling between locks, which operation might be combined with the regular method and produce flooding. However, there may be times when it is desirable to employ cross filling to economize in the use of water from Lake Gatun, in the cry season. For this reason this interlock is made removable by the use of a Yale lock and key. The key will be placed in the hands of the chief operator. In the use of the middle wall culvert, the cylindrical valves on one side or the other must be opened before the main gate valves can be opened, and the latter must be closed first. This interlock is applied in order to require the operator to control the flow of water by means of the gate valves rather than by the cylindrical valves.

In most cases the locks are divided into two unequal parts by intermediate lock gates. This arrangement makes it necessary to divide the ten cylindrical valves into two groups of seven and three, respectively, for the long and short lengths. A lever is provided for these interlocks and may be set as indicated by a nameplate on the lever to "three," "seven," or "ten," respectively; then the corresponding valves are subject to that interlock, and the others of the group of ten are locked closed if three or seven only are to be used. The failure of the operator to make his selection properly in advance will simply cause him the trouble of going back and doing so, as the remaining valves are locked closed. This arrangement permits handling small vessels without causing waste of water due to operating such vessels in the large chambers. If a short vessel were being passed downstream it would first enter the chamber having three cylindrical valves. The group selective lever would then be placed on the "three" position which would permit the opening of three valves above the intermediate gate, but would lock closed the other seven valves above it. After the vessel has been passed below the gate, the handle may be reversed releasing the lever and locking three switches. In case a large vessel is to be locked through, the interlocks on the intermediate gates can be made ineffective by the operation of a Yale lock which uncouples a clutch and disconnects the central switch from the operating mechanism.

To obviate the possibility of flooding the locks when valves are in a certain position, diagonal interlocking is introduced between the gate valves of the side wall and those of the middle wall a lock length away. This interlocking between valves diagonally across a lock when the cylindrical valves are open is needed to prevent the flow of water from, say, the upper lock by way of a side wall culvert to the middle lock, thence by way of the middle wall culvert to the lower lock, thus allowing an operator through carelessness to flood the lower lock walls. If the cylindrical valves of a certain lock are closed, the interlock is not needed on the gate valves of that lock; and since such interlock would interfere with the proper use of the valves of its twin lock on the other side of the middle wall, this interlock is automatically removed when all ten cylindrical valves are closed on the particular lock in question, and is automatically applied again if one or more of the ten cylindrical valves is opened. Furthermore, the valves of the side wall immediately at the gate which is being moved, will be open to equalize the water level, and diagonal interlocking will prevent the opening of the middle wall valves a lock length above or below the gate being moved. Each of the four valves of such a group has independent control, their control switches being so interlocked that either pair may be opened and left open as guard valves, the interlocks becoming effective when the operator tries to open the first valve of the second pair. In addition to these pairs of valves in parallel, each pair is duplicated at each change of level from one lock to the next.

All of the lock machinery motors, control panels, centralized control-boards, power station generating apparatus, switchboards, transmission line substation equipments, etc., were manufactured by the General Electric Co. The specifications for the entire generating, lock-controlling and distribution system for operating the Panama Canal were prepared under the supervision of Mr. Edward Schildhauer, electrical and mechanical engineer, Isthmian Canal Commission, assisted by a staff of able electrical engineers.

* * *

A remarkable exhibition of engine endurance was recently made by the Moline Automobile Co. in New York City under the auspices of the Automobile Club of America. A Moline-Knight four-cylinder motor was put on the testing block late in December and run continuously for two weeks—336 hours—without adjustment of the motor, carbureter, spark plugs or magneto at 1100 revolutions per minute. It developed thirty-eight horsepower and ran at a rate that would have carried it 14,700 miles on the level at forty-five miles an hour. It would have steadily climbed an eight per cent grade 10,000 miles long at twenty-seven miles an hour, or a mountain 800 miles high. At the end of the run the speed was increased to 1682 revolutions per minute for one hour, developing 53.6 horsepower. The engine was then taken apart and exhibited at the Auto Show. The parts showed very little evidence of wear. The test demonstrated that a properly proportioned motor well lubricated should have a long life and that it is the most dependable part of the modern motor car.

* * *

A petition has been presented to the German Reichstag, signed by some two hundred and fifty commercial and industrial organizations, asking their government to take steps toward the introduction of a universal international two-cent letter postage, and to endeavor to have this adopted by the International Postal Congress in Madrid next year.

CUTTING POWER OF LATHE TURNING TOOLS*†

INFLUENCE OF SPEED, DEPTH OF CUT, FEED, SHAPE, AND PHYSICAL PROPERTIES OF METAL

The question of the definite measure of the output of work or removal of material of which lathe tools are capable, is one about which there is very little information readily available, and it it was for the purpose of determining the performance of cutting tools over a fairly wide range of working conditions and of deducing therefrom some practical results that the experiments described in the following were made. The object of the tests was to determine to what extent the output of both high-speed and ordinary carbon-steel tools is affected by such elements as cutting speed, depth of cut, feed of tool, shape of tool nose and physical properties of the metal upon which the cutting tool is acting. The question of the association of a high speed and a light cut *versus* a low speed and heavy cut received particular consideration in order to find the relation between these two factors and the maximum output.

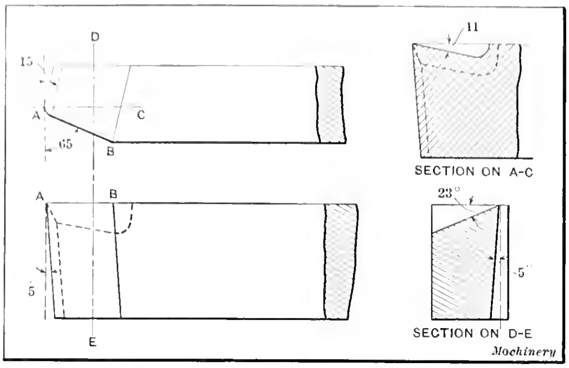

Fig. 1. Standard Shape of Tool used for Tests

Owing to the extensive use of turning tools of high-speed steel at the present time, especially when the cutting speed is an important consideration, the results of the tests made with carbon-steel tools have been omitted in this abstract.

Tools used for Tests—Test-bars

The high-speed steel tools tested were made from ¾- by ½-inch bars and were about 8 inches long. The shape of the tool used for the first series of tests is shown in Fig. 1. The tools were of high-grade steel and the ends were shaped entirely by grinding in a universal tool grinder. They were then hardened according to the directions of the maker. These tools were of the same shape and size as those used for the carbon-steel tool tests so that the results in each case could be compared.

TEST-BARS FOR HIGH-SPEED STEEL TOOL TESTS

Physical Properties

Letter of Identification	Breaking Load in Tons per Square Inch	Elongation, Per Cent	Compressive Load in Tons per Square Inch
A	27.2	28.4	81.2
B	33.5	21.7	90.0
C	50.5	12.0	126.4

Chemical Composition

Letter of Identification	Carbon	Silicon	Manganese	Sulphur	Phosphorus	Grade of Steel
A	0.29	0.100	0.42	0.037	0.028	Mild
B	0.39	0.075	0.50	0.030	0.038	Medium
C	0.60	0.249	0.83	0.053	0.030	Hard

Machinery

The tests were made on a large electrically driven experimental tool-testing lathe installed in the machine tool laboratory of the University of Sheffield. The test-bars were three in number and of different chemical compositions and physical properties, as shown by the accompanying table.

Their approximate original dimensions were: Length, 9 feet 6 inches; diameter, 1 foot 8 inches. The meaning of the identification letters is as follows: A, mild steel; B, medium steel, and C, hard steel.

With the high-speed steel tools it was found possible to obtain a definite point at which the tool failed to cut; this is the point at which the cutting edge collapses, and instead of continuing to cut causes the surface of the bar to become polished. The exact instant at which each tool broke down or began to produce this polished surface was observed and from this the durability of the tool was determined. (The method adopted for carbon-steel tools involved a microscopic examination of the cutting edge to determine the amount of bluntness or wear, this being found the only possible way of establishing a standard for measuring the working life of the tool.)

Standard for Duration of Test

One hour was selected as a convenient value for the standard life of the tools used in these tests, although in machine shops high-speed tools usually run a much longer period than this before resharpening, and the curves of performance seem to suggest that this practice has a reasonable basis, since the cutting speed which corresponds to a life of sixty minutes is, in practically every case, only about 5 or 10 per cent greater than that which will allow a tool to last for three or four hours.

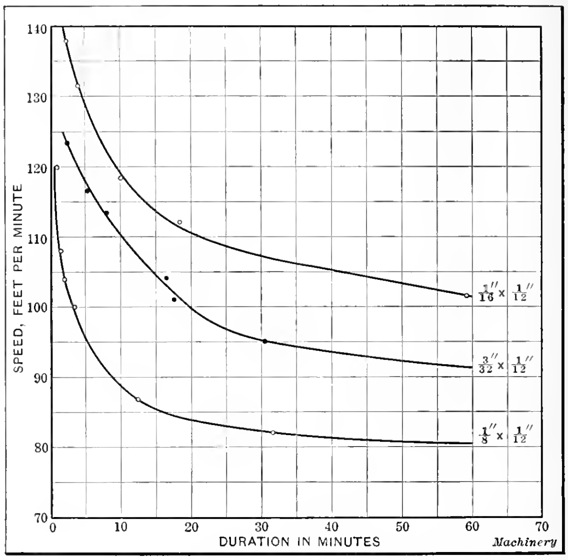

Fig. 2. Cutting Speed and Duration Tests for Varying Areas of Cut—High-speed Tools cutting Mild Steel

The failure of a high-speed turning tool working under normal conditions is, in most cases, brought about by the fusing of the nose due to the heat generated as the result of friction. The friction is due to the rubbing of the chip on the upper lip of the tool as it passes off from the work. This rubbing action frequently causes a pit or hollow to be worn out of the upper face or lip of the tool just in front of the cutting edge. There is also friction due to the cutting action of the tool as it traverses the work in a line parallel to the axis. When the tool is worked under conditions which are not excessively severe, the heat generated at the nose of the tool is conducted away as fast as it is generated, and thus the nose is not subjected to overheating; but if the cutting speed

* Abstract of paper presented before the Institution of Mechanical Engineers, at Manchester and London, by Prof. William Ripper and G. W. Burley of the University of Sheffield.

† See also the series "On the Art of Cutting Metals," published in MACHINERY from January to August, 1907, inclusive.

and area of cut are such as to generate heat faster than the tool can conduct it away, fusing and breakdown at the nose takes place. Moreover, as the work proceeds, the tool accumulates heat from the nose backward, and the rate of flow or conduction of the heat away from the nose correspondingly decreases, with an increasing tendency to accumulation of heat at the nose.

The data taken during the tests include the circumferential or cutting speed, the depth of cut, the feed per revolution, the power-input to the motor on light load at the cutting speed selected, the time of starting the cut, the power-input to the motor during the actual cutting, and the time at which the tool failed. The tools were tested for the following areas of cut on each bar. Depth of cut, 1/16, 3/32 and ⅛ inch; feed per revolution for each depth of cut, 1/30, 1/20, 1/12 and 1/8 inch, respectively.

Relation between Cutting Speed and Durability of Tool

Altogether, about two hundred tests were made, the duration of each test varying from one minute to 70 minutes.

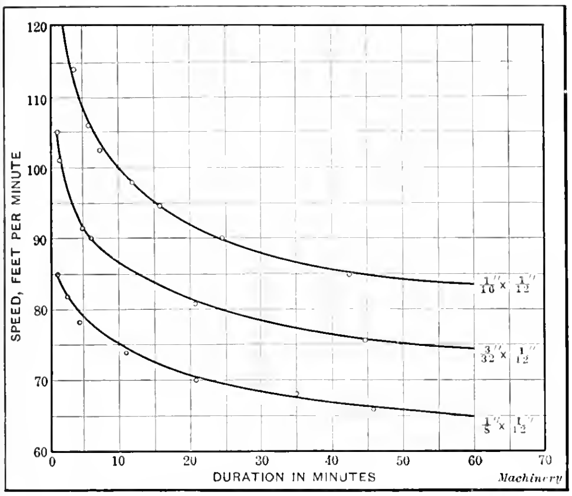

Fig. 3. Cutting Speed and Duration Tests for Varying Areas of Cut—High-Speed Tools cutting Medium Steel

For each area of cut or combination of depth of cut and feed per revolution, data for a cutting-speed-duration curve were obtained and the curves shown in Figs. 2, 3 and 4 were plotted. Fig. 2 is for mild steel (Bar A); Fig. 3 for medium steel (Bar B); and Fig. 4 for hard steel (Bar C). The curves are for a feed of 1/12 inch per revolution of the test-

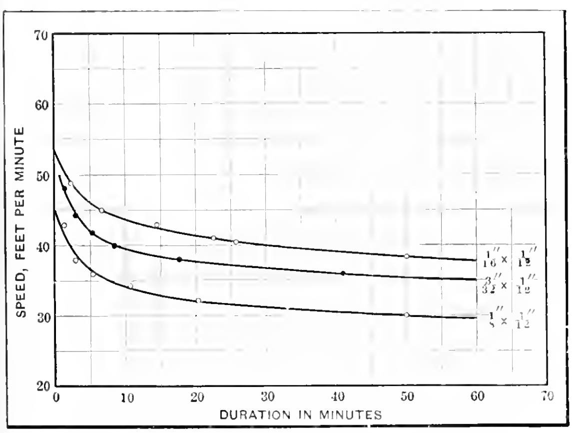

Fig. 4. Cutting Speed and Duration Tests for Varying Areas of Cut—High-speed Tools cutting Hard Steel

bar, the depth of cut, in each case, being given at the end of the curve. These curves show the effects of the hardness of the bar and area of the cut on the cutting speed, and the relation between the cutting speed and the life of the tool up to the point of failure. They further indicate that at high cutting speeds the durability of the cutting edge is very short, but that, as the rate of cutting is reduced to a speed which gives a durability of 40 or 50 minutes, the tool then continues to cut for a more or less indefinite period as indicated by the change of the curves toward the horizontal. If this speed,

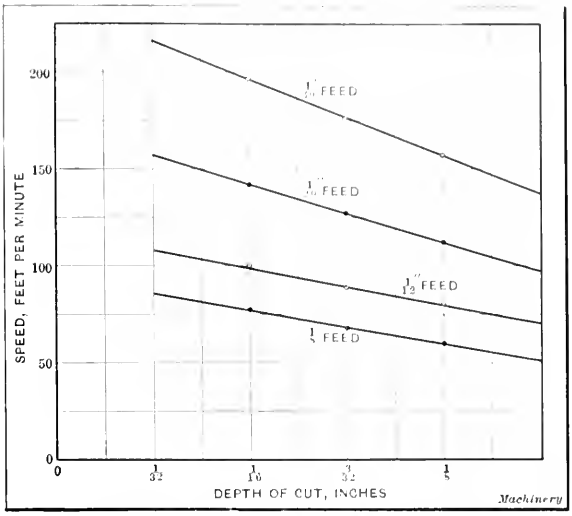

Fig. 5. Relation between Cutting Speed and Depth of Cut for Varying Feeds—Standard Life of Tool, Sixty Minutes

however, is exceeded by from 10 to 15 per cent, the life of the tool is rapidly shortened. The average relation between the cutting speed *S* and the life of the tool *M*, in minutes, for any given area of cut between durations of 10 and 60 minutes, is represented approximately by the formula:

$$SM^{\frac{1}{12}} = \text{constant.}$$

The value of the constant depends upon the quality of the steel being turned and upon the area of the cut. The relation between these two quantities, as determined by Mr. F. W. Taylor, for high-speed turning tools is

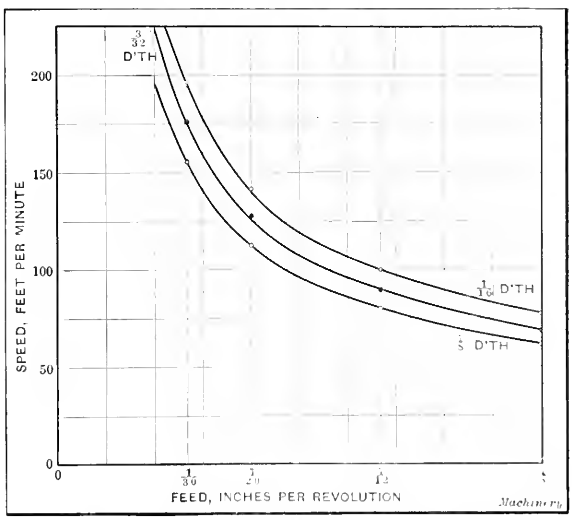

Fig. 6. Relation between Cutting Speed and Feed for Varying Depths of Cut—Standard Life of Tool, Sixty Minutes

$$SM^{\frac{1}{8}} = \text{constant.}$$

Relation between Cutting Speed and Area of Cut

For each test-bar, the relation between the cutting speed and the associated area of cut for a standard life of 60 minutes was determined, the data in regard to the cutting speed being drawn from the curves of which Figs. 2, 3 and 4 are representative. Contrary to the experience and views of Dr. Nicolson, and in agreement with those of Mr. F. W. Taylor, it was found that the cutting speed did not depend only upon the area of cut, independently of its component factors, but that it also depended upon the depth of cut and

feed per revolution, in two different ways, as shown by the curves Figs. 5 and 6. Fig. 5 shows the relation between the cutting speed, for the standard tool life, and the depth of cut for the various speeds adopted; whereas Fig. 6 shows the relation between the cutting speed and the feed per revolution for varying depths of cut, the curves referring to test bar A in each case.

By referring to Fig. 5, it will be seen that a cut 1/8 inch deep, with 1/20 inch feed, is taken at a greater cutting speed than a cut 1/16 inch deep with 1/10 inch feed, which is of equal area but less efficient as to output. A similar deduction can be made from Fig. 6, where it will be seen that a cut 1/8 inch deep with 1/24 inch feed is taken with a cutting speed of 125 feet per minute, whereas for a cut 1/16 inch deep with 1/12 inch feed the speed is 100 feet per minute. Some explanation of this is indicated by the illustrations *A* and *B* in Fig. 7. In each of these views a tool having a nose of standard shape is represented taking a cut, the area of which is the same in each case. At *A* the depth is one-half that at *B*, but the feed per revolution is twice as great. It will be noticed that the length of the cutting edge which is in contact with the work at *A* is considerably less than at *B;* hence, in the latter case there is a much larger cooling area back of the cutting edge to conduct the heat away as it is generated. Therefore, other things being equal, the rise in temperature of the cutting edge, in the second case, will not be so rapid as in the first; hence, a higher cutting speed can be employed with the tool having a longer cutting edge in contact with the work.

Output of Turning Tools

The standard output of a turning tool is defined in these tests as the number of cubic inches which the tool will remove during the standard life of 60 minutes. The maximum output or removal of metal is associated with the lowest cutting speed with which, for a standard life of 60 minutes, the heaviest depth-feed combination is associated; the greater influence is, of course, on the side of the depth. Thus, with a depth of cut of 1/8 inch and a feed of 1/20 inch per revolution, the volume of metal removed in 60 minutes is 504 cubic inches, whereas, with a 1/16-inch cut and 1/10-inch feed the output is 405 cubic inches per hour. This shows a gain of about 25 per cent in favor of the deeper cut with a reduced cutting feed. This law applies generally to all the bars and speed-depth-feed combinations; hence it may be stated that for the maximum tool output, the area of cut is

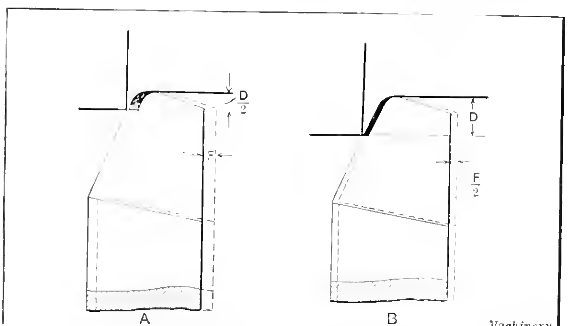

Fig. 7. Diagram showing Effect of Depth of Cut and Feed on Length of Cutting Edge in contact with Work

a maximum which the tool will stand without fracture, with the depth of cut a large factor and the associated speed correspondingly low.

To determine the effect of a change in the relation between the cutting edge of the tool and the axis of the test-bar, tools having shapes as indicated by the dotted and full lines in Fig. 8 were used. The same conditions as to the test were adopted in each case. It was found that for a given depth of cut the cutting speed was directly proportional to the length of the cutting edge of the tool in contact with the work; that is, a proportionately greater output with a tool having a longer cutting edge was obtained. In all other respects the angles of the tools were the same.

For an area of cut 1/8 inch by 1/12 inch, the cutting speed which would allow a tool to last one hour was found to be 78 feet per minute for high-speed steel, and 8 feet per minute for plain carbon steel, on a bar having a tensile strength of about 25 tons per square inch; that is, the high-speed tool removed ten times as much metal as the plain carbon tool in a given time.

Relation of Motor Power to Output

To determine the relation existing between the area of cut, the speed and the actual horsepower required, tests were made on different bars with various depths of cut and feeds and their associated cutting speeds. The power consumption was obtained by taking voltmeter and ammeter readings when the cut was in and also when it was not in, the speed being the same in each case. The net horsepower or power required for the actual cutting was calculated from the difference between the two readings. The results showed that the actual net horsepower required to remove a given number of cubic inches per hour is a constant for each quality of steel machined. In other words, the output per horsepower-hour is practically a constant quantity; that is, for a given output per hour nothing is gained in net power consumption by altering the ratio of the area of cut to the speed of cutting, the net horsepower being approximately directly proportional to the output only.

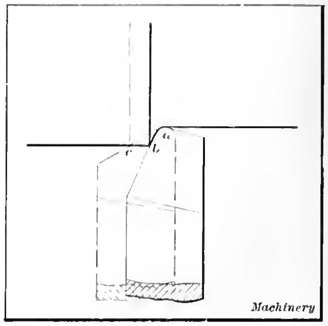

Fig. 8. The Tests showed that a Tool with a Short Cutting Edge a-b in contact with the Work cannot be used with as High a Cutting Speed as a Tool having a Longer Edge as at a-c

* * *

A SUGGESTION SCHEME

About two years ago the Automatic Electric Co., manufacturer of automatic telephone apparatus, Chicago, Ill., adopted a suggestion plan for its employes which has worked out satisfactorily. A suggestion form is supplied upon which all foremen are required to report at least once a week. They may send in one or a dozen of these forms, but one is the minimum, and it must either give a suggestion or the words "No suggestion to make this week." When a suggestion is received, the factory superintendent notes it and refers it to an engineer, who makes an investigation. The engineer obtains opinions from the employes affected and reports as to the changes in equipment necessary to put the plan into operation, giving an estimate of the saving that would result. With these data, the suggestion is returned to the factory superintendent for approval or rejection. A notice is then sent to the maker of the suggestion, advising him of the action taken and informing him of the reasons if his suggestion has been rejected.

During the past six months a modification of the plan has been tried, whereby a special subject for suggestions during certain periods is announced. The employes are informed that while suggestions on any subject will be appreciated, special attention is invited to the one named. The following subjects have been dealt with in this way. 1. Safety First. 2. Water, Light, Power and Gas. 3. Bonus Work. 4. Care of Materials. 5. Inspection. 6. Material and Finish. 7. Scheduling Work, Chasing, Requisitioning and Transferring Stock.

Substantial benefits have been realized from the suggestion plan, for while the company's plant was planned and systematized by efficiency experts of recognized ability, it has been found that the "man on the job" is often able to improve the details of the general system, thus materially adding to the efficiency of the methods employed and eliminating many causes of waste and expense. The plan has the additional value of giving employes a keener interest in their work and providing a useful channel for the criticisms always offered by workmen.

GAGING WATCH ESCAPEMENTS*

A COMPLETE SET OF GAGES FOR WORK OF UNUSUAL REFINEMENT

BY DOUGLAS T. HAMILTON†

The detached lever escapement is considered by horologists to be one of the most difficult parts of a watch movement to manufacture, because of the important function it fills in the proper timing of a watch. It transforms the rotary motion of the train of wheels into the vibratory movement of the balance, and at the same time acts as a brake to prevent the watch mechanism from "running away," retarding the motion of the wheels, and imparting the correct movement to the hands on the dial. To design an escapement properly requires not only considerable experience in this work, but also a clear understanding of the functions that this important part of a watch has to fill. The conditions are never ideal, so a compromise must always be made in order to obtain an escapement which fills the most important requirements.

As the functions and requirements of a watch escapement were described in an article on "Watch Movement Manufacture—1" which appeared in the May, 1912, number of MACHINERY, it will not be necessary to enlarge on them here, the chief aim of this article being to illustrate and describe the manner in which theoretical requirements obtained by calculation are brought down to a practical working basis. This is the problem with which horologists always experience difficulty. Drawings are first made on a scale of fifty to one, and all dimensions are obtained mathematically where possible. Reducing and producing a watch escapement with the accuracy defined by a mathematical calculation is not an easy matter.

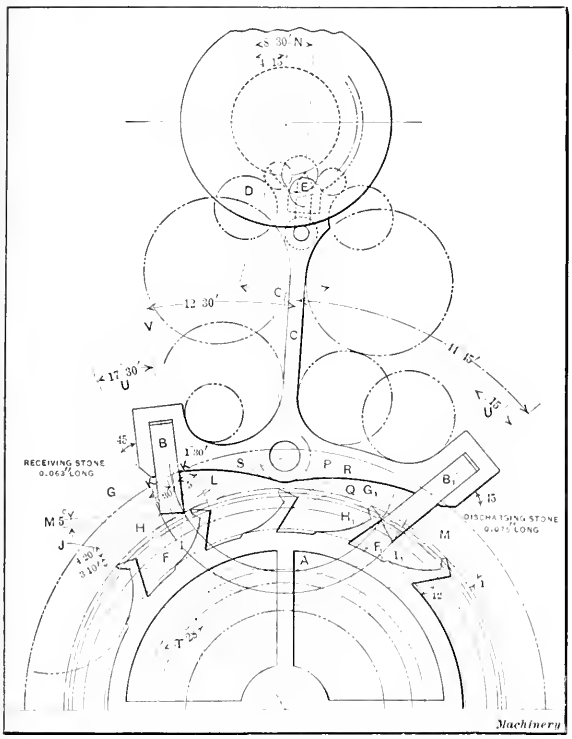

Fig. 1. Diagram illustrating Method of analyzing a Detached Lever Watch Escapement

The first step in producing a watch escapement, as mentioned, is to lay it out on paper on an enlarged scale of fifty to one, and then by means of certain parts outlined on tracing cloth, to study the movements in the manner that they take place in the watch. The proper manufacture of an escapement does not end here, and in fact the most difficult work—producing the various parts correctly—is still to follow. Several schemes are adopted in different watch making plants to check up the machining operations in order to determine whether they have been properly executed or not.

The Projector Method

One method which is used to a considerable extent is to employ a projector (an instrument designed on the principle of the magic lantern) to project and enlarge the escapement in order to determine if the machining operations have been correctly done. The escapement to be projected is placed on a pane of glass set in the frame of the projector where it is held flat against the surface of the glass by a spring. The projector is then placed in a dark room in such a relation to a screen as to obtain an enlargement of the escapement of ten diameters. The screen used generally consists of a sheet of drawing paper and the outine of the projected escapement is traced with a pencil. This sheet is then removed and the various functions, angles, etc., of the escapement are measured on this enlarged scale. The drawing paper may be replaced by a photographic plate and a photograph taken, but this process requires considerable time and is very seldom used except in horological schools, when a large number of copies are to be distributed to the pupils to study. Manufacturers, as a rule, simply make a drawing of the projection.

Fig. 2. Gage for measuring Different Angles on the Escape-wheel Teeth

The Microscope with Illuminated Chamber

The second method consists of a microscope with an illuminated chamber, mounted in such a manner as to give an enlargement of ten diameters and provided with a prism and a mirror, enabling the object to be set outside the microscope in order that its projection may be traced. The microscope is furnished with a screw, the barrel of which is provided with 100 divisions and enables measurements to be obtained to one thousandth millimeter. The lever escapement thus enlarged ten times with the aid of the microscope is then analyzed. The calibrated screw is used to check up the dimensions.

Method of Gaging Escapements Employed by the South Bend Watch Co.

The third method, and the one to be described here, is that used by the South Bend Watch Co., South Bend, Ind. This method consists in using gages which are very accurately made for measuring the various functions and members of a watch escapement. While the two methods previously described would seem to be scientific in their exactness, there is always a question in the mind of the mechanic as to the practicability of this procedure in work of an interchangeable character. There is little, if anything, to be gained by using methods of measurement which are much more accurate and worked down to greater degree of refinement than it is possible to obtain when manufacturing the parts on a commercial basis. For instance, by means of the microscope and illuminating chamber it is possible to obtain dimensions to within one thousandth millimeter. To duplicate this ac-

* For information on watch making previously published in MACHINERY, see "Watch Movement Manufacture" in the May and June, 1912, numbers, and articles there referred to.
† Associate Editor of MACHINERY.

curacy on thousands of parts produced with cutters in a mechanically operated machine is practically an impossibility. One piece could probably be made, but the slightest wear on the cutters would mean that this refinement would be lost. Gages can be made of sufficient accuracy to check up any variations in the work that may occur due to the wear of cutters or improper setting. Furthermore, the gages are at all times at hand to test the parts and determine just as soon as a slight error creeps in. If gages were not furnished it would be necessary to test the parts at short intervals as previously described, which would not only be impracticable but would not fill the requirements of the case.

In order to make the following description of the gages clear, reference should be made to Fig. 1 in which the various members of a detached lever escapement that require consideration are clearly outlined. These various members are indicated by letters, the functions and names of which are as follows: *A*, escape-wheel; *B*, receiving pallet stone; B_1, discharging pallet stone; *C*, fork; *D*, roller; *E*, impulse pin; *F*, impulse face of receiving stone; F_1, impulse face of discharging stone; *G*, locking face of receiving stone; G_1, locking face of discharging stone; *H*, locking corner of receiving stone; H_1, locking corner of discharging stone; *I*, releasing corner of receiving stone; I_1, releasing corner of discharging stone; *J*, lift of pallet; *K*, circular impulse; *L*, drop; *M*, lock; *N*, arc of impulse fork; *O*, arc of impulse of roller; *P*, impulse face of escape wheel tooth; *Q*, locking face of escape wheel tooth; *R*, locking corner of escape-wheel tooth; *S*, releasing corner of escape-wheel tooth; *T*, locking angle of escape-wheel tooth; and *U*, draft angle of pallet stone.

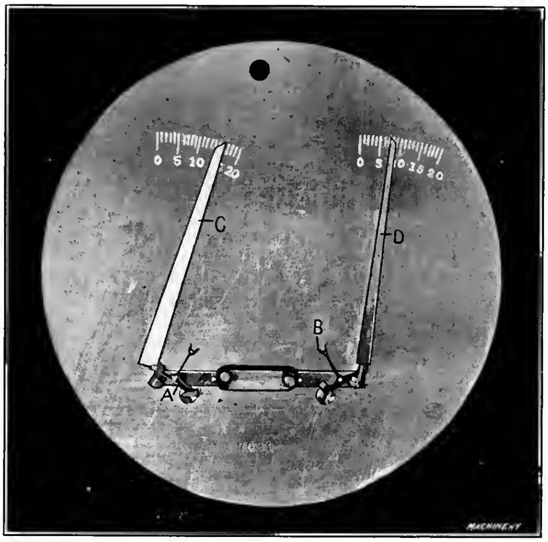

Fig. 3. Gage for measuring Position of the Forks, Pallet Stones, etc., of Detached Lever Escapement

Each one of these conditions and functions of the detached lever escapement must be checked up after machining in order to determine if the requirements secured by graphic methods and mathematical calculations have been obtained. The first gage which is used is shown in Fig. 2; the object of this is to measure the different angles on the escape-wheel teeth. It measures the angle that the impulse face *P* of the escape-wheel tooth makes with a tangent to the periphery of the escape-wheel at the releasing corner *S*; it measures the angle that the locking face *Q* of the escape-wheel tooth makes with a radial line drawn from the center of the wheel to the locking corner *R*, and it also measures the periphery diameter of the escape-wheel teeth. Straightedges *B* and *C* are used to measure the angles of the escape-wheel teeth and are set by plugs placed in the centers of the recesses, the radii of these plugs being the sines of the angles to be measured. When it is stated that one ten-thousandth inch of variation can be clearly indicated on a gage provided with knife-edge straightedges similar to that furnished on this gage, it will be evident that this method of gaging is practically as exact a method as it is possible to obtain; at least, it is close enough to check up any errors in machining which would affect the efficient working of the escapement.

The circular gage shown in Fig. 3 in which two forks *A* and *B* are located on pins is used with the aid of straightedges *C* and *D* to measure the draft angle *U* of the pallet stone, and also the angle that the impulse face of the stone makes with a line *V* passing through its center. (See Fig. 1.) This gage also measures the distance from the center of the pallet to the locking corners *H* and H_1 and the releasing corners *I* and I_1 of the pallet stones. It will be seen in this particular case that the draft angle of the receiving stone measures 15¾ degrees, and the draft angle of the discharging stone 7¼ degrees.

The third circular gage shown in Fig. 4, upon which the completed escapement is held, is used for the following measurements; Impulse face *F* and F_1 of pallet stones; the drop *L*; the lock *M*; the arc of impulse *N* of the fork; the arc of impulse *O* of the roller; the recoil of the escape-wheel in unlocking the slide or run of the escape-wheel; and the side shake of the impulse pin in the fork slot. These circular impulses of both wheel teeth and stones are taken as angular measurements from the center of the escape-wheel. The three needles, the correct positions of which are indicated on this gage, give readings as follows: The circular impulse of the

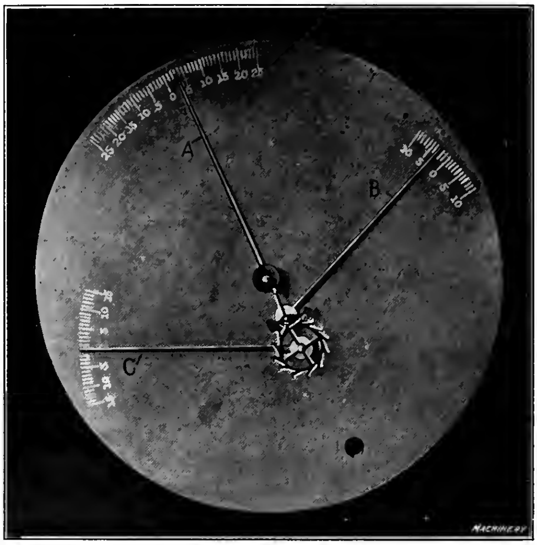

Fig. 4. Gage for measuring a Complete Assembled Escapement

pallet stone is 5½ degrees; the circular impulse of the wheel tooth 5 degrees; the drop ½ degree; and the lock 1 degree. The positions of the needles *A*, *B* and *C*, as shown in Fig. 4, have a meaning only when compared with their positions before the action of the escapement took place. The office of these needles, therefore, is to measure the angular distance at the beginning and at the end of each action.

By the use of these three gages all the functions of the detached lever escapement that it is desirable to know may be measured. An escapement can be taken from a watch and measured at every particular point. Furthermore, these gages are not made until an escapement has been produced which works as efficiently as it is possible to make it; then the various parts of the escapement are removed and the gages made to them, ideal conditions being realized in this way. It is also possible by the use of these gages to construct a perfect working escapement from a very much enlarged drawing with the positive assurance that it will be an exact miniature. This latter method, looking at it from a mechanical standpoint, would appear to be much more practical and exact than those previously described.

* * *

Telegraph poles of glass are being used in Germany with success. Woven wire is imbedded in the molten glass to reinforce the pole.

PROFIT-SHARING PLAN OF FORD MOTOR CO.

Probably no wage change made by a manufacturing concern has ever attracted more widespread attention than the profit-sharing plan of the Ford Motor Co. of Detroit, Mich. Henry Ford, head of the company, announced January 5 that his company would give to the employes $10,000,000 of the profits of the 1914 business, the payments to be made semi-monthly and added to the pay checks.

The factory will be run continuously instead of only eighteen hours a day, giving employment to several thousand more men by employing three shifts of eight hours each, instead of only two nine-hour shifts, as heretofore. A minimum wage scale of $5 per day will be established. Even the floor sweepers are included. Before any man in any department of the company who does not seem to be doing good work shall be discharged an opportunity will be given to him to try to make good in every other department. No man shall be discharged except for proved unfaithfulness or irremediable inefficiency.

The company's financial statement of September 20, 1912, showed assets of $20,815,785.63 and surplus of $14,745,095.57. One year later it showed assets of $35,033,919.86 and surplus of $28,124,173.68. Dividends paid out during the year, it is understood, aggregated $10,000,000. The indicated profits for the year, therefore, were about $37,597,312. The company's capital stock, authorized and outstanding, is $2,000,000. There is no bond issue.

About ten per cent of the employes, boys and women, will not be affected by the profit sharing, but all will have the benefit of the $5 minimum wage. Those among them who are supporting families, however, will have a share similar to the men of more than twenty-two years of age. In all, about 26,000 employes will be affected. Fifteen thousand are now at work in the Detroit factories. Four thousand more will be added by the institution of the eight-hour shift. The other seven thousand employes are scattered all over the world, in the Ford branches. They will share the same as the Detroit employes.

"It is our belief," said James Couzens, treasurer of the company, "that social justice begins at home. We want those who have helped us to produce this great institution and are helping to maintain it to share our prosperity. We want them to have present profits and future prospects. Thrift and good service and sobriety, all will be enforced and recognized. Believing as we do that a division of our earnings between capital and labor is unequal, we have sought a plan of relief suitable for our business. We do not feel sure that it is the best, but we have felt impelled to make a start, and make it now. We do not agree with those employers who declare, as did a recent writer in a magazine in excusing himself for not practicing what he preached, that 'movement toward the bettering of society must be universal.' We think that one concern can make a start and create an example for other employers. That is our chief object."

"If we are obliged," said Mr. Ford, "to lay men off for want of sufficient work at any season, we purpose to so plan our year's work that the lay-off shall be in the harvest time, July, August and September, not in the winter. We hope in such case to induce our men to respond to the calls of the farmers for harvest hands, and not to lie idle and dissipate their savings. We shall make it our business to get in touch with the farmers and to induce our employes to answer calls for harvest help. No man will be discharged if we can help it, except for unfaithfulness or inefficiency. No foreman in the Ford Motor Co. has the power to discharge a man. He may send him out of his department if he does not make good. The man is then sent to our 'clearing house,' covering all the departments, and is tried repeatedly in other work, until we find the job he is suited for, provided he is honestly trying to render good service."

It is impossible for anyone to accurately predict what the ultimate effect of this remarkable profit-sharing plan will be on the industrial conditions of the United States. Let us hope that it marks the dawning of a brighter day when labor and capital will share more equally in the profits of industry, but that such a consummation will directly follow is very doubtful. Whatever follows, one fact stands out clearly: The Ford Motor Co. has stamped itself and its product indelibly upon the minds of all classes the country over.

* * *

BRIEF HISTORY OF THE MOTOR CAR

An interesting description of early types of motor cars, and the industry's development from the seventeenth century, has been written by Walter H. Whiteside, president of the Stevens-Duryea Co. An abstract of the article follows:

The first experiments with "horseless carriages" that met with any degree of success were made in the seventeenth century, when Johann Haustach of Nuremberg constructed a carriage propelled by springs. There was no steering device, but the car would travel in a straight line when wound up. During the same period vehicles to which sails were attached were used in Holland. In 1619 another spring-driven carriage referred to in the patent paper as a "cart without horses," was patented in England, and in 1644 a French patent was issued on a four-wheel carriage propelled by foot-power. In 1748 a carriage driven by clockwork was exhibited before Louis XV of France. Several others experimented with spring drives up to the year 1800, but with little success.

Steam was first used in a road carriage in Pekin, China, in the year 1630. History credits Father Verbiest, a missionary, with achieving this feat. This was followed in 1680 by Sir Isaac Newton's steam carriage. In 1769 a steam gun carriage was built in France. It had three wheels, was driven by a two-cylinder engine, and traveled three miles per hour when loaded with 2½ tons. In 1787, Oliver Evans of Maryland invented a steam road wagon, and Nathaniel Reed, in 1790, constructed a combined road wagon and boat at Pecousic, Mass. These two men were the first ones to build steam carriages in this country that would successfully propel themselves. The first steam carriage in which the crankshaft was geared to the driving wheel was invented by Richard Trevithick in England in 1802. In 1831 a steam-driven carriage was operated between Cheltenham and Gloucester, England. This carriage could run twelve miles an hour, but the service was discontinued after four months, owing to public opposition. Walter Hancock established a steam omnibus line in 1829. His was the first chain transmission vehicle invented. In 1836 five of these carriages were operated between Paddington and Stratford, and, in twelve weeks, 12,760 passengers were carried. This line was practically forced out of business by the English government, because of a toll law with taxes so high that none could afford to run cars. This law arrested further development of the horseless carriage until its repeal in 1846.

In France in 1880 a steam carriage was built which, as late as 1895, ran 745 miles in 90 hours. In 1886 the first gasoline engines were used on road vehicles. These were the invention of Carl Benz and Gottlieb Daimler of Germany. In 1889 a two-cylinder engine was invented by Daimler; Messrs. Panhard and Levassor of Paris immediately acquired the patents and built around the engine the first gasoline motor car. The Panhard car was quickly followed by the Renault Freres and the Benz. To J. Frank Duryea belongs the distinction of being the first American to turn out a successful motor-driven vehicle. The first car was completed at Springfield, Mass., in 1891, and was equipped with a one-cylinder motor. In 1894 a vehicle propelled by a two-cylinder engine was built.

In view of the present magnitude of the automobile industry, it hardly seems possible that the first automobile factory in the United States was started only twenty-two years ago, this being the factory established by J. Frank Duryea at Springfield, Mass. Today there are over 500 factories with an estimated annual output of 350,000 cars.

* * *

The turbines which will drive the new mammoth Cunarder *Aquitania* will have a total weight of 1400 tons. There are over a million turbine blades in the rotors, the combined length of which is about 140 miles. The blades vary in length from 1½ to 20 inches.

A VISIT TO THE WINDSOR CLUB

It was real winter when I stepped from the train in Windsor, Vt., up among the Green Mountains. Ten inches of snow lay upon the ground and the thermometer was slowly climbing to the zero point from six degrees below. On the way over to the club-house, Mr. Gridley, the manager of the Windsor Machine Co., explained the why and wherefore of the company's plan. He said that when it was realized that the old plant was too small and that adjacent land was not available, the company had built the new plant at a more advantageous location near the railroad. The old building was left idle, and as a manufacturing plant of its size had no market in Windsor, the decision was made to turn it into a club-house for the employes and those of the town people who cared to use it. A very good reason for the establishment of the club-house, Mr. Gridley went on to say, was that good boarding houses in Windsor were scarce, and the prices asked for board were exorbitant. It thus became imperative, in order to keep good men at the works, to provide a satisfactory boarding place for them, so it was decided to establish this permanent club where such of the employes as desired could reside and get good accommodations at a reasonable price.

The first illustration shows the club buildings after they had been transformed from the old factory. The addition of a veranda and a front entrance greatly improved the appearance, and as soon as I had stepped in the front door I became aware of a real home atmosphere. The lobby walls and ceilings have been panelled with art-board, using the color scheme of red and white for the walls and brown for the ceiling. This treatment prevails throughout the building and it forms an ideal way of covering the unsightly walls of an old factory. An attractive feature of the lobby is the fireplace, in front of which a jolly group of the men was gathered.

Fig. 1. The Windsor Club—showing what can be done with an Old Factory Building

Passing out into the reading and writing room, I found a few of the men writing letters and others looking over copies of the current magazines. But before we could go farther, the call for dinner was announced and we entered the dining-room. This room, by the way, was formerly the lathe department of the old factory, but a new hard-wood floor, panelled walls and ceilings and modern lighting arrangements have given it an entirely different aspect. There are accommodations for seventy-five or eighty boarders; the bill-of-fare is good and low rates are charged. The ability of the chef was attested by the meal, and the sirloin steak served would have done credit to the best metropolitan hotel.

In fact, the dinner and the service were so good that I expressed a desire to look through the kitchen, so Mr. Gridley volunteered to take me out. Here are the latest types of cooking apparatus, steam kettles, hotel range, dish-washing machine, etc., and the bakery, which is adjacent, is also fully equipped. To supply ice for the eight- by twenty-foot refrigerator, an ice machine has been installed, and a glance into the ice-box showed how well the provisions are kept in condition for the dining-room.

From this point on, Mr. Cone, the factory manager, conducted me into the club-rooms proper. Mr. Cone has been especially interested in this feature of the project, and he explained as we were sitting in the arm chairs with which the main hall is furnished that the club features had as much to do with the success of the establishment as the hotel end of it. In this hall a dance is held once a week on which the interest of the entire town is centered. Besides, there are occasional concerts, and at the present time a lecture course is going on. The hall is attractively finished with white ceilings and walls and well lighted with electricity. More reading tables are provided here and except on dance nights the room has the appearance of a general recreation room. The superintendent of the club has his desk here and has a general oversight of all that goes on. A game of pool shortly after convinced me that the pool table equipment and accessories are first-class.

On the way out to bowl a few strings on the alleys, Mr. Cone showed me the modern laundry in which the needs of the hotel and club are cared for. The up-to-date washing machine and mangle comprise part of the equipment. Nearby are shower baths for the club members, which are greatly appreciated, especially during warm weather. When the company erected the new plant, a new power plant, heating and electric lighting equipment was installed. As the old apparatus was left in place in the old building, it was utilized. I found the bowling alleys, of which there are four, are of modern construction, regulation size and equipped with bottle, candle and duck pins. Rows of spectators' seats are provided at the rear and the alleys present an animated scene every evening. By providing features of this kind the management has assured that the leisure time of employes will be pleasantly and healthfully spent.

"The Windsor Machine Co.," said Mr. Cone, "gives employment to several hundred men, most of whom are skilled workmen who must naturally come from out of town." He stated that time after time they had secured good men whom they would have liked to retain but when those men found how poor the boarding accommodations of Windsor were, and how little was the chance for recreation, they soon left their jobs for others in larger cities. Since the institution of the club-house, the condition has changed and men are contented; in fact the club has proved to be a decided attraction for desirable men.

The fitting up of the club represents several thousand dollars expenditure, and though fourteen people are employed and it is open from six in the morning till eleven at night seven days in the week, it is practically self-supporting. The rates charged for board and room are remarkably low, considering the accommodations given. An excellent room with hot and cold water, including meals, costs $6.50 per week. The club also caters to the traveling public, automobile parties, etc., and for such the rate is $2.50 per day for board and room, and all guests are furnished with cards admitting them to the privileges of the club.

The dinner, inspection, bowling and chat made a pleasant evening all too short. I was conducted to a room on the second floor to spend the night. There are forty rooms and more are being constructed. They are all built in what was formerly the large second floor machine shop, and a new floor had to be laid, the walls sheathed and partitions put up. The connecting bath was a refreshing convenience that a traveler fully appreciates, and so comfortable was my bed that sound sleep was broken only when my next-door neighbor's alarm clock rang at 6:30. After a breakfast that well fortified one for the day's work, I bade adieu with reluctance to the Windsor Club, and returned to the grind of the great city.

C. L. L.

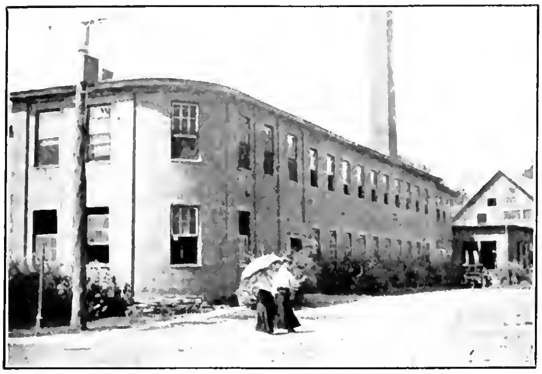

Fig. 2. The Old Factory before the Transformation

Fig. 3. The Club Members enjoy the Comforts of the Lobby

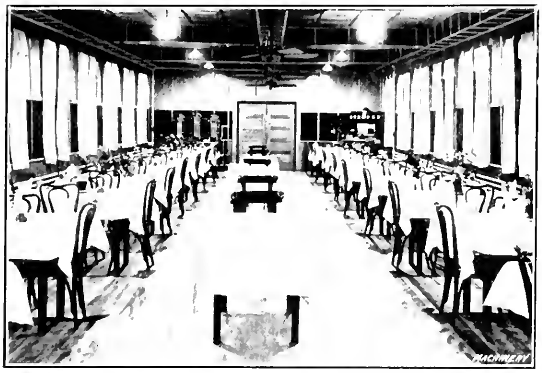

Fig. 4. A Fine Dining-room made from the Lathe Department

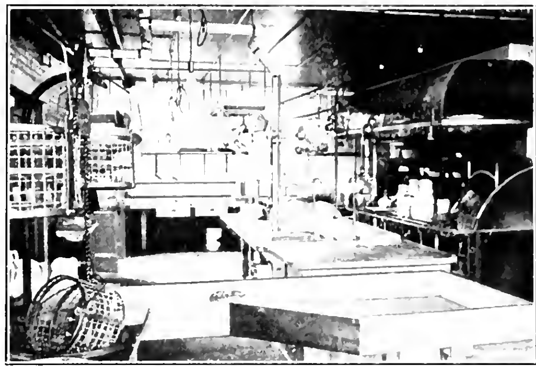

Fig. 5. The Chef has every Facility for preparing the Food

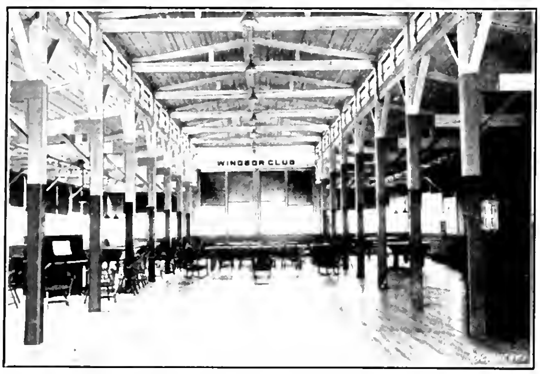

Fig. 6. The Recreation Hall is Large and Ideal for Dancing

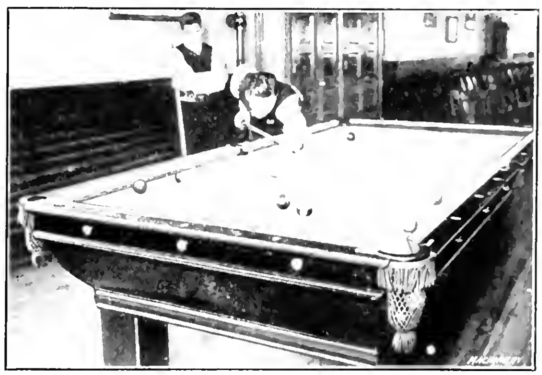

Fig. 7. Making a Critical Shot on One of the Pool-tables

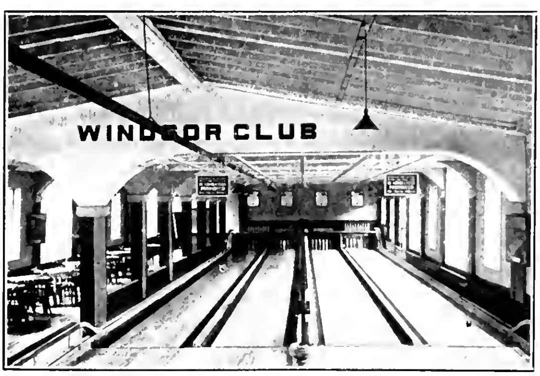

Fig. 8. The Modern Bowling Alleys are Popular with the Members

Fig. 9. My Room with its Private Bath was very Comfortable

COLD-HEADING—3

COLD-HEADING DIES AND TOOLS—POINTS IN THE TOOLMAKING—SETTING UP A COLD-HEADER

BY CHESTER L. LUCAS* AND E. W. DUSTON†

In the first two installments of this article published in the May and July, 1913, numbers of MACHINERY, the principles and different types of cold-heading machines were treated, together with the character of work for which each machine was adapted. In this number we will consider in detail the tools for solid- and open-die machines, including an outline of the operations connected with their making. As there are numerous little kinks and methods followed by individual heading die makers, it will only be possible to strike an average and outline the general processes of making the tool. As in other lines of toolmaking, no two workmen's ideas on a given set of tools will agree, although each may be right from his own point of view.

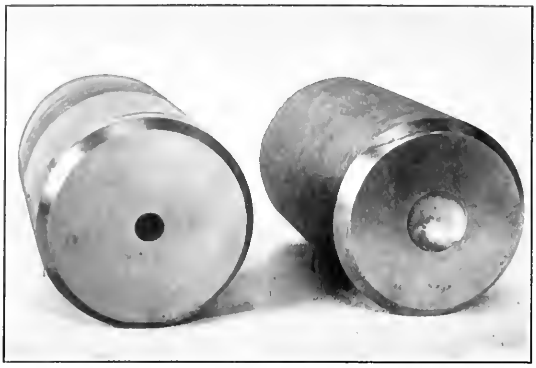

Fig. 28. A Pair of Solid Dies for the Cold-header

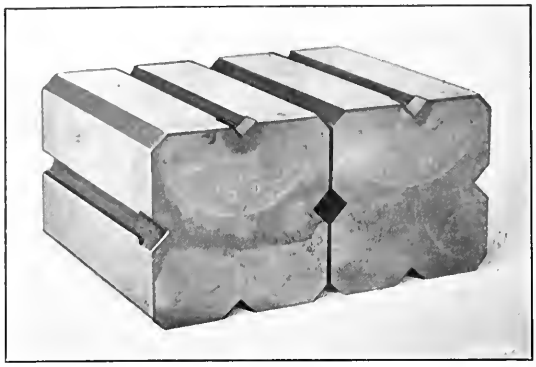

Fig. 29. A Pair of Open Dies for the Cold-header

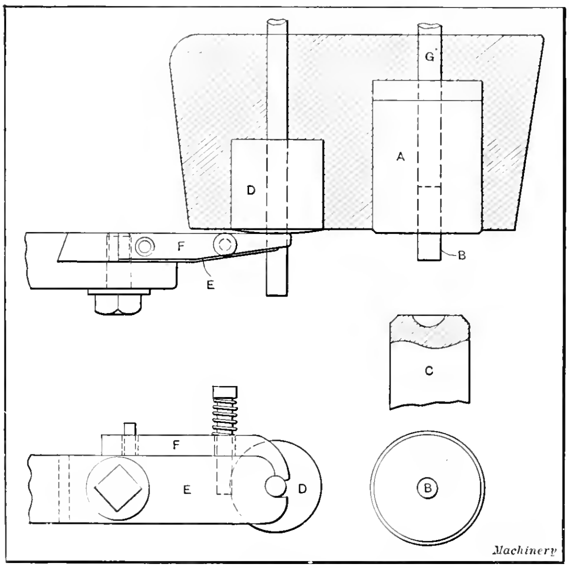

Fig. 30. Section of Cold-header showing Locations of Principal Tools

Tools for cold-heading machines may be roughly divided into two classes—those used in solid-die machines and those used in open-die machines. Whether the tools are for a single- or double-blow machine affects only one extra tool, namely, the upsetting or coning punch. In all other respects the tools are similar. The chief difference between the tools for the solid-die and open-die machines lies in the dies themselves, the punches being the same in both cases. Figs. 28 and 29 illustrate the difference between dies for the solid- and open-die machines. Fig. 28 shows a die and punch for a solid-die machine. These tools are very simple, being merely sections of round stock, the die being made with a hole to agree with the diameter of the wire, and the punch with a cavity of the correct shape for forming the head. In Fig. 29 a pair of open dies, without the punch, is illustrated. In this case the wire is held between the halves of the die, and the cutting off is done by the dies themselves, as was explained in the May installment. Therefore a pair of dies for the open-die machine must be of exactly the same length as the finished rivet under the head. The dies shown in Fig. 29 were made for forming a carriage bolt having a square shoulder under the head. By referring to Fig. 30, a set of tools for a solid-die machine may be seen in place. These consist, in the case of a single-blow machine, of the die *A*, in which the wire blank *B* is held for heading; the punch *C* which shapes the head and is actuated by the ram of the machine; the cut-off die or quill *D*, which is similar to the heading die, having a hole through its length through which the wire is fed against a feed-stop (not shown) the proper distance, and is then cut off by the cut-off blade *E*. The face of the cut-off die is crowned to help the cut-off blade do its work. Mounted on the cut-off blade is a carrier *F* that holds the blank to the cut-off blade so that it may be carried over to the heading die. A backing pin *G* fits in the hole in the heading die and regulates the length of the rivet under the head; it also serves as an ejector after the rivet has been finished. In Fig. 33 may be seen a set of heading tools,

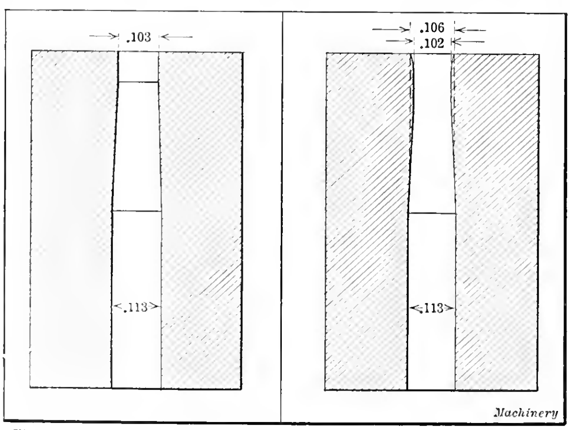

Fig. 31. Section of Solid Die showing Allowances left for Hardening Fig. 32. Section of Solid Die showing Usual Shrinkage in Hardening

with the exception of the cut-off quill. These particular tools were used in making a round-head screw that required two blows to form the head. The die is shown at *A*; the second-operation punch at *B*; the first-operation punch at *C*; the backing pin at *D*; and the cut-off blade without the carrier at *E*. At *F* may be seen the cut-off blank; at *G* the coned blank

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resulting from the first operation; and at *H* the finished round-head screw. If this same job were to be used in an open-die machine the cut-off blade and the backing pin and die would be eliminated and a pair of open dies substituted.

Making a Solid Die

At first glance, the solid die appears to be simply a round piece of stock with a hole extending through it to receive the wire. There are, nevertheless, many points to be considered in making this die, and without the knowledge of them the tools would never work satisfactorily. The heading dies, punches and cutting-off tools are made from a good grade of tool steel, annealed stock being preferred. The tools are sometimes made of low carbon steel and then carbonized, and at least one large user of heading machines follows this method exclusively, but unless the best of carbonizing and hardening facilities are available it would be inadvisable.

The length and diameter of a heading die are governed by the size of the machine in which the die is to be used. An idea of the proportion of the diameter to the length may be obtained by stating that for handling wire up to 1/8 inch

Fig. 33. A Set of Heading Tools and Work from a Double-blow Cold-header

diameter, a die of 7/8 inch diameter by 1 3/8 inch long agrees with good practice, and for handling 1/2 inch wire, the die may be 3 3/8 inches in diameter by 4 1/2 inches in length. These dimensions are not arbitrary, but are, of course, determined by the make and size of the machine in which they are to be used. In Fig. 35 is illustrated a little kink by means of which considerable die-steel may be saved. In this case a backing block is made to replace about one-third the length of the die. The dies themselves may thus be made

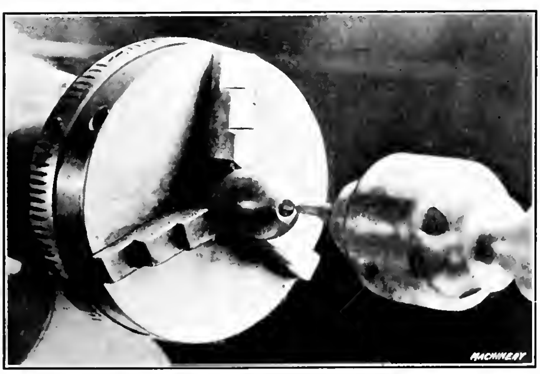


Fig. 34. Reaming out a Coning Punch

correspondingly short, and as this pillar block is used beneath each die, one-third of the steel of each heading die is saved.

Fig. 31 shows, in section, a typical heading die of the solid type, just made and ready for hardening. This die is given with actual dimensions so that the shrinkage allowances may be duly noted. The length of the die is 1 3/4 inch and the diameter 7/8 inch, and it is to be used for heading rivets from 0.105 inch wire. First, a hole a few thousandths under 0.105 inch diameter is drilled through the die. The die is then relieved from the back for a short distance with a No. 33 drill, enlarging this section to 0.113 inch. A tapered reamer which has a taper of about 0.003 inch to the inch is then used to ream out the unrelieved section very nearly to the face of the die. At this point the die is hardened and this operation causes the mouth of the die to "open," leaving it about as shown in Fig. 32. Using emery and oil, the die is then lapped out from the back until the hole measures 0.106 inch diameter, this being 0.001 inch over the diameter

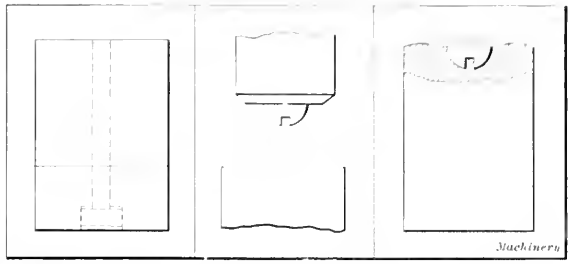


Fig. 35. A Kink for saving Die Stock Fig. 36. A "Hub" and a Punch Blank Fig. 37. Punch after hubbing

of the wire, allowing plenty of play for the working of the stock.

The hardening operation is comparatively simple, the requirements being to have the die, especially the section adjacent to the hole, very hard. A useful kink to be followed in securing the desired hardness is illustrated in Fig. 44. This consists of a funnel shaped bushing which is threaded so that it may be screwed onto the ordinary water faucet. The die is brought to the right heat and held under this conical bushing and the water turned on full force. When

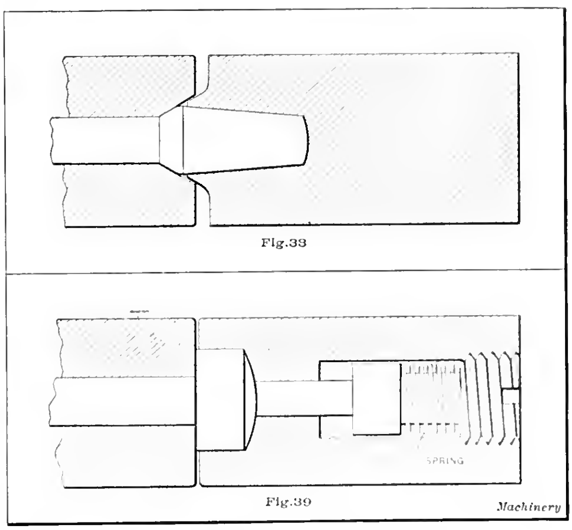


Fig. 38. Coning Punch relieved to force Wire into the Countersunk Head of the Die
Fig. 39. Spring-pin in Punch which facilitates Ejection

the water is turned on, the face of the die and the hole receive a sudden quenching, giving it the extreme hardness that is necessary.

The Punches

Before a punch can be correctly made for any rivet except a "flat-head" a counterbore is necessary to obtain the exact shape of the cavity. In the case of flat-head screws or rivets, the punch consists simply of a length of round steel having a perfectly flat face with chamfered edges. With round or fillistered head blanks, however, the finish punch must contain a cavity of the exact size and shape of the head. In making a punch like that shown in Fig. 33 for a round-head rivet, a reamer of the same semi-spherical shape is necessary. The reamer is turned up in the lathe, leaving a flat shoulder to limit the depth of the cut. The "half-type" reamer is employed, and is relieved only for a short distance behind the cutting edge so that a good bearing is secured while the

punch is being reamed, resulting in a smoothly finished cavity. In hardening these reamers they are drawn to a straw color. In the case of difficult shaped heads, it is often found advisable to hammer a piece of lead into the soft die so that measurements may be taken and checked up with the sample. Weight forms an important feature in determining the amount of metal which goes into the head. In setting up the machine, for instance, the toolmaker will often compare the weights of his rivet and the sample in order to see if the right amount of stock is being used. By cutting off the head close to the shoulder and weighing it, he can determine the amount of stock required, and by balancing the head with an equal weight of wire stock, he can readily determine the distance to which to set the wire feed.

In the case of double-blow machines, in which an upsetting or coning punch is used, there seems to be no definite rule that can be laid down for the shaping of the cavity in the coning punch. As before explained, the idea of the coning punch is to upset the metal and leave it in condition for the final distribution into the finished head. Generally speaking, this intermediate shape is that of a truncated cone, the base of which is very nearly the diameter of the finished head, and the length of which is about two-thirds the amount of wire advanced by the wire feed. The top of the wire is left approximately the same diameter as the blank and slightly rounded. If a very large amount of metal must be put into the head, the angle of the cavity in the coning punch is made as obtuse as possible. It is customary to relieve the coning punch about as shown at C in Fig. 33, the object being to remove all danger of interference with the cut-off blade, because the coning punch strikes the wire blank just as the cutting-off blade releases it; therefore it helps matters to have the cut-off blade relieved as well as the coning punch. When the coning punch is to be used in connection with a countersunk die for flat-head screws, it is relieved about as shown in Fig. 38. By so doing, the wire in the cone is supported and driven down into the countersunk section of the die, instead of being left out at the line of the die face. There are so many governing factors bearing upon the shapes of coning punches that it must be left largely to the judgment of the toolmaker. Punches for fillister head or other deep types of punches where the blanks would be likely to stick are often fitted with spring ejector pins as shown in Fig. 39. Ordinarily the die is the member in which sticking is most prevalent, but when the blank is short and the head is deep sticking will be encountered in the punch.

In the manufacture of very cheap screws, the slot in the head is often formed by the heading punch instead of being sawed. This means that the cavity in the heading punch must have a ridge of steel left standing to drive the metal down for the slot. To cut the cavity to this shape would be practically impossible; therefore the common practice is to

Fig. 40. Drilling out a Solid Die

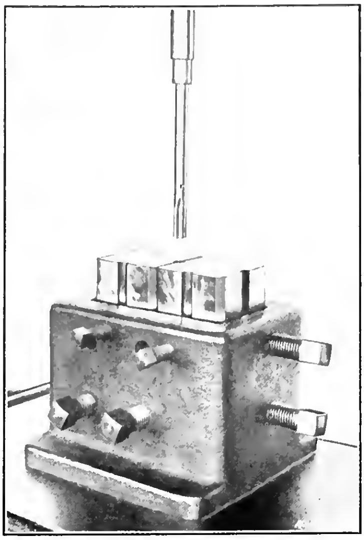


Fig. 41. Reaming a Pair of Open Dies

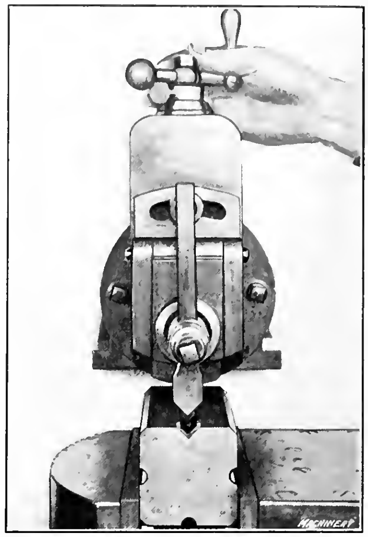


Fig. 42. Shaping Square Section in an Open Die

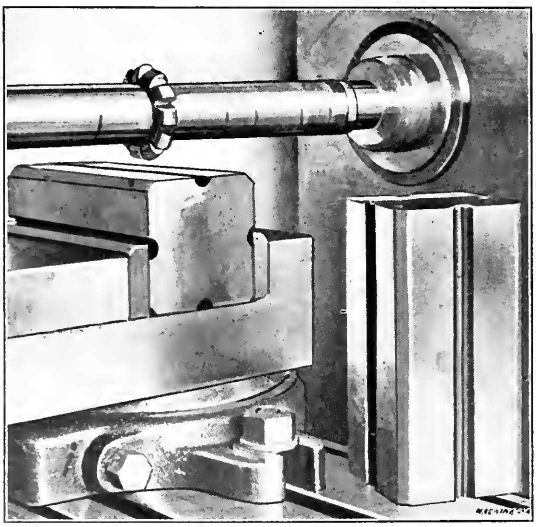


Fig. 43. Milling the Grooves in Open Dies

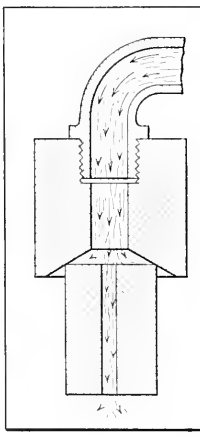


Fig. 44. A Method of hardening Solid Dies

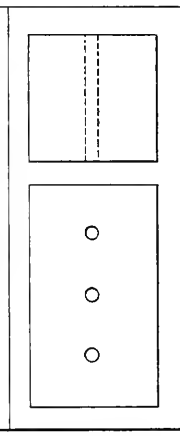


Fig. 45. Multiple Die of Square Type

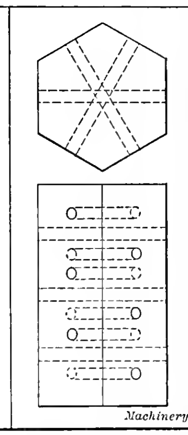


Fig. 46. Multiple Die of Hexagonal Type

hub the punch. The hub is made by turning up a blank of steel with a face of the same shape as the head of the screw to be produced. A slot is then milled or filed in the center of the head of the hub, after which it is hardened and drawn to a straw temper. Before being hubbed, the face of the heading punch is first convexed so as to leave the highest point at the center, thus providing enough stock to make a well formed cavity. The tendency is for the metal in the punch to sink away from the slot in the hub; therefore by leaving an excess amount of metal at this point, the slot is completely filled when the punch is hubbed. After being hubbed, the punch is faced off, of course, and the sides turned up for hardening. Fig. 36 represents the hub and the punch-blank before hubbing and Fig. 37 shows the hubbed punch before being faced off.

The Cut-off Tools

The cut-off die is simply a section of round stock having a hole extending through it slightly larger in diameter than that of the wire being worked. On small sizes of wire 0.001 inch is enough clearance. The face of this die is crowned slightly so that the cut-off blade which works in conjunction with it may act without binding on any other part of the die face. The cut-off blade is shown at *E* in Fig. 30, from which it will be seen that the end is filed out U-shaped, so as to partly enclose the wire, thus supporting it while the cutting-off operation is taking place. A spring-finger *F* is fitted to the cut-off blade that snaps over the wire when the cut-off blade advances to the cutting and holds the blank so that it can be carried to the heading die. There are different methods of applying the spring-finger or carrier, but a good way is illustrated in Fig. 30. Here the spring pressure is supplied from the spiral spring over the stud near the center, while the pin at the end operates in an enlarged hole in the finger serving merely as a guide to prevent the finger from swiveling. Both cut-off die and blade are hardened and drawn to a straw temper. There is little to be said about the backing pin which is shown at *D* in Fig. 33 except that as it receives the full force of the heading blow, it must be hardened and drawn to a very dark purple.

Tools for Open-die Machines

The only explanation required for tools for the open-die machines is the operations connected with the making of the die halves. These, which are illustrated in Fig. 29, are made by shaping up square sections of tool steel to fit the die-holding block of the header. The halves of the die are left large enough in size to allow for grinding, and down the center of each face is milled a half-round groove of a size slightly less than the diameter of the wire which is to be handled in the header. After the bulk of the stock has been milled out in this manner, as shown in Fig. 43, the halves are clamped in a special holder illustrated in Fig. 41 and a reamer of the proper size is run through the hole, taking half the stock from each die face. Set-screws are provided on the die-holding box to clamp the two halves together and take up end play while this operation is being performed. Each of the four pairs of faces is treated in this manner and, of course, they are marked so that they can be mated readily. The object of having all four faces grooved is simply to make use of the other three sides of the die; thus as soon as one pair of grooves has worn out of round, the dies are simply turned to bring a new pair of faces into use. As was explained in the May installment, the object of chamfering the corners of the die halves is to facilitate the opening of the dies by the spring-finger on the machine. Fig. 42 shows the manner in which the square section of a die for producing a carriage bolt is machined. This square section comes under the head of the bolt and, therefore, must be provided for in the dies. After reaming out the grooves in the die faces the square outline is marked on each of the faces of the die, and the lines scribed for the depth. A starting point is made by chipping a groove at the proper distance from the face of the die, and the rest of the stock is removed by a square shaper tool, thinned down at the face to permit of its starting in the chiseled groove. Each of the faces of the two die halves is similarly treated. As with the solid dies, the open dies are hardened and the faces and sides are ground before being put into use. It is very important that the faces of the dies be properly ground so that they will

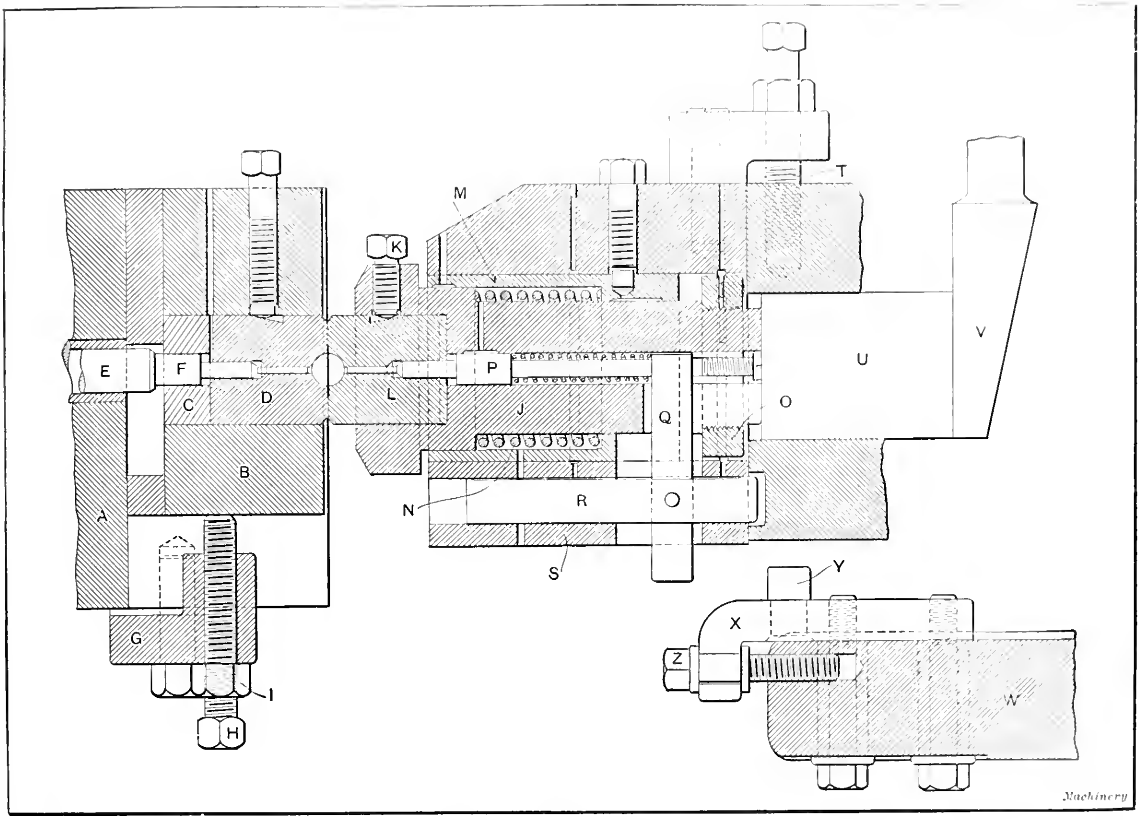


Fig. 47. Special Ball-header Tools

come close together and prevent the headed metal from bulging out in the form of fins on the sides of the work. In grinding the sides of the die halves, the stock taken off permits the faces to come together far enough to flatten the circular opening in which the wire is held. This provides the necessary clearance for gripping the wire.

Multiple solid dies are often made for the sake of economizing in steel. Examples of such dies are shown in Figs. 45 and 46. The die in Fig. 45 has three openings so that after one of them has been worn out of round, the die may be moved along in the special holder necessary to hold a square block and another hole put into use. If the work is such that the die can be made without clearance, the block can then be reversed and the opposite ends of the three holes used. Similarly, in Fig. 46 is a multiple die of hexagonal shape, providing eighteen working openings. As a general rule, however, multiple dies are not used, because of the trouble caused by special die-holders. The plan of reversing the die to use the opposite end of the hole has disadvantages on some work where the heading blows close the hole in so much that the necessary lapping out makes the method more troublesome than beneficial.

Setting up a Plain Job in the Header

In setting up a job in a solid-die header, the first step is to put in the cut-off die and adjust the cut-off blade. The blade is adjusted by snapping the finger over the wire, and while thus held it is clamped in position against the cut-off die. The die is next bolted into its seat and the backing pin adjusted to size the length of the rivet under the head. The finish punch, in the case of a double-blow machine, is then located in the punch-holder. The coning punch is next held in the punch-holder, and, if necessary, it is adjusted to bring its face into line with the finish punch. The finish punch should be set without backing or "shimming" of any kind, but if necessary the coning punch may be shimmed up to agree with it. The stroke is then adjusted so that the punch faces almost touch the die face. After this, the wire feed may be set and the machine is ready to be operated. On every job there is more or less adjusting of the feed, grip and ram movements to obtain the exact results.

In setting up the tools on an open-die machine there is, of course, no cut-off to be taken into consideration other than the proper setting of the die halves, as the cutting is done simultaneously with the movement of the dies. The operations of setting up the punches on the open-die machine are the same as on the solid-die machine.

Special Ball Heading Machinery

The E. J. Manville Machine Co. makes a special type of header adapted for forming ball blanks. The cold-header is an important adjunct to ball making. The principal feature is positive ejection for the ball blanks after heading, because ball headers operate at a very high rate of speed and positive ejection is absolutely necessary. A secondary advantage of this machine lies in its ability to handle positively the short ball blanks.

Fig. 47 shows a vertical longitudinal section taken through the working parts of one of these special ball headers. *A* is the frame or bed of the machine; *B* is the die-block of steel; *C* is a hardened tool-steel backing block for the die *D*; *E* is the backing or knock-out pin which backs up the smaller knock-out pin *F*; *G* is a cast-iron bracket screwed onto the under side of the bed to hold the adjusting screw *H* which raises or adjusts the die-block into the correct position for heading. A lock-nut *I* insures the adjustment. *J* is a tool-steel punch-holder having an enlarged head with a set-screw *K* for holding the punch *L*. The body of this holder is of smaller diameter than the head and is made a sliding fit in the bushing *M*. The holder is normally kept in its forward position under spring tension by means of the coil spring *N*. Two adjusting nuts *O* are on the back end of the holder. *P* is a small hardened tool-steel ejector pin, which is also kept under a spring tension, and is backed up by the bar *Q* that passes through the round rod *R* and is pinned in place. *S* is the punch-slide that carries the punch-holder and other parts shown and is adjusted by the screw *T*. The punch-holder is backed up by a solid block *U* that acts as a buffer as well as a filler between the holder and adjusting wedge *V*. *W* is a bar cast in the bed between the two sides carrying the adjustable bracket *X* that has the stop-pin *Y* and adjusting screw *Z*.

The action of the machine is as follows: The round bar or wire is fed in and cut off in the usual manner, and the cut-off blade carries the blank over to the heading die, but as there is no shank to be pushed into the die, as is the case with a longer blank or rivet, as soon as it is carried over, the gate or ram advances, and also the pin *F*. As pin *P* is under a spring tension the blank is very quickly seized between the two pins, and held in position until the gate has advanced far enough to hold and squeeze the blank into a ball.

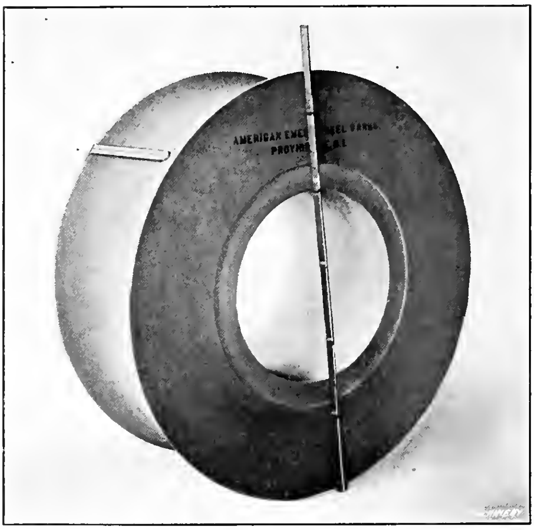
After this the gate returns and when it has reached a certain position the bar or trigger *Q* strikes the pin *P* that acts as a knock-out, and ejects the ball if it clings to the punch; if it clings to the die the other ejector pin *F* ejects it.

It will be noticed that the pins *F* and *P* are not long enough to reach to the ball arc when under the heading pressure; this leaves slight projections on the two sides which can be removed easily, whereas if the pins were even slightly too long there would be flat spots left on the finished balls. The subject of cold-heading is almost inexhaustible, but these three articles have touched upon the most important principles and it is to be hoped that other articles will be contributed showing some specific cold-heading jobs and the tools and methods used in the production.

* * *

LARGE CORUNDUM WHEEL FOR NEEDLE GRINDING

The illustration shows a corundum wheel thirty-four inches diameter and thirteen and one-half inches face, made of corundum by the American Emery Wheel Works, Providence, R. I., for Worral Bros., Sheffield, England. The wheel, which was designed for an automatic textile needle grinding machine, was made by the vitrified process, and is believed by the company to be the largest (combined diameter and



Corundum Vitrified Wheel 34 inches Diameter and 13½ inches Face made for Needle Grinding

thickness) wheel ever made by the vitrified process. The net weight of the wheel is 640 pounds, and wheel makers and users familiar with vitrified wheel manufacture will appreciate the experience and extreme care necessary in handling and finishing such a massive wheel. The final temperature at which the company's vitrified wheels are fired is nearly 3000 degrees F.

* * *

As a part of its campaign to improve agricultural methods, the Pennsylvania R. R. is to distribute among the farmers along its lines 10,000 copies of a book describing the possible uses of concrete on the farm. The distribution of these books will be made through the office of the railroad's agriculturist.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DEVICE FOR TAPPING BUSHINGS WITH COARSE PITCH THREADS

A large number of brass bushings such as are used in motor car steering rods for controlling the spark timing and inlet and outlet of gas, were to be tapped. Machining these bushings in a lathe was found to be too expensive and not practicable, and as an accurate, quick method was required, a special hand apparatus was designed. This consists of a cast-iron base having three supports as shown in Fig. 1. The one to the left has a hollow shaft and a split collet by means of which the bushing to be tapped is held. The shaft has a dividing flange with three holes which are engaged by a spring-pin for indexing, in order to cut the three threads of the screw. The central support has a cast anti-friction metal nut and carries a large lead-screw of the same pitch as the hole to be tapped. This support has an adjustable cap for taking up wear. The lead-screw is also supported by a third bearing on the right and is fitted with a pilot wheel as shown. The opposite end of the lead-screw has a key and set-screw for holding special taps.

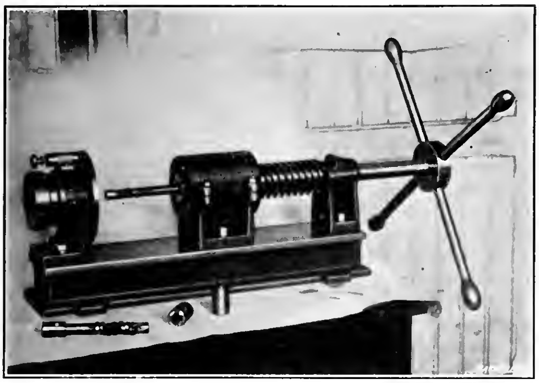


Fig. 1. Fixture for tapping Brass Bushings of Coarse Pitch

When the pilot wheel is turned, the lead-screw moves forward and feeds the tap through the bushing. These taps are an interesting part of the apparatus. Triple-threaded taps did not work satisfactorily as they broke frequently, owing to insufficient room for the dirt or chips. Single-thread taps such as are shown in Fig. 2, were then used, the three threads in the bushing being obtained by indexing the work. These taps gave excellent results, the bushings being tapped quickly and accurately with little wear of the tools.

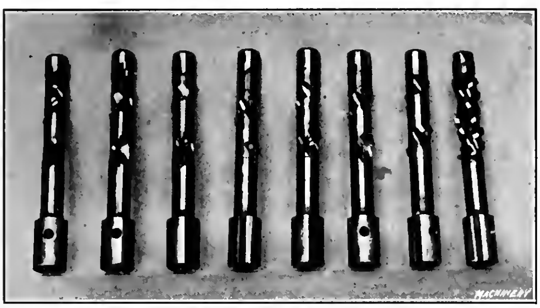


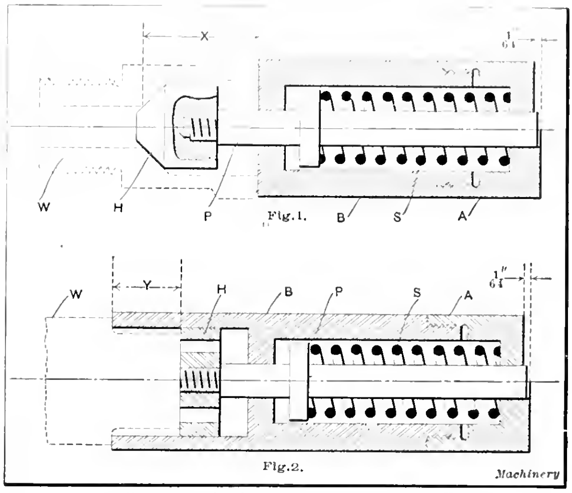
Fig. 2. Set of Eight Taps used in Fixture shown in Fig. 1

The operation of this fixture is as follows: After a roughing tap has been fed through the work, the lead-screw is drawn back; the dividing flange is then moved 1/3 turn and a second cut is taken with the same tap. The work is then indexed again and a third cut taken. The second tap of the set is next inserted and the same operation repeated for the three positions of the dividing flange, and so on for all the other eight taps of the set. The finishing tap has three threads and is used merely to correct slight imperfections left by the previous taps. Two of the finished bushings are shown in front of the fixture in Fig. 1. They are two inches long and $1\frac{1}{4}$ inch outside diameter. The engaging screw is 1 inch outside diameter and has a $1\frac{3}{8}$-inch triple thread of trapezoidal section. The output of this tapping device, when operated by a boy, is thirty pieces per day of ten hours. The lead-screw and taps were threaded in a Pratt & Whitney threading machine.

Turin, Italy. C. BOELLA

INSPECTION ROOM LIMIT GAGES

Two interesting limit gages are illustrated in Figs. 1 and 2. These gages are employed for inspecting parts that are produced at the rate of several thousand per day, and they are said to give perfect satisfaction. Both gages are built along identical lines. They consist essentially of a plunger *P*, plunger head *H*, plunger barrel *B*, spring *S* and barrel cap *A*. The outer face of the cap consists of two planes accurately ground within 1/64 inch of each other, this being the limit within which distances *X* and *Y* are permitted to vary The step or rise of 1/64 inch thus formed on the cap *A* extends across the center of the cap end.



Figs. 1 and 2. Simple Forms of Limit Gages

In Fig. 1 the important dimension is the depth *X* of the bevel seat from the outer edge of the piece *W*. In Fig. 2, *Y* is the important dimension. When *X* and *Y* are right, the outer end of the plunger projects as shown in Figs. 1 and 2. When *X* is too large or *Y* too small, the plunger end is completely inside the cap *A*. and when the reverse is the case the plunger projects beyond the shoulder formed on the face of the cap. The principal advantage of these gages is that work can be carried on with the help of either sight or touch, and thus one sense can be used to relieve the other—a feature that can be fully appreciated only by those who are continually employed in inspection work. These gages were designed by Mr. R. Vessey, superintendent of the Champion Ignition Co., Flint, Mich.

Flint, Mich. M. TERRY

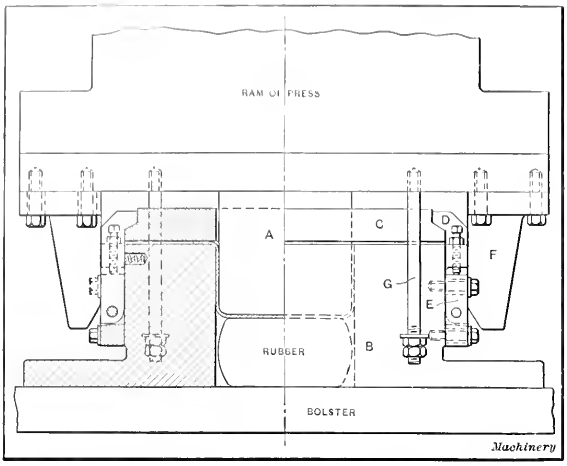
DRAWING IN A SINGLE-ACTING PRESS

We had an order for some steel cups such as would usually be made on a double-acting press. No double-acting press was available, but we did have a long-stroke single-acting press of sufficient capacity to do the job. The die was made as follows:

On the die *B* were bolted some U-shaped pieces *E* which carried the holding hooks *D*. These hooks *D* could be adjusted to any desired degree of tightness by setting down the pieces *E* with the set-screws provided and then clamping

them securely in place. The blank-holder C was suspended on four bolts G, and these bolts were adjusted to the proper length so that the blank-holder C was laid on the blank early in the stroke; then closing lugs F engage the holding hooks D and force them in on the beveled ledge of the blank-holder. The lugs F then slide along the back of hooks D during the remainder of the stroke.

On the up stroke the closing lugs leave the hooks D which are immediately thrown open by springs provided for this purpose, and then the blank-holder C is lifted up by the



Die for drawing Cups in a Long-stroke Single-acting Press

suspension bolts G. The formed piece is loosened in the die by the rubber block or, if necessary, a positive stripper can be provided.

At first we made the closing lugs F solid with the punch-holder, but after several were broken by dirt or other foreign substances getting under the blank, we made a new holder with the lugs bolted on, and now the bolts will usually allow the lugs to give enough to prevent breakage.

This die is more expensive than would be required for a double-acting press, but works nearly as well and enabled us to do the work with the equipment at hand.

W. Alton

HOLDING DEVICES FOR FIRST-OPERATION WORK

The chucking fixtures shown and described in the article on "Holding Devices for First-operation Work," by Albert A. Dowd, in Machinery for November, are very interesting examples of this kind of work, but they appear to me to be expensive, and for the most part would only be justified by

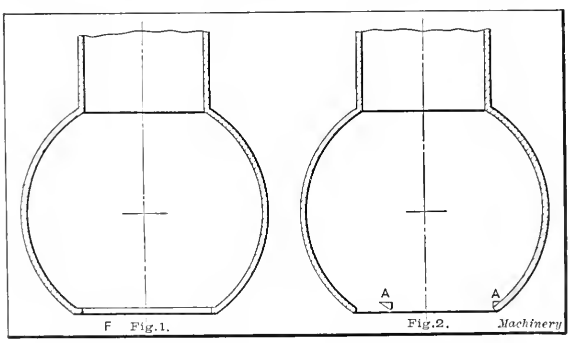


Fig. 1. Ball Joint having Internal Flange to provide Clamping Surface Fig. 2. Ball Joint with Clamping Lugs to be used if Internal Flange is not permissible

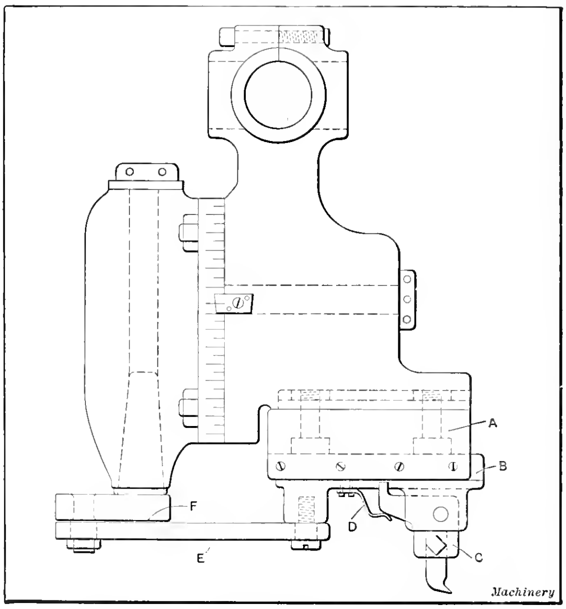
the production of large numbers of the parts for which they were designed. I shall, however, confine my discussion to the fixtures for ball and socket pipe joints shown in Figs. 3, 11 and 12 of the article referred to. Such pieces as this, especially when of large size, as shown in Figs. 11 and 12, are likely to be made in such small quantities that the fixtures should be of the cheapest if they are required at all.

The designer of any piece of machinery should not only be capable of designing mechanism that will perform the functions desired, but should so shape the various parts that they may be readily machined in ordinary machine tools with the least possible outlay for special equipment. In this case I think the designer has failed in just that respect. It would have been better to have made the patterns for both of these joints with an internal flange on the lower end of the ball, as shown in the accompanying illustration Fig. 1, the opening through the flange being the same size as the throat at the other end of the piece. The casting could then be held by a regular three-jawed chuck with the jaws inside, and the bull center could be used for an outboard support as shown in Fig. 3 of Mr. Dowd's article. With the pattern made in this way, either end of the piece could be machined first, and the core would make a smoother opening in the flanged end of the casting. If the face F, Fig. 1, is machined, and a cut taken through the opening, a finished surface is provided for locating the piece for future operations. If the flange in the opening is not permissible, three small lugs A, Fig. 2, could be cast inside the ball; then the first chucking becomes a simple matter of clamping by bolts and straps to the faceplate of either the lathe or boring mill. No special fixtures are required for either method of holding the work.

Springfield, Mass. F. H. Bullard

SLOTTING ATTACHMENT FOR VERTICAL MILLING ATTACHMENT

The illustration shows a slotting attachment which was designed by the writer for use on a Brown & Sharpe compound vertical spindle milling attachment. Those who are familiar with this type of vertical milling attachment know that there



Slotting Attachment for B. & S. Compound Vertical Spindle Milling Attachment

are two flat surfaces provided with T-slots to which the bracket is fastened which supports the attachment. These two surfaces are located at right angles to each other and only one surface is used to support the attachment, the provision of the two surfaces enabling it to be set up in different positions. The writer did not make use of the bracket in connection with the slotting attachment, although it could be used if desirable.

Referring to the illustration, it will be seen that the slotting attachment consists of a frame A which is bolted to the T-slots of the milling attachment. The slide B fits into the frame A and carries the tool-holder C, in which the tool is secured

by means of a set-screw at the side. Almost any form of shaper tool such as a lip, diamond-point or square-nose tool can be used in this holder. A spring *D* is provided at the back of the holder which allows the tool to drag on returning.

The slide is driven by means of a connecting rod *E* which transmits power from the crank *F*. This crank is mounted in the spindle of the milling attachment by means of a tapered shank, and the crank may be made of any length to give the desired stroke. This slotting attachment can be used in a number of ways and suitable tools can be made for slotting small keyways in gears or pulleys, for use on die work, etc.

Harrisburg, Pa. A. F. Lighthart

SPRING SUPPORTED CANTILEVER

In the December number of Machinery, "How and Why" section, an error occurs in the solution given by William L. Cathcart of a spring supported cantilever. The deflection as arrived at is correct, but the stress *S*, as given, is incorrect. The method pursued would give the maximum stress at the end of the beam, but no stress at all at the support, whereas the two stresses, of course, are exactly opposite to this. The bending moment in a section 15 inches from the support is evidently equal to 500 (20 — 15) = 2500 inch-pounds, this being the moment of all forces to the right of the section. It is not necessary to deal with the reactions at the support. In the solution given the reaction is given as 395 pounds, but to this should be added a couple which equals 500 × 20 — 105 × 10 = 8950 inch-pounds. This is a necessary condition if the forces are to be in equilibrium.

Hartford, Conn. A. E. Larsson

SCREW COMPENSATION FOR SHRINKAGE IN HARDENING

In the December number of Machinery "W. B. T." presents an interesting problem: He wishes to cut a screw to fit the threaded portion of a chuck jaw, the length of which and, consequently, the pitch of the thread, has been diminished by the contraction incident to hardening. In other words, he wishes to cut a thread of slightly less than standard pitch. What may be called the reverse of this problem is familiar to many of us; that is, cutting a thread slightly coarser than standard pitch, to compensate for the shrinkage in subsequent hardening of the threaded piece.

If, for example, a tap is to have 8 threads per inch and we know that the contraction of the steel necessitates cutting the thread 0.12502 inch pitch instead of 0.125 inch, the lathe is geared to cut 0.125 inch pitch and the taper attachment is set to an angle the cosine of which is $\frac{0.125}{0.12502}$. The tailstock is also set over to bring the axis of the work parallel with the taper attachment.

The same method could be applied as readily to the cutting of threads slightly finer than a standard pitch, if the lathe were supplied with gears to cut a little finer than the required pitch. For instance, if 0.197 inch pitch were required, it could be easily obtained if we had gears to cut 0.195 inch pitch. The way in which this result is attained by the writer is to insert in the change gear train compound gears of nearly the same size. Compound gears which are often used have 83 and 84 teeth, respectively, giving a pitch 83/84 of what the lathe would cut if the compound gears were not used. Thus, the 0.200 inch pitch (5 threads per inch) of W. B. T.'s problem would become 83/84 of 0.200 inch or 0.19762 inch. The length of the threaded part of the chuck jaw is not stated, but if it were 2 inches the contraction would reduce the 0.200 inch pitch to 0.19843 inch. Dividing 0.19762 by 0.19843 gives the cosine of 5 degrees 12 minutes, to which angle the taper attachment should be set.

The writer is aware that devices are in use on other tools than the engine lathe for giving a pitch slightly coarser or finer than standard, but has assumed that the thread is to be cut by one who has only the ordinary lathe at his command. It is often possible to obtain the desired pitch without the 83- and 84-tooth gears or their equivalent, if one has a metric lead-screw. For example, to cut a thread of 0.19843 inch pitch, as in the preceding case, gear the lathe for cutting a thread of 5 millimeters pitch (0.19685 inch); then set the taper attachment to 7 degrees 14 minutes, which will give a pitch of 0.19843 inch (0.19685 : 0.19843 = cos 7° 14').

The use of compound gears has the great advantage of wide applicability, as the gears can be used for any pitch. There is a well-known objection to cutting threads with the tailstock set over, as the dog does not drive the work with constant velocity, the tail oscillating in the faceplate slot. If the work is so fine as to make correction necessary, this defect can be overcome by driving with a pair of bevel gears, as is customary in some shops when taper work is to be threaded, and in the relieving of angular cutters.

New London, N. H. Guy H. Gardner

Regarding "W. B. T.'s" problem of decreasing the pitch of a screw, the condition of the piece which the screw is to fit is not quite clearly stated, as that much discussed matter of "pitch" is left open. As I understand the pitch of a screw, it is the length divided by the number of threads in that length, or, in this case, 1 inch divided by 5, which equals 0.2 inch pitch. If this is the case and the pitch has shrunk 1/64 inch, then the number of threads is 1 divided by 0.2 — 1/64, or 5.423 threads per inch. However, since W. B. T. wishes a compensating device and not a definition of the word "pitch," I will say no more about that.

A compensating device to increase the pitch is very simple, if a lathe with a taper attachment is at hand. It is done by setting over the tailstock of the lathe, either way, and setting the taper attachment to cut the screw parallel. This causes the center line of the work to form an angle with the travel of the carriage, the movement of the latter being along the side adjacent to the angle while the work represents the hypothenuse; hence the amount of compensation in any given length will be the difference between the length of the side adjacent and the hypothenuse of the angle.

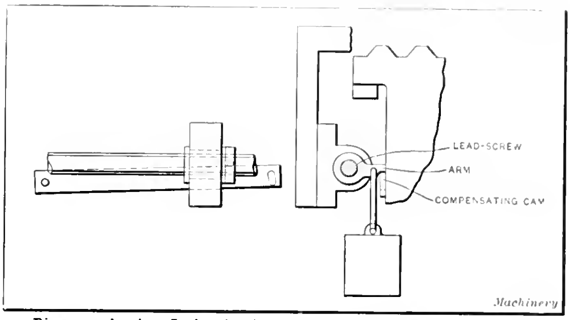


Diagram showing Lathe Carriage with Special Lead-screw Nut to decrease Pitch of Thread being cut

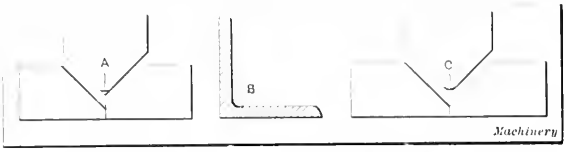
Decreasing the pitch is a more difficult proposition, and where the amount of compensation is known probably the simplest way is to make a special gear or number of gears to cut it. Another way, and a very good one, is to remove the regular nut from the lead-screw and fasten a bracket to the lathe carriage to carry a special nut that can be caused to rotate in the bracket. An arm is fastened to the nut and arranged to bear on the upper surface of a compensating strip or cam fastened to the lathe bed, the arm being held in contact with the cam by means of a weight. (The accompanying illustration shows the arrangement roughly). The compensating strip can be adjusted to give any desired increase or decrease of travel within reasonable limits.

I have never seen this device used for this purpose, but some time ago a similar one was described in some technical paper as a means of correcting inaccuracy in lead-screws, and I think it would answer W. B. T.'s purpose in every way. However, I believe it would be more practical to make the jaws of a grade of steel less liable to variation in hardening, and then correct the inaccuracy due to hardening by lapping on a long screw made of brass or soft steel, as this would give a more uniform contact.

Watervliet, N. Y. D. Tappan

ANGLES OF ANGLE BEAM SHEAR BLADES

I wish to submit an answer to J. D. Y.'s question in reference to the angle of the angle beam shear blades, published in the November number of MACHINERY. Some four years ago we were having a lot of trouble with our shearing machine, due to the point of the upper blade breaking off, as shown at *A*. The problem of overcoming this difficulty was turned over to me. I found that the angle beams we were shearing were of



Original and Improved Types of Angle Beam Shear Blades

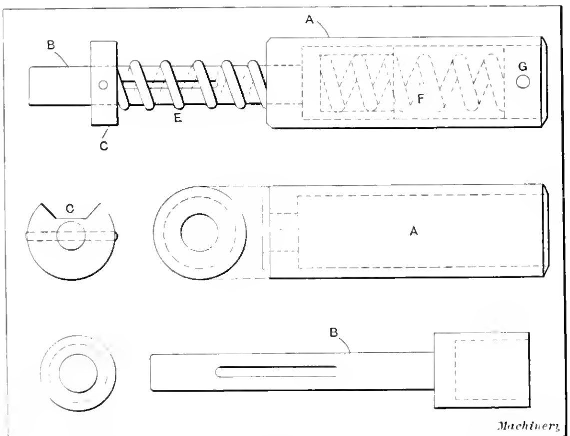
the form shown in cross-section at *B*, with the inside corner slightly rounded. It appeared reasonable to assume that the trouble was due to this rounded corner for in shearing such a beam, all of the pressure would be concentrated on the point of the blade for a short period of time. Acting on this assumption, I made the upper blade of the shear with a round point, as shown at *C*, instead of with a sharp point of the form shown at *A*. After this blade was put in operation, no further difficulty was experienced. In conclusion, it may be stated that the angles of the upper and lower blades should be the same.

Auburn, N. Y. JAMES BURKE

TURRET ARBOR AND EJECTOR FOR GANG CUTTING OPERATIONS

The arbor illustrated herewith was designed for use on the Cleveland automatic screw machine when cutting off collars or washers with a gang cutter. The illustration shows the parts assembled and in detail. This arbor has several advantages.

The hollow shank *A* is gripped in the turret of the screw machine and contains the plunger *B*, which is free to move backward against the coil spring *F* held in place by plug *G*.



Turret Arbor for Gang Cutting-off Operations—The Spring-plunger enters Drilled Hole and Collar C ejects the Cut-off Washers or Collars

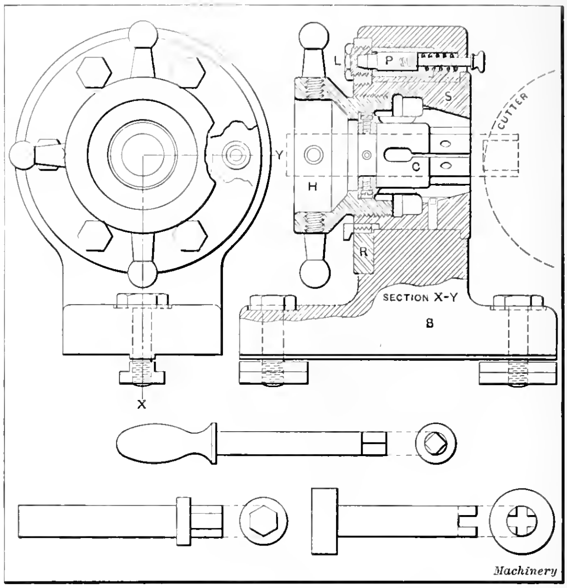
In using this fixture, the plunger *B* enters a hole drilled in the end of the stock, from which the collars are to be cut off by the gang cutter on the cross-slide. In case the cross-slide has traveled its entire distance before the turret has advanced to its limit of movement, the end of plunger *B* will strike the bottom of the hole and will cause a pressure against the coil spring *F*, which allows a sliding movement backward into shank *A;* this has proved to be a valuable advantage. The collar *C* is fitted with a pin for sliding in the slot shown in *B*, and is cut away (see end view) to provide clearance for the gang cutters. This collar acts as an ejector when the turret reverses. During the forward movement the collar recedes so that plunger *B* can hold a number of collars or washers. As soon as the turret has started on its backward movement, the parts are ejected into the work pan by the compressed coil spring *E*.

One great advantage this arbor or fixture has over others used for this purpose is that after the gang cutter has finished cutting the washers or collars from the bar stock, they have already passed over plunger *B* which holds them when the cross-slide moves away from the bar; thus, in case of chips clogging the gang cutter, there is no danger of the washers or collars hanging fast between the cutters and causing trouble.

O. GORDON

INDEX HEAD FOR HAND MILLING MACHINES

A useful index head for hand milling machines used for machining duplicate parts, is shown in the accompanying illustration. This head is made with a hole through the center, so that the parts to be milled can be inserted in the collet from the rear. The work projects through the front just far enough to allow clearance for the cutters. This fixture is especially suitable for milling pieces such as are shown in the



Index Head for Hand Milling Machines and Samples of Work

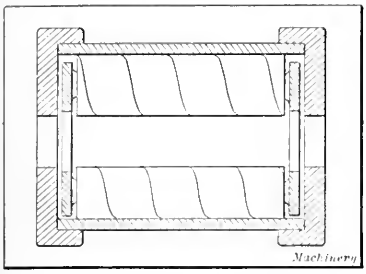
lower part of the illustration, although it can be used as a regular index center in connection with a tailstock center by using a special "dummy collet."

The upright part of the body is made as narrow as possible in order to accommodate short pieces, the heads or shoulders of which might be too large to pass through the collet. The fixture consists of a cast-iron body *B*, in which there is a hardened steel sleeve *S* carrying a spring collet *C*. The latter is equipped with pads and a bushing bored out to suit the part to be milled. The handwheel *H* serves for tightening the collet on the work and also for indexing. The index pin *P* slides in a hardened steel sleeve, and fits in the hexagonal bushings *L*. The latter are carried in an index ring *R*, which is screwed tightly to the sleeve and keyed. The ring is made to index either four or six holes, any holes not in use being plugged with "dummy bushings." The collet has four slots, and on account of its being quite short in proportion to the diameter, it is necessary that the side walls be only about 3/32 inch thick; the slots are also relieved in the middle by openings 1/2 inch wide, in order that the collet may not be too stiff to be closed easily by the handwheel. The largest stock that the collet will take through the pads is 1 1/8 inch diameter.

Oak Park, Ill. R. W. ULLMANN

ROLLER BEARING IDLER PULLEY

We recently received an order for a number of idler pulleys for a 1¼-inch belt. These pulleys were required for use on a group of machines, and aside from specifying that the diameter was to be about 1¼ inch and that they were to be carried on ½-inch shafts, the construction was not specified. The machines on which these idlers were to be used were built with roller or ball bearings and it seemed advisable to follow the same course with the idlers. The method that was finally hit upon is shown in the accompanying illustration. A standard Hyatt roller bearing was selected with a diameter over the sleeve of 1 3/16 inch, which was close enough for the required purpose. Two caps were turned to fit over the sleeve of the bearing, 1 7/16-inch bar stock being used for this purpose. The caps were machined to make them a press fit on the sleeve. By referring to the illustration it will be evident that these caps serve the double purpose of forming flanges for the pulley and heads for enclosing the cage of the roller bearing. The idler pulleys produced in this way were quite accurate and of good appearance; they were practically frictionless and cost less than turned pulleys with bronze bushings.

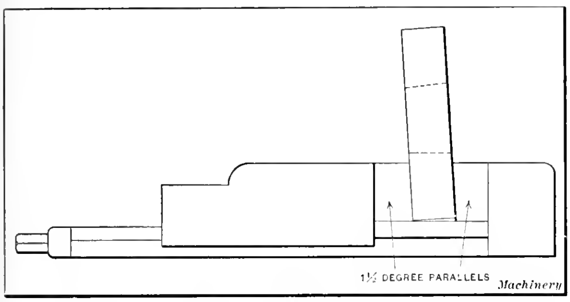


Idler Pulley made from a Standard Hyatt Roller Bearing

Middletown, N. Y. DONALD A. HAMPSON

MACHINING CLEARANCE IN DIES

On page 305 of the engineering edition of MACHINERY for December, A. J. Brickner shows a method of holding dies in the shaper while machining the clearance, by loosening up the shaper apron and tipping it forward. The accompanying illustration shows still another method. The die to be machined is held in the shaper vise by two 1½-degree parallels which hold the die in such a position that the desired angle of clearance is readily machined. These parallels, besides being inexpensive, greatly facilitate work of this kind, and should be a part of every tool-room equipment.



Die held between 1½-Degree Parallels for obtaining Clearance

Waterbury, Conn. CHARLES DOESCHER

BELTS IN COLD WEATHER

In the December number of MACHINERY the following note appeared:

> It has been found by experiments that the difference in power that can be transmitted by the same belt in damp and dry weather may vary as much as 50 per cent, especially if the drive is a vertical one; that is, if in general the pulleys are placed in an unfavorable position.

The writer can imagine no position so unfavorable to pulleys that a difference as great as 50 per cent is possible with belts that are correctly cared for, unless the pulleys are operated out in the open where they might become coated with ice or be subjected to rain or snow. It is true that an excess of snow, ice, or other slippery materials will greatly affect the transmitting capacity of a pulley, regardless of belt treatment, but the mere rise and fall of temperature in a dry or even in a wet atmosphere should have no effect whatsoever. In fact, belts are now waterproofed to such an extent that actual immersion in water for short periods, as in floods, has no appreciable effect on the pliability and pulling power of the belt. A belt that has not been made sufficiently pliable, that has not been waterproofed, and that has absorbed considerable moisture will naturally harden in cold winter weather. And a hard, stiff belt, of course, cannot pull as great a load as when it is pliable. Hardness and stiffness, however, are rapidly going out of date. N. G. NEAR

SPHERICAL BORING-BAR

In the following article is presented a design for a spherical boring-bar for use on a horizontal boring mill. I recently designed this bar and used it successfully in boring a housing for a flexible automobile jackshaft. The housing was first bored straight, forming a cylindrical bore of diameter *D* as shown in Fig. 1. The sides of the work were then faced off to make the total thickness *T*. After these preliminary operations had been completed, the spherical boring-bar was brought into action to machine the inside of the housing to the desired spherical form.

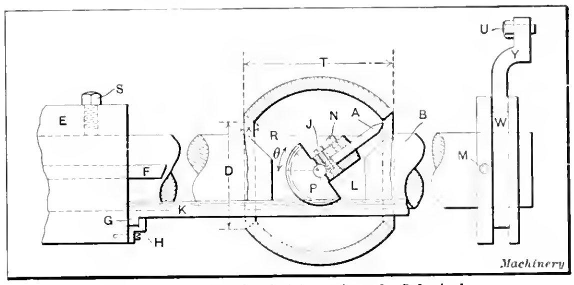


Fig. 1. Cross-sectional View through Spherical Boring-bar and Work

The design of the boring-bar will be readily understood by referring to the accompanying illustration, where it will be seen that the cutter *A* is pivoted in the bar *B*. The bar is keyed to the driving sleeve *E* by means of a feather key *F*. A second key *K* is secured to the driving sleeve; this key has rack teeth cut in it which mesh with a segment gear *P* secured to the lower side of the cutter. The periphery of this segment is of sufficient length to rotate the cutter through the desired angle. The key *K* with the rack teeth cut in it is held to the bar by means of fillister head screws working in slots. When the bar is used for boring cylindrical holes, the cap-screw *S* is used to secure the bar to the sleeve. The action is then the same as that of an ordinary boring-bar.

It will be seen that a grooved collar *W* is provided at the right-hand end of the bar, to which it is held by means of a taper pin *M*; this pin is removed when the bar is engaged in boring cylindrical holes, so that it can be fed through the collar. When used for spherical boring, lateral travel of the bar is prevented by means of the yoke *Y* which is secured to the frame of the machine by means of a stud *U*. The feed of the tool for spherical boring is obtained by the usual bar-feed which moves the sleeve *E* and key *K* along the bar, thereby imparting a uniform feed to the tool by means of the rack and segment gear. It will be seen in Fig. 2 that the key *K* is provided with a lug *G*, over which the keeper *H* is fitted; this prevents the slipping of the key and returns

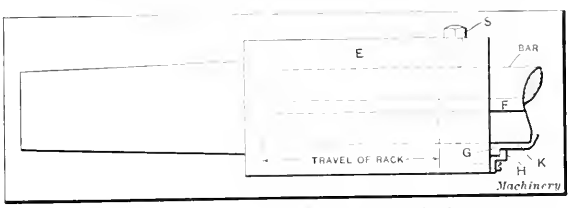


Fig. 2. Bushing for feeding Spherical Boring-bar

the tool to the original position ready for starting a second cut.

In setting up the tool it is necessary to remove the taper pin M and tighten the set-screw S. The bar may then be withdrawn a sufficient distance to the left to operate the gib-screw J and the set-screw N in order to obtain the desired setting of the tool. A fine adjustment is obtained by means of the taper gib L. Before starting the spherical bore, care should be taken to bring the pin upon which the tool is pivoted to a position exactly central between the two faces of the work or a distance $\frac{T}{2}$ from each end. The diameter D of the preliminary bore should be $2R \sin \theta$. The distance X on the work is $\frac{T}{2} - R \cos \theta$. Where a boring-bar of this kind is to be used on standard work, it is generally advisable to have a separate tool for the spherical boring, as the cutting point of the tool used for this work must have a greater radius than the radius of the cutting point of a tool used for cylindrical boring.

Denver, Col. STANLEY EDWARDS

A PLEA FOR BEVELED EDGES

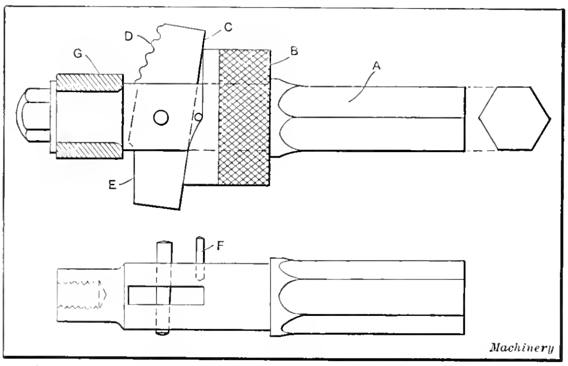
With the advent of modern grinding methods, a practice has developed that is to be deplored. The writer has noticed of late years, that many new machine tools have finished corners ground to a razor edge. A new dividing head (the product of a Cincinnati firm) was so bad in this respect that it was necessary to "break" the sharp edges before it could be handled with safety. One is almost forced to believe that the workmen who build such tools use steel gloves. It would be well if all tools, jigs and appliances were given a uniform curve on their finished lines.

The Brown & Sharpe milling machine is a good example of this practice. All sharp edges are rounded with a 1/16 inch radius tool. This takes little time, and permits the operator to handle the machine with much greater freedom. Let us not forget that the machine tool that is a success must be built for the operator's convenience.

Lafayette, Ind. WILLIAM H. ADDIS

TOOL FOR FACING HUBS

A tool for facing hubs or bosses on castings is shown by the accompanying illustration. As will readily be seen this tool is a roughing and finishing tool combined. The shank or body A has a knurled collar B which holds a high-speed steel cutter C in position. One side of the cutter has a serrated or scalloped edge as at D. This rough edge is set at right angles to the tool shank by turning collar B half a revolution from the position shown. The idea of the teeth is to rip or tear through the scale. After the scale is removed, the collar is turned to locate the smooth finishing edge of the cutter in position, as indicated by the illustration.



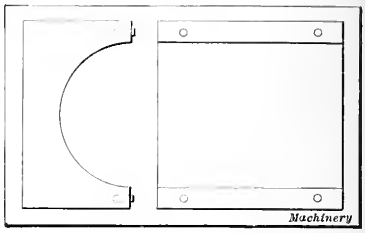
Combined Roughing and Finishing Tool for facing Bosses or Hubs

The pin F acts as a stop for the collar and, at the same time, holds the collar against a shoulder on A. Roller G acts as a pilot for the tool. It is free to rotate and can be exchanged for other sizes. This tool has a hexagonal shank which fits the jaws of the drill chuck and prevents slipping. The roughing and finishing edges of the cutter should be faced off in the lathe before hardening, the shank A being used as an arbor and collar B for holding the cutter in the proper position. The cutter, after being faced, is given the proper clearance. This tool is easily made and is effective, the teeth ripping their way through the scale and leaving clean iron for the finishing side.

B. J. F.

ADJUSTING BEARING BRASSES

It is the practice of some engine builders to leave a space between the brasses of connecting-rod ends, so that wear may be taken up without dismantling the bearings. Usually a piece of leather is put in the space to exert a more or less elastic pressure on the brasses, as well as help to retain the oil; but the first time the rod gets hot, the usefulness of the leather is gone and the joint is generally left open.



Method of adjusting Bearing Brasses

In the writer's experience, brasses thus fitted do not give such good service as when bolted close together. They are likely to cling to the pin at each reversal of stroke; and the play which should take place between the brass and the pin takes place between the brass and the rod, thus interfering with lubrication. Then, in the event of accidental heating, the edges of the brass close on the pin, causing serious damage to the bearing surfaces and invariably requiring the brasses to be removed and eased at the side.

The writer recently tried a little "dodge" on a pair of cross-head brasses which supplied the advantage of the solidly bolted joints and yet allowed wear to be taken up without dismantling the end.

The accompanying illustration shows the device. It consists simply in drilling four holes in the face of one of the half brasses, as shown, and driving in brass pins, which in this case are a little over 3/16 inch in diameter. These pins should be driven to the bottom of the holes. The projecting ends are then filed off until they allow the halves to come together to give a suitable working fit. When wear has to be taken up—if it is attended to in time, as it ought to be—it is found that these pins will crush or imbed in the opposite face sufficiently to allow of this, while the pressure required still leaves the brasses practically solid.

In making adjustments of such brasses as these, it is a custom that is successfully followed both with land and marine engines, to jerk the rod sideways, back and forth, using force according to the size of the engine. This method merely insures that you have not tightened them up too much, which, after all, is perhaps as important as anything.

Christchurch, New Zealand. JOHN PEDDIE

SHRINK VS. PRESSED FITS

In reply to the inquiry by "J. B. F." in the December number, relative to the merits of a pressed or a shrink fit, I favor the shrink fit for the following reasons:

In a large number of shops there are not yet facilities for pressing the machined ring on the shaft (see illustration in December number) other than the sledge hammer, and if the small end of the ring is to be placed last on the shaft there is a possibility of bruising the ring, if it is put on tight enough to hold. In making a pressed fit the average mechanic will file the shaft, cutting off the tops of the ridges left by the tool, and often filing the fit out of parallel, thereby weakening it. The bore of the ring cannot be filed, and it would be considered poor practice to grind or ream the bore as it would lessen, to some extent, the gripping power of the ring.

When the ring is pressed on, the ridges in the bore left by the tool become flattened and are sometimes sheared. To overcome the cutting of the metals, a foreign substance such as oil, paint, white lead, etc., is placed on the surface of the fit, which, in a measure, prevents the metal-to-metal contact. Scoring also takes place sometimes as the shaft is forced through the ring. If the small end of the ring is placed first on the shaft, there is a possibility of its becoming enlarged due to the pressure necessary to hold the ring securely, or ofttimes to the shock produced by the sledge, and sometimes by the cutting, scoring or balling up of the sheared tops of the ridges.

In regard to the molecular arrangement, the molecules adjacent to the fit become compressed or under a strain that is not uniformly distributed. If the ring is subject to shocks, as in the case of gears, the gradual realignment of the molecules will, in time, loosen the holding power of the ring.

In shrink fits it is not necessary to file the fit on the shaft or to ream or grind the bore of the ring, thereby leaving the tool ridges on both the ring and the shaft. When the ring is heated for shrinking, these ridges will clear each other when the parts are being assembled, and, upon cooling, they will, in many places, curl and interlock with each other, insuring a more permanent grip. Again, in shrink fits, it is not necessary to interpose any foreign substance, thereby obtaining a metal-to-metal contact. When the ring is hot it gives the molecules a chance to rearrange themselves, and the strain induced by the pressure upon the cooling of the ring is uniformly distributed.

Anyone having experience with shrink fits that have "stuck" fast knows that it is more trouble to get them loose than with a pressed fit, and, in many cases, the former requires drilling or boring. The only objection to the shrink fit is the discoloration of the parts due to the heat, but if the shrunk ring has to be further machined, this will not be a serious objection. Shrink fits are more easily put together than press fits, and generally a helper is not needed.

Dallas, Tex. SIDNEY HETHERINGTON

In the December number of MACHINERY, J. B. F. inquires about the relative merits of shrink and pressed fits. Assuming that the conditions are alike in both cases, there is this in favor of the shrink fit: The shrink fit can be successfully assembled without lubrication, whereas the press fit can not, and it is reasonable to assume that surfaces will move upon each other more easily with lubrication than without. Of course a hardening lubricant, such as white lead, could be used, but even with this I doubt very much if the adhesion would be as great as with no lubricant at all.

Again, suppose the surfaces were not perfectly smooth, then the irregularities, with a shrink fit, would become imbedded in each other with a doweling effect which could not be obtained with a press fit. I had this proved to my satisfaction about ten years ago by making a mistake in boring out a ring about 10 inches inside diameter, 12 inches outside diameter and 1 inch thick, to be shrunk on the outside of the base of a large valve to increase its diameter. Before heating the ring I happened to try it on the base of the valve and found that it slipped on readily. I mixed some sand and white lead and spread a liberal coat on the valve base, heated up the ring and shrunk it in place, after which the valve was chucked in the lathe and a cut fully one-fourth inch deep taken off the outside of the ring. To the best of my knowledge that fit is doing satisfactory service yet.

Where the quality of the steel is such that it is likely to be impaired by heating, that is, steel that has to be tempered to bring it up to certain physical requirements, care should be taken not to heat the piece above, or up to, the temperature at which it was drawn in its treatment; if this were done then the press fit would excel the shrink fit. This may possibly need some explanation. Suppose the piece of steel illustrated on page 313 of the engineering edition of MACHINERY for December were a good quality of carbon tool steel, and were heated to about 1200 degrees F., hardened in oil, and then drawn to 1100 degrees, which should give the steel its maximum strength and still leave it soft enough to machine. Such a piece would require more pressure to seat under a press than one made of soft machine steel, provided the allowance was the same in both cases.

Where a pyrometer is available it is not at all difficult to avoid overheating the steel, as very little steel whose qualities depend on its treatment is drawn below 700 degrees, and 600 degrees is ample for any shrink fit. If a suitable furnace and pyrometer is not available, the temperature can be obtained accurately enough for all practical purposes by measurement derived from the following formula: Taking the coefficient of linear expansion of tempered steel as 0.000007, D as the diameter of the piece before heating, S as the shrinkage allowance, C as the clearance, T as the difference in temperature, then

$$\frac{(S + C)}{0.000007\ (D - S)} = T$$

or

$$\frac{(0.002 + 0.003)}{0.000007 \times (1.9375 - 0.002)} = 366$$

degrees. If the piece to be shrunk is bored to 1.9355 at a temperature of 60 degrees (allowing 0.002 inch shrinkage) we have 366 + 60 as the heat necessary to increase the bore 0.005 inch, and when the bore measures 1.9405 inch we know that the piece is at 426 degrees approximately. For untempered steel and cast iron, a coefficient of 0.000006 should be used.

With larger diameters where there is likely to be a force exerted tending to push the piece off its seat, interlocking shoulders can frequently be used. In a piece 24 inches in diameter an expansion of 0.1 inch can readily be obtained, which would allow shoulders of 0.05 inch to be used. Of course it would be impossible to assemble such fits by means of a press.

Watervliet, N. Y. D. TAPPAN

CONSTRUCTION OF MOLDS FOR DIE CASTING

The following description of a die-casting mold is intended to give those not familiar with die casting, a general idea of the constructional features of such a mold; the writer has also given some practical pointers on the making of these molds which should be of value to any diemaker thinking of entering the die-casting business. The accompanying illustrations show a mold for a ball-and-socket joint. The mold for a die casting usually consists of the bottom die, top die, the base casting for supporting the dies, and the mechanism for operating the ejector-pins and core-pins. The surface A (Fig. 1) between the bottom and top dies represents the dividing line of the mold, the two dies being separated at this point when the casting is formed and is ready to be removed from the mold. The bottom die is located in the proper position by four dowel pins B (Fig. 2) fastened in the top die. Aside from these main parts of the mold, there is the core-pin plate C, Fig. 1, and the ejector-pin plate D; the former, which is shown to the left in Fig. 2, consists of two parts, E and F, which are fastened together by screws. This plate supports the core-pins G, which form the holes in the casting, and, in some cases, sections of the core which are under cut, as it is not always possible to design the cores in the die so as to provide clearance in all directions. Core-pins intended for clearance holes in the casting, are made not less than 0.003 inch larger than the regular clearance size. When core-pins are 1/4 inch and larger in diameter, spotted holes are preferable to oil grooves, because the lubricant stays in the spotted holes, whereas it has a free movement through an oil groove.

When a large number of core-pins is necessary to form the different holes in a casting, it is usually a good plan to give a number of them (and sometimes all of them) a "floating fit" in the core-pin holder E, Fig. 2. Otherwise, if the core-pins are driven in and headed or riveted over on the under side of plate E, they are sometimes forced out of alignment by being headed a little more on one side than the other, or perhaps the core-pin hole in E is not in perfect alignment with the core-pin hole in the top die, through which the pins pass when operating the mold. Both cases would tend to retard the movement of the core-pins and increase the wear on one side or the other, and in the constant operation of the mold, the

pins might be worn rough or work stiffly, thus making it necessary to have the die repaired. If the pins are given a floating fit in the holder, however, by making the core-pin holes in plate E from 0.001 to 0.002 inch larger than the diameter of the core-pin, the difficulties stated would be overcome.

For core-pins ¼ inch in diameter and larger, it is customary to have a shoulder of from 0.003 to 0.005 inch, so located that it will extend 1/64 inch into the casting. The reason for having this shoulder is that when withdrawing the core-pins from the finished casting, that part of the core-pin which forms the hole, being from 0.003 to 0.005 inch smaller than the core-pin hole in the top die, will have no bearing except in the hole formed in the finished casting. This clearance between the top die and core-pins reduces the liability of the core-pins being roughed up at this vital point, by the dirt that collects around them and is likely to be drawn into the holes when they are withdrawn below the working surface of the top die, preparatory to ejecting the finished casting.

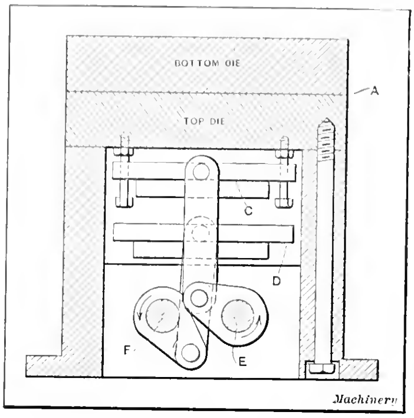


Fig. 1. Diagrammatical View showing Arrangement of Mold for Die Casting

The core-pins are withdrawn by an upward movement of the lever attached to shaft E, Fig. 1, and the shaft F operates the ejector-pins. The movement of the core-pin plate C is controlled by a positive stop consisting of four screws and check-nuts, as shown in the illustration. The length of this movement is governed usually by the thickness of the casting, plus the distance the core-pins enter the bottom die; but in all cases the pins must be withdrawn sufficiently to be entirely removed from the casting. The distance between the core-pin plate and the ejector-pin plate is governed entirely by the length of movement required to withdraw the core-pins, plus the distance necessary for ejector-pins of sufficient length to lift the completed casting clear of the die. The core-pins have a downward movement, whereas the ejector-pins move upward, but both operating levers work in an upward direction. The core-pin plate is usually located next to the top die, and the core-pins should pass through the top die (in the proper location to form the required holes in the casting) and into the bottom die about ¼ inch.

The ejector-pin plate D, Fig. 1, is placed under the core-pin plate and it is guided by the ejector-pins which pass through the top die. These pins are prevented from coming below the surface of the top die by means of four screws and check nuts, similar to the arrangement shown for the core-pin plate C. The ejector-pins usually are fastened rigidly to the plate and are not given a floating fit, as the core-pins are. The ejector-pins, as the name implies, are used only for ejecting the finished casting from the top die after the mold has been separated and the cores withdrawn. The ejector-pins, when in their proper location, should be about 0.001 to 0.002 inch above the working surface of the top die, if the casting is not to be finished, and if the casting is to be finished, they should be about the same distance below the surface. The location of the ejector-pins relative to the casting varies in different dies, and depends upon the form of the casting.

The sprue cutter is used to cut off the sprue in the bottom die after the metal has been forced in, thus leaving the casting free and clear in the die. In Fig. 2 the sprue cutter hole is represented by the cross-sectioned part. It passes from the under side of the base, through clearance holes in the core-pin and ejector-pin plates, and then through the top die (where it should be a perfect sliding fit) into the bottom die. The latter should also be perfectly fitted to the sprue cutter for about ⅛ inch below the cutting edge; beyond this point the hole is tapered for clearance. In operating the mold, the sprue cutter is entered into the top die until it is flush with the working surface, and the metal is forced through the sprue hole into the bottom die; then the sprue cutter is forced through the bottom die, cutting off the sprue, which passes out through the tapered sprue hole in the bottom die, thus leaving the casting in the mold free to be ejected when the mold is separated.

Union Hill, N. J. G. I. Johnson

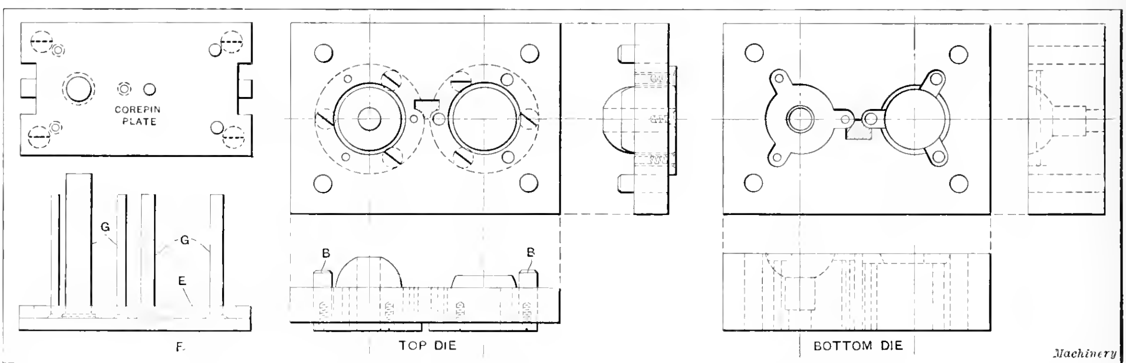


Fig. 2. Core-pin Plate, Top Die and Bottom Die for Die-casting Mold

PROVING MULTIPLICATION AND DIVISION CALCULATIONS

The following is a very simple method of proving multiplication and division calculations which has proved extremely valuable to me in the course of my work, and should be equally so to readers of Machinery who have accurate figuring to do.

For multiplication, proceed as follows: First add the figures of the multiplicand, and if the sum is more than one figure, add again as many times as necessary to reduce the sum to one figure. Next, treat the multiplier and result separately in the same manner. Now multiply the two figures representing the multiplicand and multiplier, and reduce the result to one figure. If the calculation is correct, this figure and that representing the result of the calculation will be the same.

For division, find the sums separately each in one figure, of the divisor, dividend, quotient, and remainder if any. Next multiply the sums of the divisor and quotient, reducing the result to one figure. Now add the remainder, if any, to this result, and reduce the sum to one figure. If the division is correct, this figure will be the same as the one representing the dividend.

While at first sight this method may seem a trifle long and complicated, it is all mental work, and therefore can be done very quickly, which a trial will soon prove.

Montreal, Canada. Oscar W. Miess

SPIRAL PERFORATING

I have read a number of articles in MACHINERY describing methods of perforating, but they all pertain to producing holes in straight lines. We recently had to perforate a number of shells of the type shown in Fig. 1 which have four holes pierced on a spiral at four different places on the shell. After trying various methods, the die illustrated in Fig. 2 was finally designed and proved very satisfactory for handling the work. It will be seen that the tool consists of a die-holder *A*, which is carried by the die bed *B*. This die-holder is counterbored to receive the mandrel *C* and cam *D*, which controls the movement of the shell to obtain the desired location for the holes. An index ratchet *E* is keyed to the left-hand end of the mandrel and held in position by a nut *F* which holds it against the die bed. This ratchet is operated by a pawl carried by the ram of the press. In order to take up any backlash and secure accurate indexing, a spring pin *G* is provided. This pin enters counterbored holes in the ratchet, which are properly spaced to locate the holes in the desired positions in the shell; when the ratchet is moved on to the next station, the pin is forced back into the die bed and then enters the next hole in the ratchet.

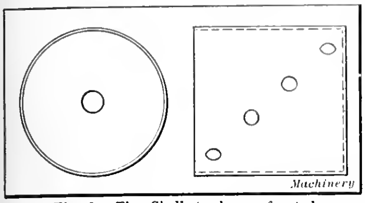


Fig. 1. The Shell to be perforated

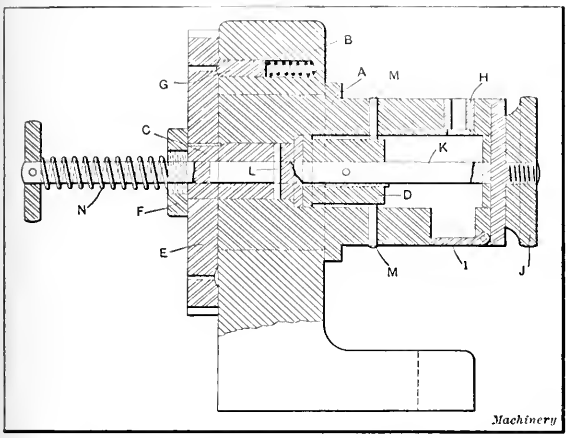


Fig. 2. Type of Die used for the Spiral Perforating Operation

The piercing die *H* is driven into the die-holder and the piercings are held inside the drum until all of the holes have been punched, by means of a trap door *I*. The shell is held in position by means of the nut *J* carried at the right-hand end of the shaft *K*. It will be evident from the illustration that the cam *D* which controls the movement of the shell is secured to the shaft *K* by means of a key and pin. Four pins *M* extend into the bore of the die-holder and these pins are engaged successively by the cam *D*. The left-hand hole of a series is first pierced; the ratchet then rotates the shell and the action of the cam moves it to the right. The indexing is effected as previously described, one hole being pierced at each station. After the four holes on one spiral have been pierced and the ratchet starts to index for the next hole, the pin *M* slips over the point of the cam and the tension of the spring *N* then returns the cam and the work to the extreme left where the cam is engaged by the next one of the pins *M*. This process is repeated four times to complete piercing the holes on the four spirals in the shell. The longitudinal movement of the shell is limited by the pin *L* which fits in a slot in the shaft *K*.

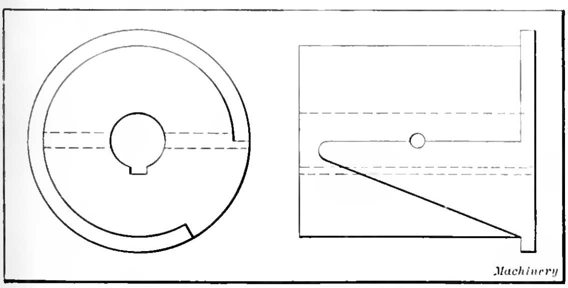


Fig. 3. Cam used on Spiral Perforating Die

C. G.

HAND KNURLING TOOLS

The tools illustrated in Figs. 1 and 2 will be found handy for knurling small stock in the lathe, when the ordinary knurling tool cannot be used on account of the spring of the work.

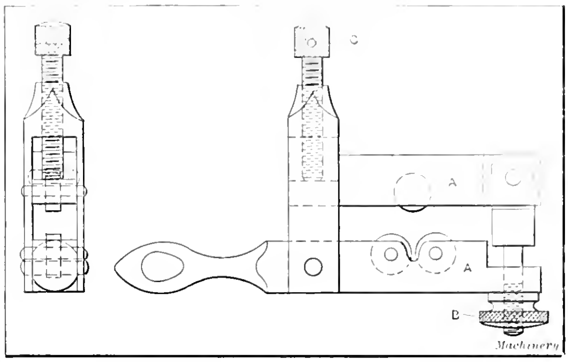


Fig. 1. Hand Knurling Tool for use on Slender Parts

To use the tool in Fig. 1, the bars *A* are adjusted by screw *B*, to come parallel to each other when the knurls are in contact with the work, and the pressure is applied by tightening screw *C*. The tool shown in Fig. 2 is a novelty, but is very cheap and useful. The body *A* is a cheap pair of six-inch pliers having soft jaws which are milled for the knurls. A pair of pliers with parallel opening jaws are the best for this purpose, although the common pliers work very well. The illustration is self-explanatory. The pressure for knurling is produced by the thumb-screw *B*.

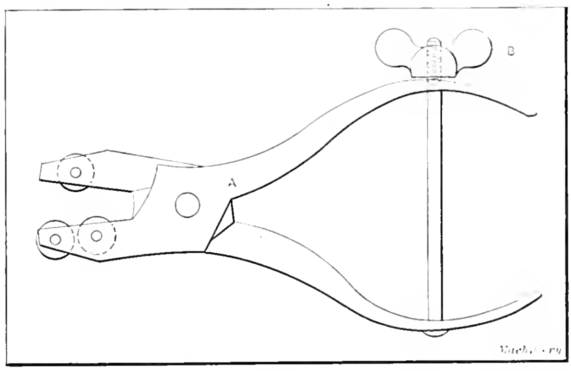


Fig. 2. Hand Knurling Tool made from Pliers

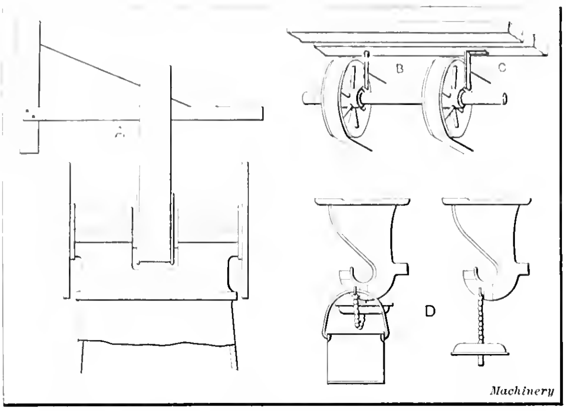
New Britain, Conn. W. C. Betz

OVERHEAD SAFETY SUGGESTIONS

In the average shop, nearly 50 per cent of the belt shifter handles are located out of the operator's reach when he is in the working position. The danger of having a shifter handle out of reach of the operator is evident, and when such a condition exists, some method should be provided whereby the operator can control the machine from the working position. Similarly, machines such as disk grinders, that have two working sides, should be equipped with double shifter handles or an extension should be placed on the

single handle. An example of this kind is illustrated at *A* in the accompanying illustration.

When a belt on an overhead pulley does not run properly, owing to its having become stretched on one side so that it slips off easily, or from any other cause, it is common practice to drive a pointed rod *B* into the beam on the side of the pulley where the belt has a tendency to run off. Should this rod work loose and fall to the floor, it is more than likely to injure someone passing underneath it. In every case where it is required to keep a belt from slipping off a pulley in this way, a forged bracket should be made and screwed onto the beam as shown at *C*. Such a method is but a makeshift at best, but where a bracket of this kind is screwed into place it cannot work loose.



Safety Suggestions for Belt-shifters, Belt-guides and Drip-cups

Accidents from falling drip-cups occur from time to time. There are few instances, however, in which any provision is made for securing drip-cups to the hangers, in order to prevent them from falling in case they become unscrewed due to the vibration of the shafting. To provide for the safety of those working under the shafting in shops, all drip-cups should be periodically inspected, and they should be fastened in such a way that they can be unscrewed in order to enable the oil to be emptied from them while they are still attached to the hanger. The right-hand illustration at *D* shows what happens when a cup becomes unscrewed or slips out of the workman's hand while he is attending to it. It will be seen that the drip-cup is secured to the hanger by a chain so that it cannot fall. Provision should also be made for the oiler or attendant to hang his pail on the hanger while attending to his work. The hook that holds the chain to the hanger could be utilized for this purpose, the idea being clearly shown in the illustration. Such an arrangement gives the oiler the free use of both hands when attending to the drip-cups.

Hartford, Conn. JAMES E. COOLEY

REMOVING A BROKEN TAP

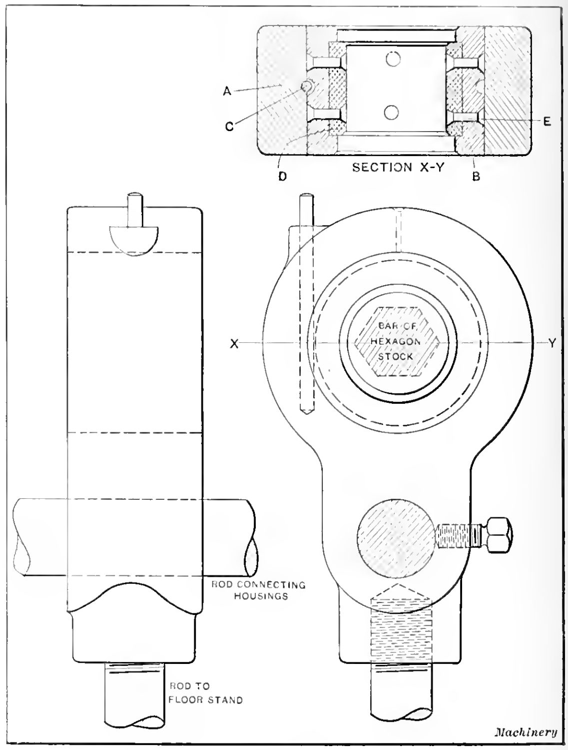
Of all the numerous ideas which have been applied in removing a broken tap, the use of a mixture of sulphuric and muriatic acid seems to be one of the best. In using this method, the first step is to clean all grease and other foreign matter from the hole, using either gasoline or heat for this purpose. Then apply the acid, a few drops at a time; in doing this, particular care must be taken if the tap is bottomed in the hole. The acid cuts both ways, reducing the size of the tap and enlarging the size of the thread, and after a short time the tap can be easily backed out with an extractor or an ordinary pair of pliers. After the acid has been applied, a constant pressure should be maintained on the tap in order to back it out as soon as possible. The hole is then washed out with water to prevent the metal being attacked any more than is absolutely necessary. The use of a little white chalk or alkali in the water is beneficial, as it tends to neutralize the acid and stop all further action. The application of heat will accelerate the rate at which the acid works. The idea is to cut a chip which is formed by the teeth of the tap. Of course where the tap is bottomed hard, a clearance has to be eaten away by the acid, as previously described.

Erie, Pa. A. N. HAMMOND

BACKSTAND FOR AUTOMATIC SCREW MACHINE

The backstand head for an automatic screw machine, shown in the accompanying illustration, was designed to eliminate the noise caused by bars of stock rattling around in the ordinary style of backstand. This improved backstand head consists of a cast-iron housing *A* in which a steel bushing *B* is held in place by a retaining pin *C* in such a manner that the bushing is free to rotate. The center line of the retaining pin is in line with the outside of the bushing, thus allowing half of the pin to enter a groove in the bushing and hold it in place. The groove is of such a size that the pin fits freely in it. The bushing is recessed on the inside to accommodate a piece of double thick leather belting *D* which is fastened to the bushing by brass rivets *E* with countersunk heads. The grip of the leather on the bar stock causes the bushing to rotate, thus distributing any wear which may occur. Bushings of this style are made in three sizes suitable for different diameters of stock.

Three heads of the type illustrated make up a complete backstand, thus supporting the stock at three points and preventing any "whipping" action on account of the short distance between the heads, which is about thirty inches. We have had a stand of this type in use for several months and have found it entirely satisfactory. The stock handled by this particular machine varies from 1 to 2 inches in diameter by 12 feet in length. At present, we are planning to put the same style of backstand on other machines which we are using.



One of the Heads used on the Noiseless Backstand for an Automatic Screw Machine

Chicago, Ill. R. W. ULLMANN

* * *

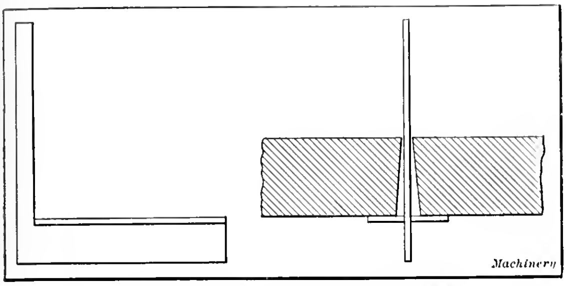
A new soft solder which is said to possess superior properties and to be less costly than ordinary lead-tin solder contains approximately 41.5 per cent tin, 2 per cent antimony, and 0.02 per cent phosphorus, with the remainder lead.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

TOOLMAKER'S SQUARE

Small squares or angle gages of the kind used by toolmakers when filing out a blanking or piercing die will be found much more useful if a flat piece of steel is soldered onto the inside of the stock. This piece of steel is brought exactly square with the blade, the arrangement being clearly shown in the



Useful Attachment for a Toolmaker's Square

accompanying illustration. It will be evident that such a square can be used to advantage when making a narrow die which will only take the blade of the square edgewise. In addition to this application, a square fitted up in this way will be found useful for many other toolmaking operations.

Meriden, Conn. JAMES GALLIMORE

SCALE OF FRACTIONS AND DECIMAL EQUIVALENTS

Of the numerous tables that a draftsman has to have for constant reference, one of those most frequently used is a table of fractions and decimal equivalents. Tables of this kind have been prepared in many different forms, the aim being to produce a form that will give the results in the quickest and easiest way. The accompanying illustration shows a diagram of fractions of an inch and corresponding decimal equivalents which takes the place of tables and is, in the writer's opinion, more convenient for many classes of work than an ordinary table would be. Such a diagram can be easily constructed by any draftsman, a pair of bow-dividers used with ordinary care enabling it to be laid out within the required limits of accuracy. Most of the calculations made by a draftsman do not involve the use of fractions smaller than 1/64 inch and as 0.01, or the second decimal place is smaller than a sixty-fourth, it is useless to use a smaller decimal. Regardless of this fact, many tables of decimal equivalents for fractions up to 1/64 inch are carried out to the fourth, fifth and even sixth decimal place.

The accompanying diagram gives the decimal equivalent of sixty-fourths of an inch to the second decimal place direct, and when desired the third decimal point can be readily estimated. The great convenience of this diagram lies in the fact that it shows at a glance the relative values of fractions of an inch and the corresponding decimal equivalents.

Meadville, Pa. C. H. FARIS

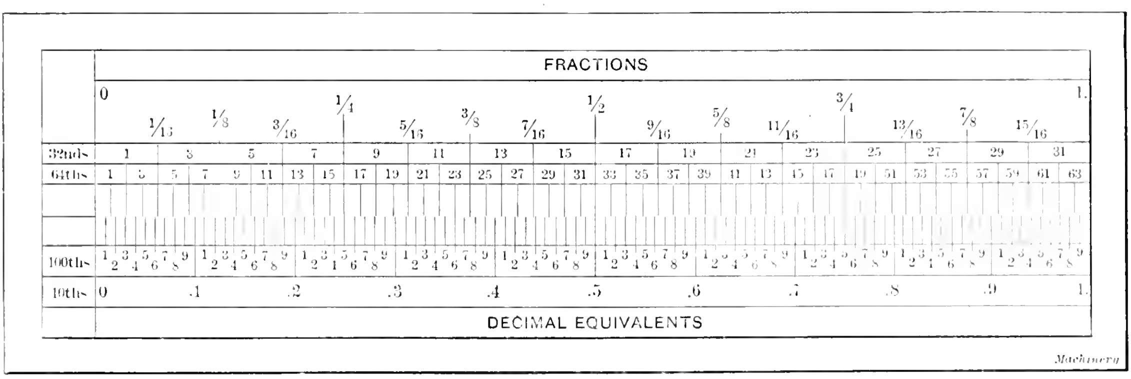
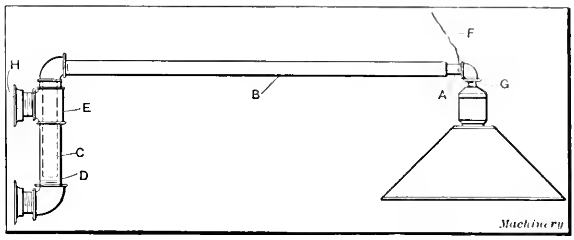


Diagram of Decimal Equivalents, giving Exact Values of Second and Approximations of Third Decimal Place

ADJUSTABLE DRAFTING-ROOM LIGHT

A serviceable form of adjustable lamp bracket for use in the drafting-room is illustrated herewith. This bracket is designed to be attached to the wall or to a window casing and may be used directly in front or to one side of the drawing board. Referring to the illustration, it will be seen that the bracket is made entirely of pipe and pipe fittings, the pipe being cut to the required lengths and threaded at one end only. Horizontal adjustment is secured by slipping the pipe *A* in or out of the pipe *B*, and vertical adjustment is obtained by raising the pipe *C* in pipe *D*. The overhang of the bracket will clamp the pipe *C* sufficiently to hold it at the desired height without the aid of a thumb-screw or other binding device. Any angular adjustment may be obtained by swinging the pipe *C* in pipe *D*.

In making the parts, a drill is run through the ¾-inch tee *E* in order to remove the threads so that it will slip over the



Adjustable Bracket for Electric Light

end of the ¾-inch pipe *D*. This tee is only used as a brace and when it is screwed onto the ¾-inch nipple, the pipe *D* is held in a vertical position. The ⅜-inch pipe *C* slips into the pipe *D* which is made of double strength pipe in order to give a tighter fit. The ⅛-inch pipe *A* slips into the ⅜-inch pipe *B*. A hole is drilled in the pipe *A* close to the elbow to receive the lamp cord *F* which passes down through the elbow and nipple *G* to the lamp socket. The lamp socket screws directly onto the nipple. It is evident that the bracket is secured to the wall by means of screws fitting into the flanges *H*. Dimensions have been omitted from the illustration, as the bracket will naturally be made of different sizes to meet the requirements of individual cases.

Three Rivers, Mich. C. DON MCKIM

* * *

Don't, when a drill gets stuck in a jig, lower the table and try to drive the jig down while it hangs on the drill; knock the drill out of the spindle and remove it from the jig by attaching a dog to it.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DRAWING BRASS TUBING ON STEEL RODS

Answered by C. Fred Gorham, Chicago, Ill.

In answer to the query by G. W. A. in the November number of MACHINERY, regarding drawing brass tubing onto steel rods, I would suggest that instead of drawing or rolling the tubing onto the rod, the following method would give more satisfactory results. Rough-cut the required length of rod in a lathe without lubricating the tool, so that the rod will be perfectly clean but not smooth. Then heat the rod and cast brass around it without using a flux. After the brass has cooled, set the work up in a lathe and turn it down to the required size. The rod should be heated to about the same temperature as the molten brass, but neither the rod nor the brass should be hotter than is necessary to let the brass run freely. The rod should be heated immediately before the casting operation and should not be held at a high temperature any longer than necessary.

PERMANENT SET OF CAST IRON

P. A. L.—I am repairing air cylinders used for opening and closing the doors of elevated cars. Cast-iron spreaders are used to hold the leather packing rings out against the cylinder. I have found a number of these cast-iron spreaders collapsed after being several months in use, which indicates that cast iron can take a permanent set. My foreman says that there is no such thing as a permanent set to cast iron.

A.—Cast iron will undoubtedly take a slight permanent set. The softer the iron the greater the amount of set it will take. This is shown by common experience with piston rings, especially when made of soft cast iron. Often piston rings will be found in a collapsed state, being smaller than the cylinder bore by an amount considerably greater than that due to wear. A common expedient is to peen the inside of the rings, thus giving the rings a permanent set and enlarging the diameter sufficiently to fill the cylinder bore.

CHANGE OF LUMEN METAL BUSHINGS ASSEMBLED BY PRESSURE

H. K.—About sixteen months ago I finished a stock order for our company consisting of a large number of steel shrouds into which "Lumen" metal bushings had been pressed. After being pressed into place the bushings were reamed out to 1.5 + 0.002 inch (1.502 inch), to form a running fit on the shaft. The shafts were made of cold-rolled steel and did not vary more than 0.0005 inch under or over 1.500 inch. The reason for allowing only 0.001 to 0.0025 inch clearance is that the shafts rotated very little in the bearings. After being carefully inspected the parts were boxed and placed in the storehouse ready for use. A few weeks after, we had occasion to send a number of these parts to a contract job, and the construction men found on opening the boxes that the shafts would not enter the reamed holes in the bushings. On inspection we found that a plug gage 1.495 inch would not enter the holes. What was the cause of the trouble?

Answered by Bierbaum-Dollar, Inc., consulting engineers, Lumen Bearing Co., Buffalo, N. Y.

It would be difficult to make an experiment that would show more characteristically a peculiar physical property of "Lumen" metal, an alloy having a compressive strength of 70,000 to 80,000 pounds per square inch. That it should flow under pressure as much as indicated in the foregoing experience will seem rather strange to anyone who has had occasion to observe it for the first time, but that it does act in this way is well attested by our experience. One of the most difficult problems we encountered in the early history of the "Lumen" business was that we could not give satisfactory bushing service. But after experimenting and noting the experience of large users we arrived at the conclusion that "Lumen" bushings must never be forced into a bearing—in other words, made a forced fit. We recommend that all bushings be made a loose fit, or so they can be driven into place with a light pine wood block. Set-screws should be provided to hold the bushing in place. These set-screws should not bottom against the bushing, but should fit in holes drilled deeper in the bushing than the length of the projecting end of the set-screw. Our rule for journal clearance in "Lumen" bushings is 0.001 inch plus an additional 0.001 inch for every inch diameter of the journal. For example, a five-inch bearing should have a clearance of 0.006 inch.

TRADES WAGES IN NEW YORK CITY

F. D. J.—What are the prevailing rates of wages for the building trades, mechanics, etc., of New York City?

A.—The building trades wages per day for 1914 as specified by the United Board of Business Agents, New York, are as follows:

Asbestos workers, boiler felters, pipe coverers, insulators	$4.75
Asbestos workers' helpers	3.00
Blue stone cutters, flaggers, bridge and curb setters	4.50
Blue stone cutters' helpers	3.00
Boilermakers and iron ship builders	5.00
Boilermakers' helpers	3.50
Bricklayers	6.00
Bricklayers' helpers	3.00
Carpenters and framers	5.00
Cabinet makers	5.00
Cement and concrete masons	5.00
Cement, concrete and asphalt laborers	3.00
Derrickmen and riggers	4.00
Decorators and gilders	4.50
Decorative art glass workers	5.00
Elevator constructors	5.28
Elevator constructors' helpers	3.40
Electrical workers	4.80
Electricians' helpers	2.20
Electrical fixture workers	4.80
Engineers, portable hoisting, etc., $30.25 weekly; by the day	6.00
Engineers on boilers, pumps or pile driving machines, per week	30.00
Engineers, stationary	4.50
Framers	5.00
Granite cutters, $5.00 yard; bridge	5.50
House shorers, movers and sheath pilers	3.75
House shorers' helpers	2.65
Housesmiths and bridgemen	5.00
Ironworkers	5.00
Ironworkers' helpers	3.50
Ironworkers' apprentices	3.00
Metallic lathers	5.00
Marble cutters and setters	5.50
Marble carvers	6.00
Marble polishers	4.40
Marble sawyers	4.65
Marble bed rubbers	4.90
Marble cutters' helpers, $3.25; rigging and crane operators	3.75
Mosaic workers	4.50
Mosaic workers' helpers	3.00
Machine stone workers	4.00
Machinists of all description	5.00
Plate and sheet glass glaziers	3.50
Plasterers, plain and ornamental	5.50
Plasterer modelers, per week	$30.00 to 100.00
Plasterers' laborers	3.25
Plumbers and gas fitters	5.50
Painters	4.00
Painter-decorator, painter-striper, painter-gilder	4.50
Painter-letterer, painter-grainer, painter-varnisher	4.50
Riggers on machinery, dynamos, boilers, etc	4.00
Roofers, tar, felt, composition, damp and waterproofers	4.25
Rockmen	2.50
Rock drillers and tool sharpeners, open work, $3.68; tunnel	3.75
Sheet metal workers, coppersmiths, tinsmiths, metal roofers	5.00
Slate and tile roofers	5.00
Steam, hot water and general pipe fitters	5.50
Steam fitters' helpers	3.00
Tile layers	5.50
Tile layers' helpers	3.25
Tunnel and subway constructors	3.75
Upholsterers of all description	4.50
Varnishers	4.00
Wood lathers on new work, $3.50 per M; overhauling jobs	5.00

Foremen's wages range from fifty cents to a dollar a day more than the schedule. All legal holidays and Sundays are figured at double time.

* * *

During 1913 approximately 30,000 applications for patents were made in the United Kingdom, 500 relating to aeronautics.

MACHINING A TRIPLE STAGGERED TOOTH GEAR

A steel gear that is very unusual and probably the largest of its kind ever built was shipped recently by the Mesta Machine Co. of Pittsburg, to the Inland Steel Co., Chicago, and will be used for driving a sheet mill. By the use of this gear and its mating pinion, a single-stage speed reduction is obtained from the motor to the mill. The accompanying illustration Fig. 1 shows this gear in the company's works at West Homestead, Pa. The diameter of the gear is 22 feet, 8 inches, the face width 38 inches, and the circular pitch 5½ inches. The mating pinion is 2 feet 11 inches in diameter. There are 154 teeth in the gear and 20 teeth in the pinion.

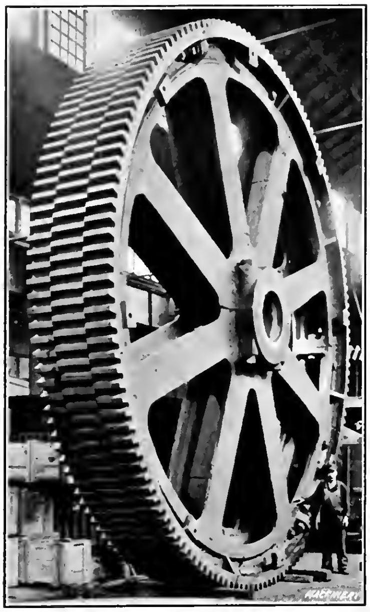


Fig. 1. Large Gear built by the Mesta Machine Co.—Diameter, 22 feet 8 inches: Circular Pitch, 5½ inches; Face Width, 38 inches

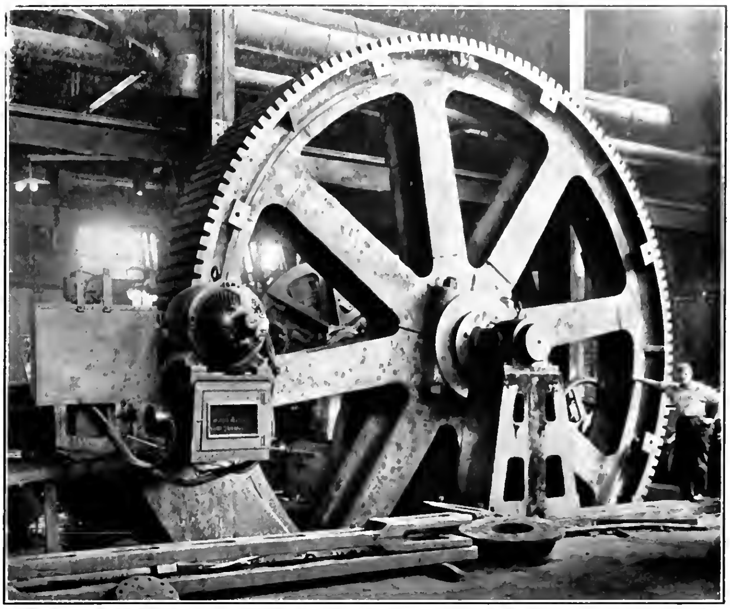


Fig. 2. Large Gear and Special Planer used for cutting the Teeth—Outer Sections of Rim were shifted after Teeth were cut to stagger the Teeth as shown in Fig. 1

The design varies from ordinary practice, the teeth being staggered, as the illustration shows. The gear is built up of six parts. The gear center, including the arms, etc., carries the central rim in which the central row of teeth are cut. The outer rows are cut in separate rims that do not form an integral part of the central casting. The two halves of the gear were bolted together and the separate rims fastened to the central part by bolts extending through the casting. On account of the axial motion to which the gear is subjected, it was necessary to use a spur gear. Herringbone gears were not considered because of the unequal pressures that would be exerted on the sides of the tooth faces. The gears have a peripheral speed of 2000 feet per minute. Because of this high speed the teeth were not only staggered, but very carefully cut, and the drive arranged to run in an oil bath.

The method of machining the gears is very interesting. All the teeth were cut on a planer (shown in Fig. 2) designed and built by the Mesta Machine Co. For such large work, crank-operated tools were found too yielding and, consequently, a special planer was built. The tool of this planer is driven directly by a heavy lead-screw, which, in turn, is operated by a variable speed reversing motor. Starting with the rough casting, the operation of machining this gear will be described. After annealing the casting, the joints at the hub and rim of the central part of the gear were planed. These joints were then drilled, reamed and the two halves

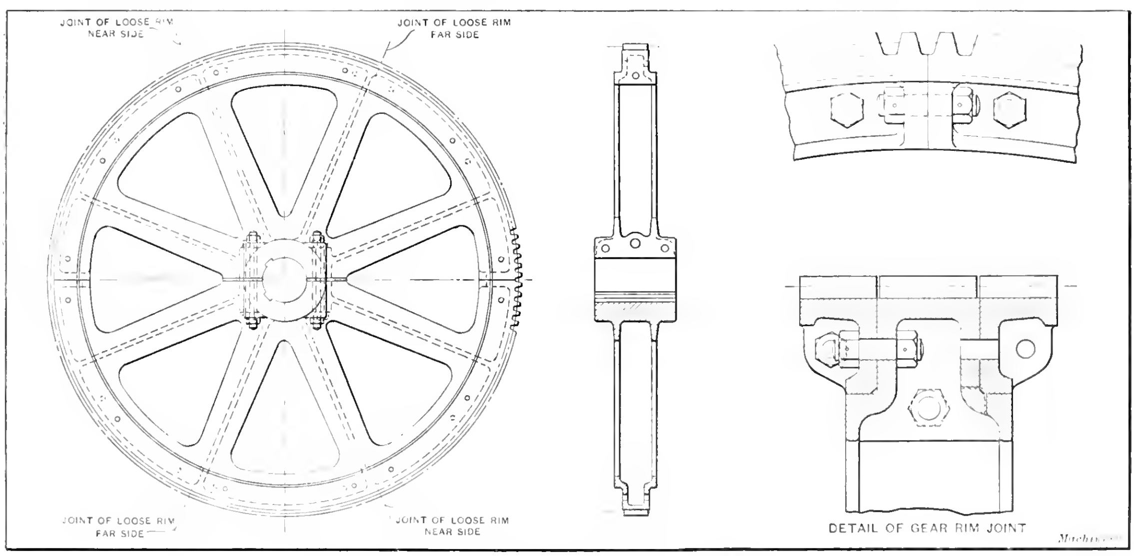


Fig. 3. Large Triple Staggered Tooth Gear made by the Mesta Machine Co.

of the central section bolted together. The wheel was then placed in the pit lathe and the gear center was turned down to the correct diameter; the surface or fitting for the rim segments was also machined. The main gear was then removed from the lathe and the rim segments machined. Lugs were cast on these segments to aid in holding the work onto the faceplate. After bolting a segment onto the faceplate, one side was turned; it was then reversed, the other side machined and the segment turned to the required diameter. The surface of the segment that was to rest on the main gear was also machined at this time.

The rims were next bolted securely to the main gear center with all the rough teeth in alignment across the face of the gear, as shown in Fig. 2. The teeth were then planed through the center and side sections at the same time. The final cut was taken without removing the tool during the entire operation of cutting.

The method of machining the mating pinion was, in a way, similar to that employed for the large gear. After the teeth were cut the bolts were taken out and the two side sections shifted around the center section to give the proper stagger to the teeth. This was done by using an indicating micrometer so that the slightest variation from the required dimensions could be detected. After the teeth of the pinion were staggered, the teeth of the large gear were set to match those of the pinion. Holes were then drilled through both outer rims and the center of the gear, and after these holes were reamed, machined bolts were inserted. The gear was then taken apart and shipped. Inasmuch as the gear is built up of six parts which are fitted together at the plant with machined bolts, its installation will be very simple and it will not be necessary to disturb the machinery already installed.

* * *

THE PARIS AEROPLANE EXPOSITION

The Fourth International Exhibition of Aerial Locomotion, which was held in Paris last December, indicated the keen interest that is taken in all matters pertaining to aviation. The exhibition showed clearly that the aeroplane has reached fixed and definite types. Its development in this respect is similar to that of the automobile. There were no longer displayed the startling novelties and innovations seen in the earlier exhibitions. The monoplanes were exceptionally prominent, and most of them were provided with an enclosure or metallic hood for the motor and pilot, affording protection from wind and storm, and, in military machines, from bullets fired from beneath. All parts of the machine—motor, wings and maneuvering apparatus—were stronger and more durable than in the past. The most marked improvements that have been made are almost exclusively in the direction of stability and safety from breakages and failure of parts. Experience has also taught that with a powerful and trustworthy motor the great spread of wing which was formerly thought essential is not necessary. Great improvements have been made in motors and the best of those exhibited have really attained a standard of reliability very near perfection. These motors have made possible the long continued flights without descents which have marked the past year and which were considered impossible only two years ago, the record being a continuous flight of over 500 miles in somewhat more than eight hours.

There was an interesting and large display of hydro-aeroplanes. The majority of these, as well as of the other types exhibited, were intended for military use, many being protected by armor and fitted with quick-firing rifles. Besides the aeroplanes, there was exhibited a huge military car for a dirigible, which was about 30 feet in length, enclosed in a bullet-proof armor and equipped with quick-firing guns and a complete wireless telegraphy outfit.

The only important American exhibit was the new Curtiss four-passenger hydroplane which is essentially a motor-boat with a biplane attached to it. It was the only four-passenger machine in the exhibition. It has a speed record of sixty miles an hour and is especially adapted to meet the requirements of naval service. The exhibition was attended by a large number of military and naval officers from all countries, who studied every detail of the latest improvements with a view to the requirements of their own army and navy service.

* * *

DIFFERENCE IN ACTION OF PLANING AND MILLING CUTTERS

BY H. A. S. HOWARTH*

Reference was made in the March, 1913, number to the marked difference in all planer tools and face milling cutters on the grids of magnetic chucks, quoting from the experience of the Walker Magnetic Chuck & Grinder Co. Mention was made of the tendency of cast iron to break out at the edge as the planer tool passes over the edge when it completes the cut, whereas with the face milling cutter the tendency to break at the edges of the grids is much less pronounced. Let us assume that the planer tool is ground exactly the same as one of the inserted blades of the face mill, which is a reasonable assumption because it leads us to look elsewhere for the answer. Following are some differences in the action of the two tools:

(1) The path of the planer tool is straight while that of the milling cutter is curved; (2) the planer tool crosses an edge at right angles while the milling cutter crosses at an angle varying from 0 to 90 degrees; (3) the planer tool takes a heavy cut, usually with a single cutting edge, while the milling cutter takes a light cut with each of several cutting edges; (4) the planer tool lacks the support or control of other edges cutting at the same time, thus it is free to jump forward as soon as the resistance ahead of it is reduced; the milling cutter presents several cutting edges to the work at one time and hence only one edge begins or ends its cut at a time; the rest of the cutting edges under cut are buried in the metal, thus preventing the departing cutter jumping forward; (5) the cutting speed of the planer is likely to be much less than that of the milling cutter because of the difficulty of reversing the table when moving at high speed. Obviously, there is no such condition limiting the speed of the milling cutter. (6) The planer in most cases when small has a pinion, gear and rack drive for the table. The driving mechanism is full of spring, due to the twisting shafts. The milling machine table almost invariably has a screw feed for the table. The milling cutter has a gear drive usually, and this corresponds in a large degree with the gear drive of the planer table, as far as jumping effect is concerned.

Looking over the above comparisons, it seems probable that (3), (4), (5) and (6) explain the difference in action noted. The planer tool is given a comparatively heavy feed in order to get the work out quickly. The result is that the tool jumps forward at the end of this cut and breaks off a piece that extends slightly below the planed surface. The milling cutter takes several fine chips at once and only one breaks over the edge at a time. Hence, the cutter does not jump forward because it is supported by several other cutting edges. The screw feed of the milling machine table steadies its motion and to a large degree removes the tendency to jump.

* * *

NEW SIZE JOURNAL, A. S. M. E.

The *Journal* of the American Society of Mechanical Engineers has been enlarged from 6 by 9 inches to 9 by 12 inches. The new size of page favors the presentation of tables, large diagrams, etc., and it will rarely be necessary to resort to inserts and folders, which are costly and inconvenient to the reader. The transactions of the society will not be bound and distributed to the members hereafter. The numbers of the *Journal* will contain the complete transactions and should be kept and bound if the members wish to preserve them.

* * *

During 1913, out of a total of nearly 3200 passenger cars ordered for the railways in the United States, 2765 were of steel, 171 were steel under-frame, and only 177 were of wood; the construction of the remainder is not specified. There is also a very marked increase in the use of steel-frame box cars.

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NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

CLEVELAND ROTARY TILTING MAGAZINE

The rotary type of tilting magazine, front and rear views of which are shown in Figs. 1 and 3, is a recent product of the Cleveland Automatic Machine Co., Cleveland, Ohio, that has been developed for use in connection with the Cleveland "automatic." This attachment is used on second-operation work and is shown producing pieces of the form illustrated in

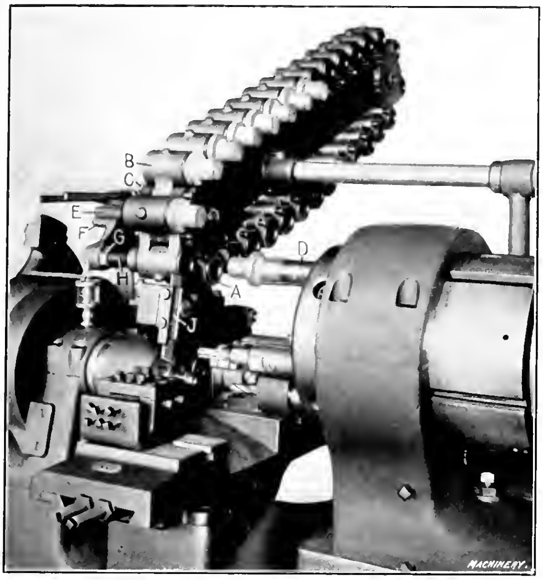


Fig. 1. Front View of Cleveland Rotary Tilting Magazine

Fig. 2. These pieces are produced from cast-iron blanks and it is necessary in this case to separate the work that is gripped in the chuck from the remaining portion. For this purpose the independent cut-off is used. Pieces of this type were produced in five minutes with an actual labor cost of one-half cent. A feature of the attachment is that a bushing required for a large piece of work can be provided with internal bushings to adapt it for holding smaller sized pieces. Occasionally when the magazine is used for some odd shaped piece that has surface enough to grip in the chuck, it is

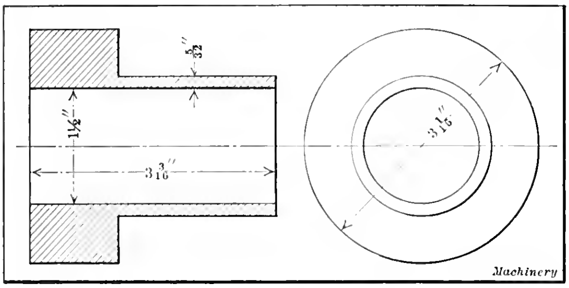


Fig. 2. Example of Work handled by Cleveland Rotary Tilting Magazine

necessary to employ a simple form of latch held by a spring to keep the piece from falling out. This statement applies only to second-operation work and is referred to to show that the magazine may be employed for practically any shaped piece upon which a second operation must be performed. Aside from the tools required for different jobs, the only special equipment necessary is bushings of the required size.

Fig. 1 shows the magazine in the working position. The magazine tilts to the working position and after the piece has been removed it rises to clear the turret tools. In this respect it is similar to the original form of tilting magazine built by this company, but differs from the preceding design in that the parts to be machined are placed in the bushings *A* which are mounted in the links *B*. This arrangement permits of handling a greater variety of irregular shaped parts than was possible with the original form of magazine, where the parts were laid one upon the other and guided by parallel bars. The chain composed of the links *B* is indexed by means of the lower pair of sprocket wheels *C*, one of which is provided with a series of pins that engage an index pawl not shown in the illustration. This pawl rotates the sprockets upon the downward tilt of the magazine and brings each link *B* in line with the conveyor *D* in the turret hole; upon the upward tilt, the pawl drops down and engages the pin following the one that has acted upon it. The sprocket shaft *E* rests in the saddle *F* on the main supporting arm *G*, which serves as a stop and also maintains the required alignment while the conveyor is removing the part to be machined.

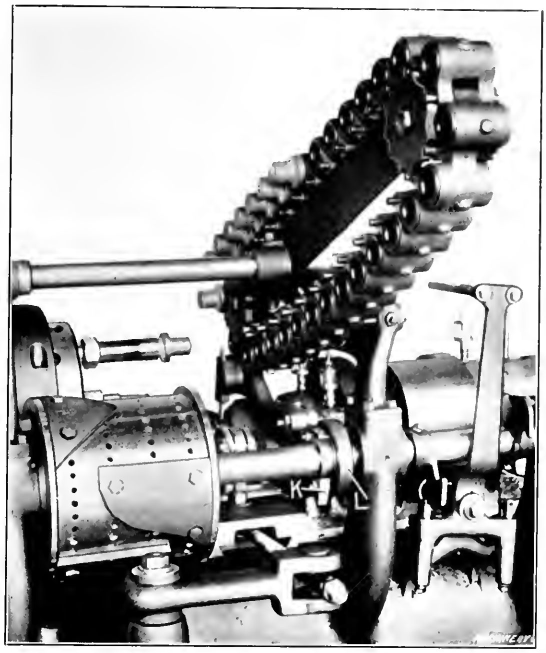


Fig. 3. Rear View of Cleveland Magazine

The adjustable stop *H* mounted on the main supporting arm prevents the conveyor straining the magazine while removing the work from the bushing. Fig. 3 shows the cam *K* and the disk *L* that are employed to operate the independent cut-off attachment. The cam and lever which operate the magazine are mounted on the cam-shaft at the extreme left of Fig. 3, and are not shown in the illustration. This magazine does not interfere with the use of the independent cut-off attachment shown at *J* in Fig. 1, or with the operation of the machine on bar work.

LANGELIER DRILLING AND TAPPING MACHINE

The four-spindle horizontal drilling and tapping machine shown in Figs. 1 and 2 is a recent product of the Langelier Mfg. Co., Providence, R. I. This machine is intended for drilling and counterboring or for tapping four holes simultaneously. An idea of the classes of work for which it is adapted will be obtained by referring to Fig. 3. The positions of the spindles are adjustable to enable the machine to handle a great variety of work. Machines of this type

are built with different numbers of spindles and in different sizes. The four-spindle machine shown in Figs. 1 and 2 has a capacity for drilling and tapping holes up to 3/8 inch in diameter in cast iron, mild steel, brass and other metals. The height from the top of the fixture platen to the center line of the spindles is 5 3/4 inches, which allows plenty of room for handling work or jigs of considerable size.

The two heads at each end of the machine may be moved back until the ends of opposing spindles are 18 1/2 inches apart, or the heads may be advanced toward each other until the distance between the ends of the spindles is only 8 1/2 inches. The front spindle at each end of the machine is provided with transverse adjustment so that these spindles may be located at distances ranging from 1 1/4 to 3 1/2 inches from the center line of the rear spindles. This adjustment is obtained by a cross-slide and screw. Each head is mounted separately on a finished and gibbed saddle interconnected with the feed. The two heads at each end of the machine are withdrawn as a unit by manipulating a single hand lever. Positive adjustable stops are provided for accurately controlling the movement of the saddles so that work produced by an unskilled operator will be uniform, and time losses resulting from over-travel of the saddles are eliminated.

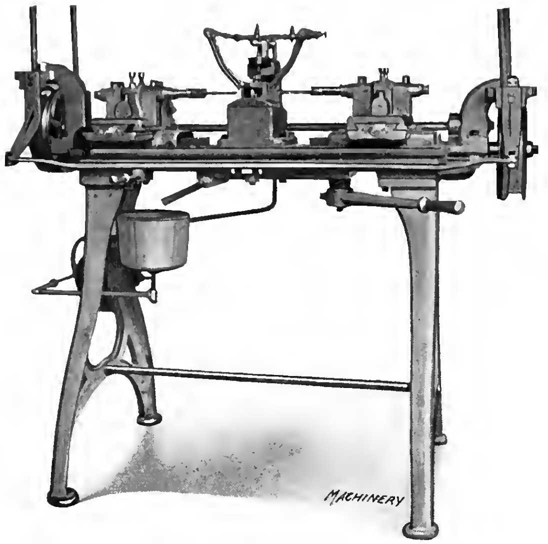


Fig. 1. Front View of Langelier Four-spindle Drilling and Tapping Machine

The spindles have No. 1 Morse taper to receive drill chucks or tap-holders with No. 1 taper shanks. A hard phosphor-bronze gear is keyed to each spindle and driven by a steel driver mounted at right angles to the spindles. The cross-shafts on which the driving gears are mounted are driven from the main horizontal shaft at the back of the machine through another right-angle spiral gear drive. Drilling and tapping thrusts are carried by hard phosphor-bronze and hardened steel washers, and means are provided for taking up end-play.

The machine is driven by tight and loose pulleys which are grooved to carry built-up round leather belts located at the left-hand end of the main driving shaft. Round belts were selected for this purpose because the machine can be reversed with them more quickly than would be possible if flat belts were used. In fact, reversal may be obtained almost simultaneously and without any slipping of the belt. As previously stated, the spindles are driven by the pulleys at the left-hand end of the machine. For tapping operations, when the stop governing the depth to which the work is to be tapped is reached, the tap-holders unclutch and the operator shifts the driving belt to the loose pulley. In so doing, the reverse driving belt at the right-hand end of the machine is shifted from the loose to the tight pulley, thus reversing the direction of rotation of the spindles and backing the taps out of the holes. The taps are backed out at a faster speed than that at which they are fed into the work. The change of speed and direction of rotation is obtained without employing crossed belts, by the use of accelerating gears interposed between the jack-shaft and the main horizontal driving shaft. A special countershaft has been designed for use in connection with this machine which provides two drilling and two tapping speeds.

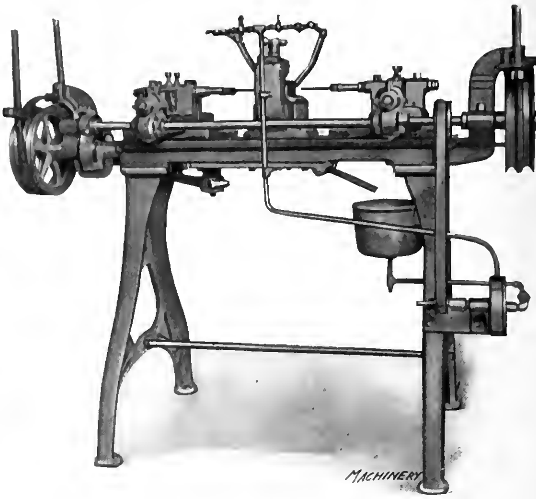


Fig. 2. Opposite Side of Machine shown in Fig. 1

The flow of oil is under the direct control of the operator. Suitable flexible piping connections with pet-cocks lead the oil supply delivered by the rotary pump to the required points. This pump is located at the back of the machine, as shown in Fig. 2, where it will be seen that it is belted to the main driving shaft. All surplus oil and chips are retained on the bed of the machine by the high rim which runs around it. The oil runs into a self-straining reservoir which is piped to the pump suction. In this way the oil is kept in constant circulation without requiring any attention from the operator. Efficient oilers are provided for lubricating the spindles, gearing and other moving parts. This machine occupies a floor space of about 24 by 60 inches; the height from the floor to the spindles is 42 inches, and the weight of the machine is 1750 pounds.

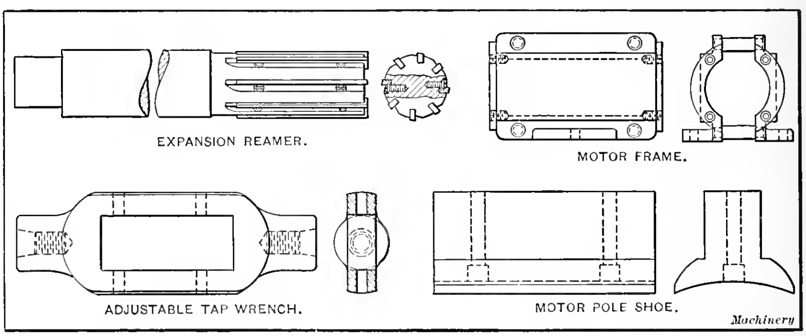


Fig. 3. Examples of Work done on Langelier Drilling and Tapping Machine

ROCKFORD MULTIPLE SPINDLE DRILL

In the design of a line of multiple spindle drills which has been brought out by the Rockford Lathe & Drill Co., Rockford, Ill., the idea has been to produce a simple and accurate machine that is convenient to operate and of ample weight to meet the requirements of modern manufacturing

methods. Referring to the accompanying illustration, which shows one of these machines, it will be seen that the column is of the box type. The table is raised and lowered by a handwheel and has adjustable supports. It may be removed for replaning in event of its becoming badly worn. The spindles are made of high-carbon steel, forged and accurately ground. Ball-thrust bearings and stop-collars are provided, and the spindles are counterbalanced by chains and weights.

Rockford No. 210 "Economy" Floor Drill

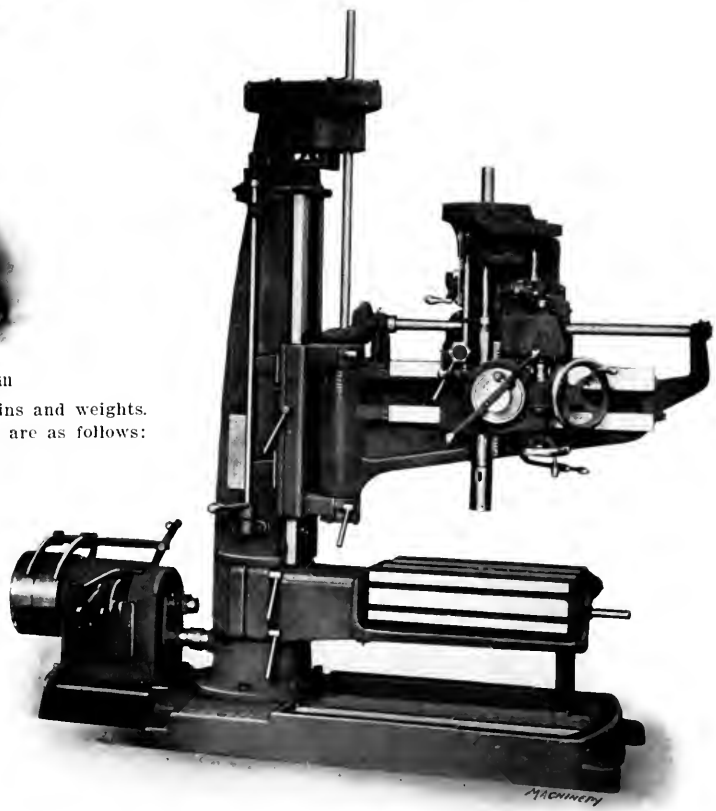
The important dimensions of this machine are as follows: Distance from column to center of spindles, 7¼ inches; greatest distance from spindles to table, 27 inches; distance from center to center of spindles, 10 inches; vertical travel of spindles, 5½ inches; vertical adjustment of head, 9 inches; holes in spindles, No. 2 Morse taper; size of table, 12 by 20 inches; and net weight of machine 655 pounds. The capacity is for drills up to ⅝ inch in diameter. In addition to the two-spindle machine shown in the illustration, this line comprises three- and four-spindle machines.

FOSDICK HEAVY-DUTY RADIAL DRILL

The three-foot size heavy-duty radial drill illustrated herewith is the latest product of the Fosdick Machine Tool Co., Cincinnati, Ohio. With the exception of the box type of column, the arm and the table, this machine is similar in design to the round-column radial drill of the company's manufacture which was illustrated and described in the August, 1913, number of MACHINERY. This new radial drill is adapted for handling a great variety of work. Correct feeds and speeds are instantly obtainable for all sizes of drills from 5/16-inch carbon up to 3-inch high-speed steel. A complete feed and speed table is attached to the column of the machine where it may be conveniently referred to by the operator. To provide means of lubrication for heavy drilling and tapping operations in steel, an oil channel is cast around the base of the machine; this channel drains into a large reservoir under the column where a pump and piping system may be attached. For lighter drilling and tapping operations in steel, a liberal sized channel has been provided around the table; this channel drains to one corner under which a receptacle may be placed to receive the lubricant, thus avoiding the necessity of using a pump and return piping.

It has already been mentioned that the design of the column and arm are one of the new features of this machine. The column is a heavy one-piece box section internally ribbed to provide the necessary rigidity. The arm is of pipe and beam section, this form of construction having proved itself to be an exceptionally rigid combination. This design also provides for a long saddle bearing which can be securely gibbed to the wide flat face of the column, thus reducing the possibility of the arm sagging to a minimum. Means are provided for taking up any amount of wear, and the binder levers are located close to the operating position. The arm rests on a special ball bearing, which reduces the effort required to swing from one position to another, and as the pivoting point is in the saddle close to the work the movement of the arm is made very sensitive. This enables exact settings to be made very rapidly.

The elevating screw which raises and lowers the arm on the highest speed by power is suspended from a ball bearing and the handle is placed in a convenient position for the operator. Safety trips are provided at both extremes of the movement. The tapping reverse frictions are of simple construction and afford ample power. They may be instantly adjusted for any amount of wear, this adjustment being made from the outside of the case in which the gears run in oil.



Fosdick Three-foot Heavy-duty Radial Drill

The back gears are located on the head and give three changes, any one of which is obtained by the operation of a single lever. These changes can be made without the necessity of stopping the machine. The back gears are located between the spindle and the frictions and permit the heaviest work to be handled without slipping. The bevel gears used on this machine are planed to a theoretically correct outline, and the spur gears are cut with special cutters which insure noiseless operation. The gears are of steel, and where exceptionally heavy service is encountered the gears are hardened.

The feed worm-wheel runs in oil. Five changes of feed are available, all changes being made by a single lever without requiring the machine to be stopped. The feed-box is designed to give support at both ends of the feed worm. The speed box provides six changes, any of which is obtained by the operation of a single lever which is secured by a latch to prevent chattering when the machine is engaged on the heaviest class of work. A positive over-take keeps the machine running at a reduced speed, thus avoiding shock when making speed changes. All of the gears are adequately covered and yet readily accessible. The lubrication system is very complete. Oil chambers or felt wipers are used accord-

Fig. 1. Victor Bolt and Pipe Threading Machine

ing to the location, and the bearings are bushed with phosphor-bronze.

Motor drive may be employed on this machine at any time without requiring a special base or speed box. A constant speed or a 3 to 1 variable speed motor is suitable for this purpose, the size required being from 3 to 5 horsepower. The motor should be arranged to drive through a rawhide pinion. Although this machine is nominally a three-foot size, the maximum distance from the spindle to the column is 39 inches, and the distance from the spindle to the base is 52 inches. The net weight of the machine is 4200 pounds.

VICTOR BOLT AND PIPE THREADING MACHINE

The Victor Tool Co., Waynesboro, Pa., recently added to its line the bolt and pipe threading machine shown in Fig. 1. This machine is equipped with a patented die-head which opens and closes positively, no springs being employed. The head is equipped with an adjusting device for regulating the chasers to the required size. All four chasers are moved at the same time by means of this adjustment. When the chasers have been set to the size of the thread to be cut, the head is locked, thus holding the die to a uniform size. Each chaser holder is fitted with a set-screw at the side, by which the angle of the chasers can be regulated to suit the pitch of the thread to be cut. All adjustments can be easily and quickly made. There are no delicate or complex parts of the mechanism to get out of order and cause delay in operation.

Fig. 2 shows a side view of the die-head, illustrating how the opening and closing ring operates. The graduated adjusting screw and the locking screw are also shown in this illustration. Front and rear views of two chasers are shown, from which their design will be readily understood. The chasers are held in the holders by means of hardened screws which enable them to be quickly removed. They are hardened for their entire length and the rake can be ground to suit the various kinds of material that are being threaded. The same chaser can be used on either right- or left-hand work by using a special holder for left-hand threading operations and reversing the chaser. The chasers can be adjusted independently of each other by using the backing-up screw in the end of the holder. This die-head can be attached to any make of bolt threader.

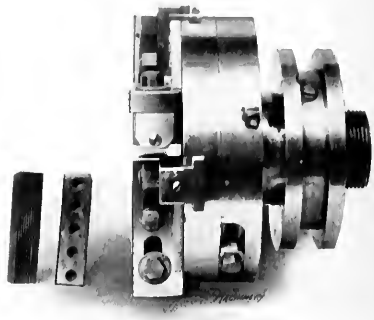
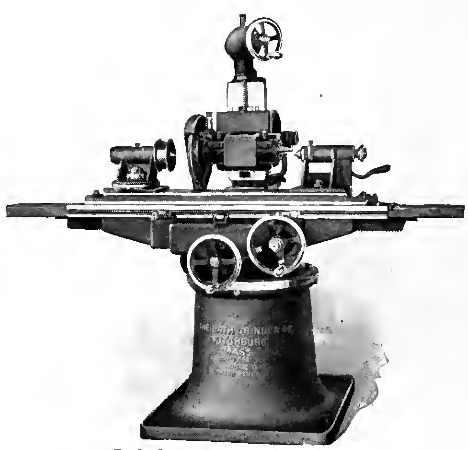


Fig. 2. Die-head used on Victor Bolt and Pipe Threading Machine

BATH CUTTER AND REAMER GRINDER

The accompanying illustration shows the No. 0 cutter and reamer grinder developed by the Bath Grinder Co., Fitchburg, Mass. The general lines are somewhat similar to those of the universal grinder of this company's manufacture, but the present machine embodies a number of distinctive features which are essential for rapid and accurate production on cylindrical, internal, surface, disk, cutter and reamer grinding. The base of the machine has the column permanently bolted to it, the column being internally ribbed to resist torsional strains. The wheel-head is gibbed to the column and has but one movement, which is vertical.

The cross-slide knee carries the cross and longitudinal slides, and has a circular base of liberal proportions. It swings around the vertical column through an arc of 90 de-



Bath Cutter and Reamer Grinder

grees so that the work-table may be brought to the required position for the various grinding operations for which this machine is adapted. The cross-slide is substantially ribbed and of liberal dimensions. The ways are scraped to master plates and thoroughly protected from water and grit. The table is provided with a swivel-plate for grinding taper work.

and has a scale graduated to indicate tapers in inches per foot. The headstock has a swivel base graduated to 180 degrees, and dead and live centers may be used.

The wheel-head is of rigid construction, the wheel spindle being hardened and ground. The spindle runs in adjustable phosphor-bronze boxes which are thoroughly protected from grit. The handwheel which feeds the wheel-head vertically is graduated to 0.001 inch, and is provided with a positive stop. This handwheel can be readily operated from either the front or side of the machine. The table is operated by hand and equipped with slow and fast travel. Positive stops are provided for both longitudinal and cross feeds, the cross feed handwheel being graduated to 0.001 inch. Water may be used on all operations for which this machine is adapted. The machine is of massive construction and the full universal feature adapts it for grinding large inserted tooth milling cutters up to 20 inches in diameter.

The principal dimensions of the machine are as follows: length between centers, 20 inches; swing, 10 inches; normal range for surface grinding, 9 inches wide by 15 inches long by 5½ inches high; normal range for disk grinding, 10 inches in diameter by 2 inches thick. The vertical movement of the grinding wheel head is 7 inches, and the swivel-plate is graduated to provide for grinding tapers up to 3 inches per foot. The net weight of the machine is about 2100 pounds.

Special attachments which can be obtained for use in connection with this grinder are a water attachment, a radius attachment, an internal grinding attachment and a gear-cutter attachment. The equipment includes a universal work-holder and flange plate, a horizontal vise, a 5-inch four-jaw chuck, a faceplate and draw-in collet, a combined spring and center-rest and countershafts. The following accessories are made for use in connection with this grinder: High and low tooth rests, a diamond stand, two swivel plate clamps, two grinder dogs, three wheel collets, a wheel hood and a wheel flange. The machine may be obtained with full or partial equipment, as desired.

UNITED STATES UNIVERSAL DRILL

The important feature of the portable electric drill illustrated in this connection is that the motor is applicable for use on either 110 volt direct current or 110 volt alternating current of 25, 30, 40 or 60 cycles, single phase. This type of motor was designed by the Westinghouse Electric & Mfg. Co. for use in connection with these drills, the motors being of the series wound type and air cooled.

The gears used in this portable drill are made of chrome-

United States Universal Electric Drill for Use on Alternating or Direct Current

nickel steel; they are hardened and run in grease. The spindle bearings also run in grease. The electric switch is simple in design and construction and is capable of standing up under hard service. This type of electric drill is adapted for either metal drilling or wood boring. Drills of this type are made in three sizes having capacities of ⅜ inch, ½ inch and ⅞ inch by the United States Electrical Tool Co., 6th Ave. and Mount Hope St., Cincinnati, Ohio.

BAKER HIGH-SPEED DRILL

Baker Brothers, Toledo, Ohio, have recently added to their line of drilling machines the No. 1-B high-speed ball bearing drill shown in Fig. 1. One of the characteristic features of this machine is the arrangement of the drive; this is effected through hardened steel gears mounted on shafts which run in ball bearings. Six speed changes are obtainable through the arrangement of sliding gears shown in Fig. 2. For a driving pulley speed of 500 revolutions per minute, the

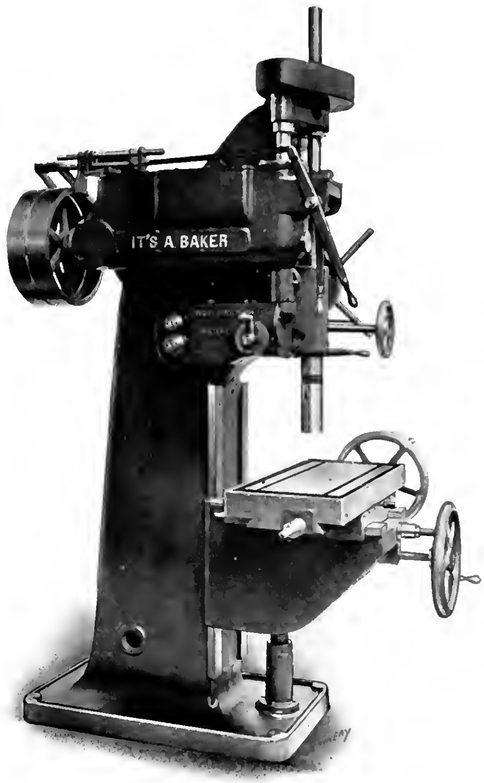


Fig. 1. Baker No. 1-B High-speed Drill

spindle speeds are as follows: 500, 369, 258, 179, 130 and 92.5 revolutions per minute. This corresponds as nearly as possible with the proposed "chromatic scale" of speeds which is advocated by some of the well-known efficiency engineers. It will be noticed by referring to Fig. 2 that with any of the six speed changes, only one pair of gears is in mesh. This not only increases the efficiency of the machine, but also adds to its durability. The latter is a particularly essential feature, as drilling machines experience very rough treatment at the hands of the average drill press operator. The gears are shifted by three parallel rods, the gear shifting lever sliding across an H-plate, giving positive interlocking and at the same time a smooth quick change.

The spindle is made from a high carbon steel forging and the thrust is effectively taken by ball bearings. The diameter of the spindle at the driving end is 2 inches, and the diameter in the quill 2¼ inches. It is bored No. 5 Morse taper. The spindle has a vertical feed of 16 inches, and is equipped with a depth stop. Twelve changes of feed are obtainable, these changes being as follows: 0.006, 0.007, 0.008, 0.010, 0.012, 0.013, 0.015, 0.017, 0.020, 0.024, 0.028 and 0.032 inch per revolution of the spindle. These changes are obtainable by means of a powerful drive key and quick change slip gears. A safety device on the spindle feed shaft is provided to protect the mechanism from injury, and to provide uniform wear on the large worm-gear.

Machines of this type are equipped with either a plain or a compound table. The size of the plain table used is 24 by 29 inches over-all, and 17 by 23 inches inside the oil

grooves. The table is elevated by a screw. The compound table has screw adjustments in all directions and micrometer collars are provided for making accurate in-an-out and cross movements. With the screw adjustments it is not necessary to lock the table in position after adjustments have been made. The over-all size of the compound table is 16 by 30 inches. By way of conclusion, it may be mentioned that drilling machines of this type are equipped for either parallel drive, as shown in Fig. 1, or for the right-angle drive illustrated in Fig. 2.

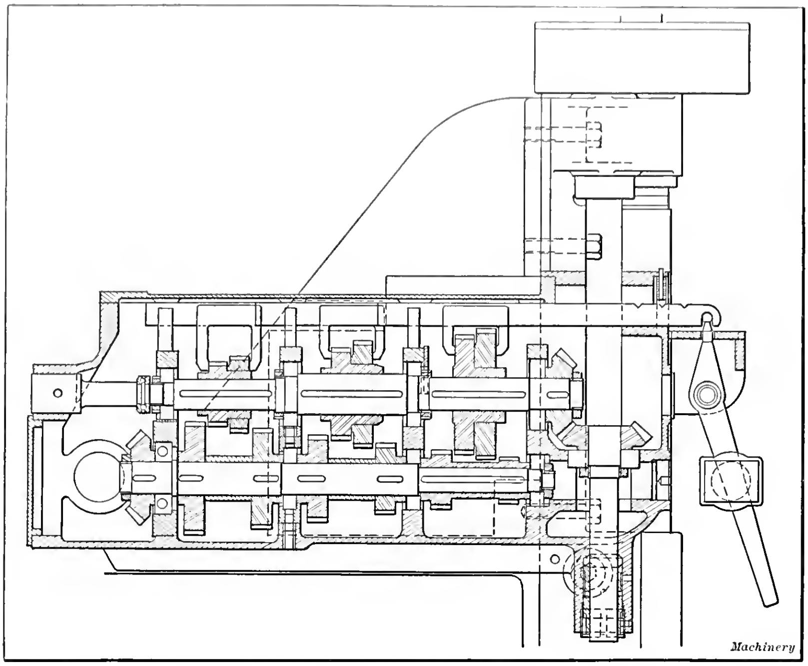


Fig. 2. Speed Box on Baker Drill arranged for Right-angle Drive

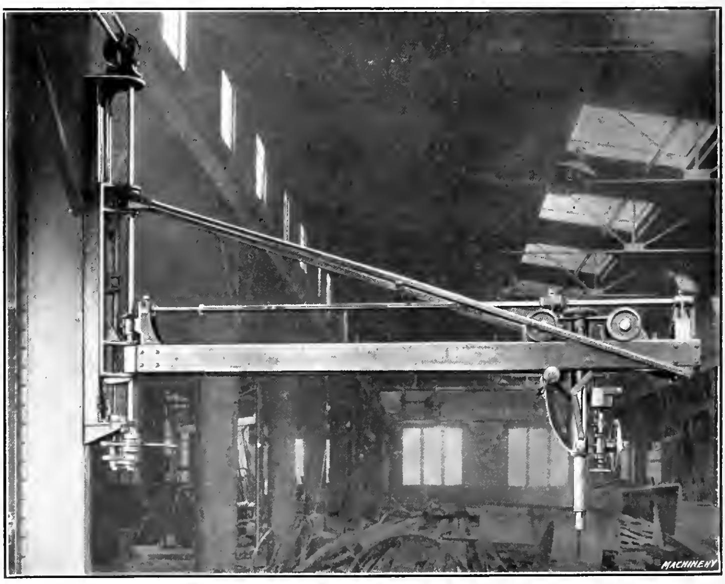
MILWAUKEE WALL TYPE RADIAL DRILL

The accompanying illustration shows the Milwaukee wall type radial drill which is a recent product of the J. C. Busch Co., Lake and Ferry Sts., Milwaukee, Wis. The Vulcan Engineering Sales Co., 2059 Elston Ave., Chicago, Ill., is the sales agent. This drill was designed to meet the requirements of bridge and structural shops and numerous other factories where large surface areas are to be covered for drilling, reaming or countersinking. In working out the design it has been borne in mind that the average machine in such shops receives very hard usage and correspondingly slight attention. To produce a drill that would stand up under such service, the construction has been made exceptionally rigid. All gears are cut from solid blanks and all bearings are bronze bushed, thus reducing friction losses to a minimum.

The machine can either be bolted to a building column or to the wall, or it may be carried on a truck in order to obtain the advantage of a portable tool. A stud is furnished at the end of the arm to afford a means of anchoring the arm to the floor when the machine is engaged in drilling holes of large diameter. Power is obtained by coupling a countershaft to the upper horizontal friction-clutch shaft. The wall plate is a heavy casting with machined ways to guide the elevating carriage which supports the arm and stay-bars. This carriage is provided with bronze bushed lugs by which the vertical shaft is carried. Cupped bronze frictions engaging with spur gears operate the screw shaft for actuating the carriage. Ball bearings take the vertical thrust.

The spindle carriage is a heavily ribbed casting and the wheels on which the carriage runs are carried by roller bearings. Provision is made for locking the carriage in position when drilling and reaming. A substantial sleeve ground to fit the bore in the carriage frame is fitted with ball bearings to receive the end-thrust. The large bevel gear guides and drives the upper end of the spindle. The changes of power feed are obtained through an arrangement of four sets of change gears which operate in connection with a worm-gear and friction clutch. The hand feed is operated by a handwheel which also constitutes the quick return device that is brought into action when the power feed is disengaged. A counterweight automatically raises the spindle when the hand feed is released. All levers and handwheels are located within easy reach of the operator, making the machine easy to control without requiring the attention of more than one man.

The principal dimensions are as follows: The spindle is bored No. 4 Morse taper, and the available spindle feed is 15 inches. The minimum distance from the wall to the spindle is 3 feet, and the spindle carriage has a horizontal traverse of 10 feet, 9 inches. The vertical traverse of the arm is 3 feet, 6 inches, and the arm can be swung through an angle of 180 degrees. The four available feed changes are 0.008, 0.016, 0.030 and 0.069 inch per revolution of the spindle. The weight of the machine is approximately 5000 pounds.



Milwaukee Wall Type Radial Drill

THOMAS SHAFT COUPLING

The accompanying illustrations show two styles of the "Little Giant" shaft coupling which are manufactured by the Thomas Coupling Co., Warren, Pa. The design of the coupling is worked out along lines which eliminate the necessity of cut-

ting keyways in the shafts before they are mounted in the coupling, the keyways in this case being cut by the keys which constitute a part of the coupling. Figs. 1 and 2 illustrate a coupling designed for shafts from 1 3/16 inch to 2 15/16 inches in diameter, and Fig. 3 shows a coupling for shafts ranging from 3 to 6 inches in diameter.

It will be seen from the illustrations that this coupling consists of a round iron or steel casting through which a

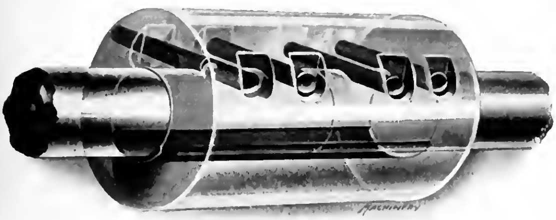


Fig. 1. The Thomas Self-seating and Self-keying Shaft Coupling

longitudinal hole is bored to receive the ends of the two shafts which are to be coupled together. A clearance space is also milled through the body of the coupling in a lengthwise direction, this clearance space being shown at *A* in

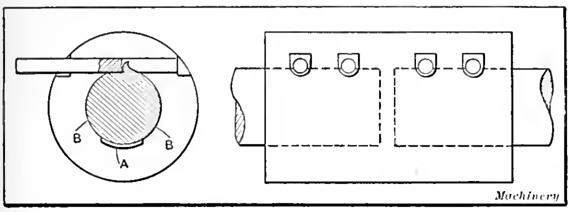


Fig. 2. Details of Coupling shown in Fig. 1

Figs. 2 and 3. The keyways are accurately located and drilled, as shown in the illustrations, so that a portion of the key enters the bore of the coupling. Special heat-treated tool steel pins or keys with cupped ends are driven into the coupling after the shafts have been entered to the desired positions. These keys are driven in by an ordinary hammer and cut away a portion of the shaft which extends above the keyways, the action of the key in cutting away the shaft being illustrated in the end view, Fig. 2. In this way the shaft is securely held against either rotary or longitudinal movement.

Referring again to the clearance space *A* shown in the end views, Figs. 2 and 3, it will be seen that there is a double bearing surface for the entire length of the coupling, these bearing surfaces being shown at *B*. In this way a wedging action is produced and the resistance offered at the surfaces *B* is always proportional to the power which the shaft is transmitting. A feature of this coupling is the entire absence of set-screws, bolt heads or other projections which are likely

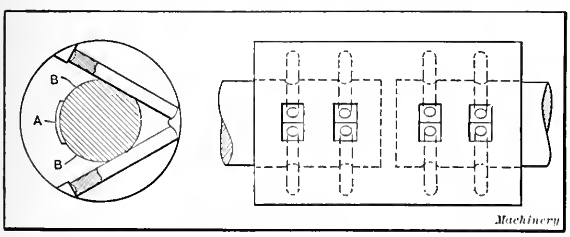


Fig. 3. Thomas Coupling with Keys on Both Sides of Shaft

to catch the clothing of men who are engaged in attending to the shafting in a factory.

FULLER TOOL-HOLDER

The tool-holder shown in Figs. 1, 2 and 3 has recently been developed and placed on the market by S. S. Fuller, 59 Wordsworth St., East Boston, Mass. This holder was designed with the idea of eliminating the breakage of cutters and set-screws which occurs when using tool-holders where the cutter is held in place by a set-screw. The features of the Fuller tool-holder are its simplicity and the flat clamping effect on the cutter. Fig. 1 shows a tool-holder open, in position to receive the cutter, while Fig. 2 shows a holder with the cutter clamped in position ready for use. The principle upon which this holder operates will be better understood by referring to Fig. 3, where it will be seen that the holder consists of two parts—the shank *A* and the movable block *B*. End stops *C* and *D* are provided on the shank, which limit the movement of the block *B*. The seat *E* upon which the block *B* slides is at an angle to the cutter seat *F*, and when the block slides in the direction of the stop *C*, the cutter seat

Fig. 1. Fuller Tool-holder in Position to receive Cutter

G in the block moves toward the seat on the shank of the tool-holder. This causes the cutter to be clamped between the seats *F* and *G*, the pressure being applied over a flat surface which eliminates the danger of breaking the cutter through concentrating the pressure at a single point.

The clamping block *B* is operated by a removable key which is shown in the operating position in Fig. 1. This key has a cam which engages the sides *H* and *J* of a recess in the clamping block when the key is rotated about a pivot fitting in the hole *K* in the shank of the tool-holder. In this way the cutter can be tightened in or released from the tool-

Fig. 2. Fuller Tool-holder with Cutter in Place ready for Use

holder as desired. The key may be used on either side of the tool-holder, and in the event of its becoming lost, the clamping block may be manipulated by tapping it with a soft metal

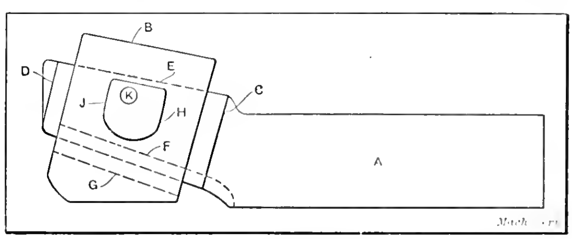


Fig. 3. Principle upon which the Fuller Tool-holder operates

hammer. Another feature of this tool-holder is the self-wedging effect which results from the pressure of the cutter against the work. This pressure tends to clamp the cutter more firmly as the feed is increased, so that the security with which the cutter is held is proportional to the severity of the service.

HORVATH INTERMITTENT MOVEMENT

The accompanying illustrations show a spiral cam and roll plate which was designed by the Horvath Mfg. Co., 190 Hague Ave., Detroit, Mich., to transmit an intermittent motion to a dial. This movement was designed for use on a high-speed automatic machine which required very accurate indexing and locking of a dial at each 1/8 revolution. The Geneva or other intermittent movement could not be used on account of the high speed at which the machine was to be operated, but the cam and roll plate arrangement which forms the subject of this article proves very successful at a speed of 350 revolutions per minute. It operates without shock or

Fig. 1. Horvath Intermittent Movement in the Operating Position

vibration and is noiseless, the curve of the cam being so designed that it starts the dial slowly, then accelerates the speed at the middle of the movement and gradually slows it down again before coming to rest. There is positively no lost motion of the dial in any position.

The operation of this intermittent movement is as follows: The spiral cam, which is the driver, has spiral grooves cut in it, the length and curve of these grooves determining

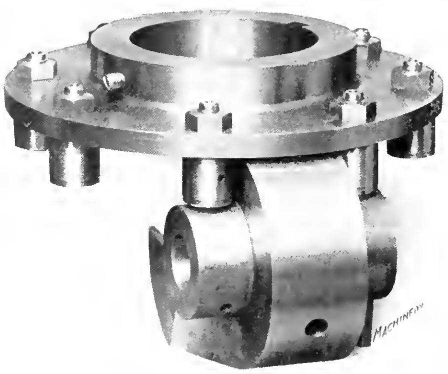


Fig. 2. Horvath Intermittent Movement locked during the Period of Rest

the time required to turn the dial and the period of rest between movements. This relation can be varied to obtain any desired result. The cam groove engages a roll on the plate and revolves it through the required part of a revolution. Any number of stops can be made according to the spacing and number of rolls. The part of the machine to receive the intermittent motion is fastened to the same shaft as the roll plate. As previously stated, the cam and roll plate could be designed to transmit any kind of intermittent motion that was desired. The advantages of this movement may be briefly summarized as follows: The dial is positively locked in every position; any desired period of rest or motion can be obtained; the movement is noiseless at high speed; and as it is of compact form, it occupies very little space. The Horvath Mfg. Co. is prepared to make this type of intermittent movement to meet various requirements.

FAFNIR BALL BEARING BOX

The Fafnir double ball bearing box, illustrated herewith, is a product of the Fafnir Bearing Co., New Britain, Conn. This box was designed to replace plain bearings on existing installations of lineshafting, the substitution being easily accomplished with little loss of time. The dimensions of the casting are such that the ball bearing box may be installed in any standard type of shaft hanger; consequently it is unnecessary to tear down the complete line of shafting, as the substitution of ball bearings for plain bearings may be accomplished by simply removing the coupling and possibly a pulley on each section of the shafting. The ball bearing box is then slipped onto the shaft.

Fig. 2 shows a cross-sectional view of the Fafnir bearing box, from which the construction will be readily understood. The sleeve is an integral part of the two bearings, having a ball raceway ground at each end. The outer rings of the

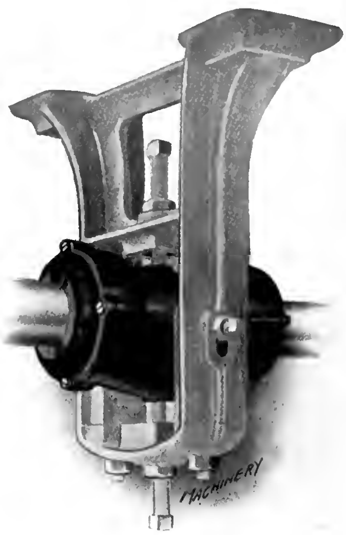


Fig. 1. The Fafnir Ball Bearing Box for Lineshaft Hangers

bearings are held in the box casting, the box being supported in the hanger frame by means of two vertical adjusting screws fitting into cups placed on the casting for this purpose. Where a hanger frame is also provided with side adjusting screws, bearings for the screws are provided by lugs on each side of the casting. As a matter of fact, the top and bottom adjusting screws afford ample support, the side adjustment being unnecessary. The sleeve is a tight slip fit and revolves with the shafting. The two end caps are furnished with grooves which become filled with grease when the bearing is first charged with lubricant, and afford an effective frictionless seal which excludes dust or moisture. Another feature

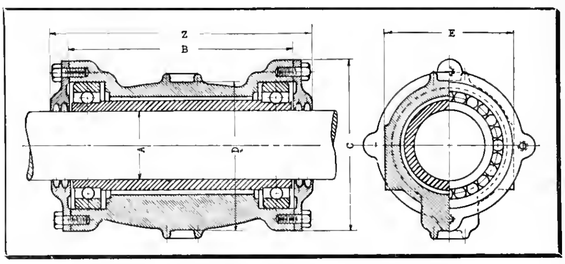


Fig. 2. Cross-sectional View of the Fafnir Bearing Box

of the construction is that it eliminates the necessity for adapters, slip bushings or adjusting nuts of any kind.

The bearings are made of high-grade alloy steel of a special composition that has been found particularly well suited for ball bearings. The rings are subjected to a special heat-treatment, and then ground and polished with the greatest

care. The balls are perfectly spherical and accurate to within 0.0001 inch. The complete bearing operates without noise and is practically frictionless. The manufacturers claim that the substitution of this type of bearing in place of plain bearings effects a reduction of friction losses on the line-shaft ranging from 25 to 60 per cent, and even as high as 75 per cent in certain cases. These figures apply when the shafting is running either idle or loaded. The bearings are charged with non-fluid oil and it is not necessary to replenish this lubricant oftener than once a year. It will be evident from this that the use of these ball bearings also effects a material saving in the cost of shafting maintenance.

HUTHER INSERTED-TOOTH MILLING SAW

Huther Brothers Saw Mfg. Co., 1108 University Ave., Rochester, N. Y., has recently added to its line the inserted-tooth type of milling saw shown in the accompanying illustration. The body of this saw is made of two crucible steel plates which are spring tempered and firmly riveted together. The inserted teeth are made of high-speed steel and they are so formed that sharpening is done only at the front of the teeth. A set of inserts adds about three inches to the diameter of the saw. The construction has been worked out along lines to combine strength and thinness. The latter is a particularly important feature where the saw is engaged in cutting expensive stock, as the saving of material is an important factor. The inserted tooth feature makes it possible to replace worn or damaged teeth at a slight expense.

The manufacturers recommend driving these saws to give a peripheral speed of 60 feet per minute. When operated at this speed the saw can be advanced at the rate of two or three inches per minute according to the capacity of the machine.

Huther Inserted-tooth Milling Saw

Saws of this type are made in a variety of different sizes. The thickness of the teeth for saws of various diameters is as follows: For a 14-inch saw, 3/16 inch; for an 18-inch saw, 7/32 inch; for a 26-inch saw, 1/4 inch; for a 30-inch saw, 9/32 inch; for a 40-inch saw, 5/16 inch; and for a 60-inch saw, 3/8 inch. The thinness of these saws enables them to cut faster and effect a saving in power and material.

GERSTNER TOOL CASE

The accompanying illustration shows a new design of portable tool case which has been brought out by H. Gerstner & Sons, 15-23 Columbia St., Dayton, Ohio. It is known as Style No. 41, and is made in three different sizes to meet different requirements. A convenient set of drawers affords a place for the tools, which are instantly accessible and adequately protected from damage. The top compartment of the case affords space for the larger and more bulky tools.

This case is neatly finished and of light weight, although it is quite substantial and capable of giving good service. The handle, which is similar to that of a suit case, is fastened to the top and enables this tool case to be conveniently carried from one job to another. To close the case, the front lid is pulled out from under the bottom drawer; this lid is mounted on hinges and is swung up at the same time that the top lid is lowered. The case is provided with a lock.

The drawers have felt-lined metal bottoms and the fronts of the drawers are finished in quartered oak. The outside of

No. 41. Gerstner Tool Case

the case is covered with black imitation seal grain leather which is very serviceable and gives the case a neat appearance. The top compartment is felt-lined throughout, and the metal trimmings used on the case are of either polished or nickel plated brass.

ATHOL VISE TAPER ATTACHMENT

Toolmakers frequently find it necessary to hold tapered pieces of work in a vise and for this purpose vises are made with a swiveling jaw. Figs. 1 and 2 show two simple attachments which can be used on an ordinary vise to adapt it for holding tapered work. In this way the plain vise is made to serve in place of the more expensive vise equipped with a swiveling jaw. These attachments are a recent product of the Athol Machine Co., Athol, Mass.

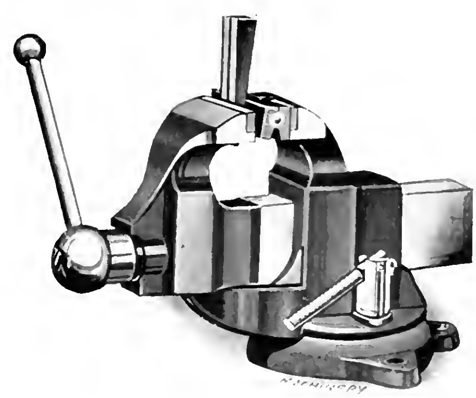


Fig. 1. Athol Vise Attachment for holding Tapered Work in a Vertical Position

Fig. 1 shows the attachment used for holding tapered work in a vertical position. Referring to this illustration it will be seen that the attachment consists of two blocks which are secured to each other by a horizontal pivot. One of these blocks is secured to the stationary jaw of the vise while the other swings on the pivot to adjust its position for the required taper angle of the work.

Fig. 2 shows the attachment for holding a tapered piece in a horizontal position. It will be seen that this attachment consists of a block which is held to the fixed jaw of the vise. This block has two small blocks secured to it by vertical pivots. When the vise is tightened on the tapered piece, these two blocks adjust themselves to the required angle.

This attachment is particularly useful for holding short pieces of tapered work. It will be seen that these two attachments are shown mounted on the Athol swivel base vise

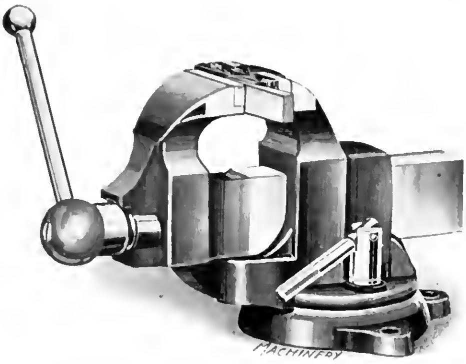


Fig. 2. Viso Attachment for holding Tapered Work in a Horizontal Position

which was illustrated and described in the April, 1913, number of MACHINERY.

SCHUCHARDT & SCHUTTE PROFILE MILLING MACHINE

Schuchardt & Schutte, Cedar and West Sts., New York City, are now building the duplex automatic profile milling machine shown in Fig. 1. This machine is adapted for handling any form of work within its range that can be held on the end of a revolving spindle. It will be seen from the illustration that the machine is equipped with duplex heads, and this feature, in connection with the automatic feeds and trips with which the machine is provided, gives a high rate of production and a corresponding reduction of manufacturing costs. The cutter spindles are belted to the countershaft which is driven at 240 revolutions per minute, except when the machine is engaged in profiling brass parts, in which case the countershaft speed recommended by the manufacturers of the machine is 360 revolutions per minute. These figures are by no means exact, and in many cases it will be found desirable to depart from them. The cutter spindle is hardened and runs in adjustable bearings, the end thrust being taken on a hardened pin which runs in oil. Spiral

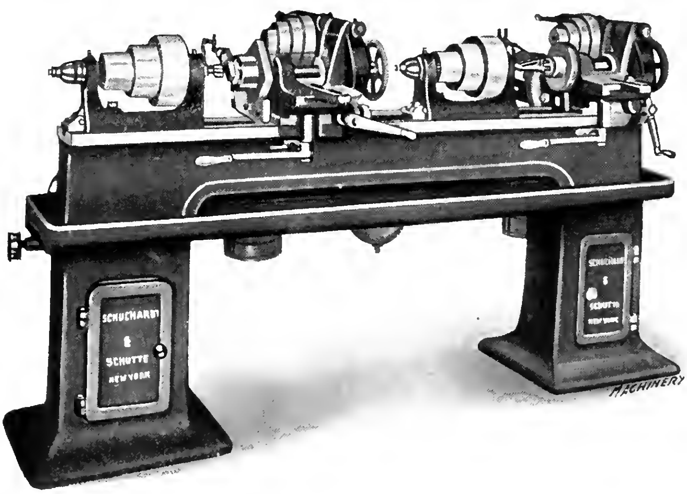


Fig. 1. Schuchardt & Schutte Duplex Automatic Profile Milling Machine

cutters are used which are inexpensive to make and to maintain.

The work is mounted on the ends of spindles carried by the duplex heads of the machine. These heads are supported on cross-slides with adjustable bearings and are moved in and out by means of the master-cams or "copy-plates" which are held in contact with the rollers by weights at the back of the machine. The feed motion which revolves the work against the cutter is driven from the countershaft by means

RATE OF PRODUCTION ON WORK SHOWN IN FIG. 2

Mark	Description	Material	Output	
			Pieces per Hr.	No. of Cuts
A	Pinion cam for motor cycle.	Steel	15	2
B	Cam for gas or oil engine ...	Cast iron	15-30	2-1
C	Valve rod bushing..........	Gun metal	50	1
D	Ball bearing cup............	Steel	50	1
E	Trigger-guard for rifle	Steel	4	2
F	Nut for wheel cap	Gun metal	6	2
G	Hexagon nut	Steel	15	2
H	Cam for gas engine	Steel	15	2
I	Gland for gas engine........	Gun metal	30	1
J	Ball-head lug for bicycle....	Steel	50-60	Either operation
K	Connecting-rod end.........	Steel	30	1

Machinery

of a cone pulley and worm-gearing. Automatic feed trips are provided which can be set to stop the feed at any point

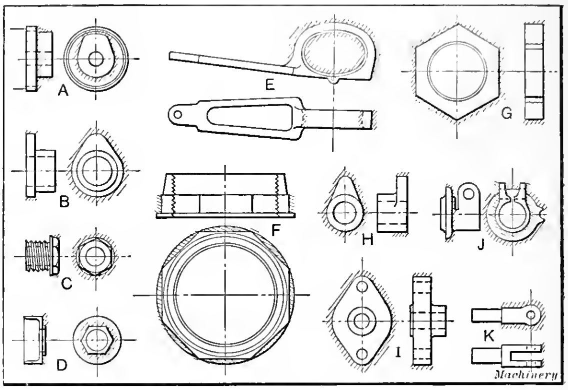


Fig. 2. Examples of Work done on Schuchardt & Schutte Profile Miller

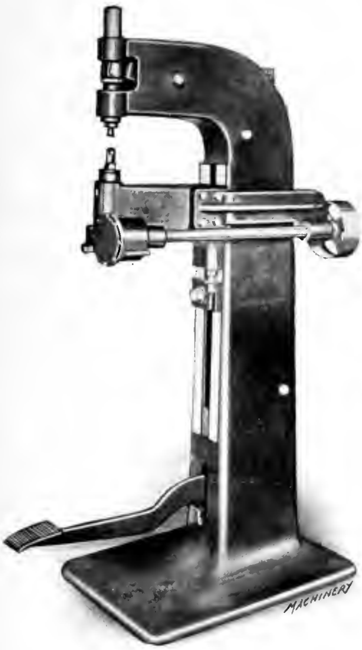
in the revolution. In cases where it is desired to take a second or finishing cut, the trip can be set to operate at the end of the second revolution. Relief clutches are provided on the worm-wheels which enable irregular profiles to be milled that could not be handled by other means. Fig. 2 shows examples of profile milling done on this machine and the table gives the rate of production for each piece.

The saddles have a short movement along the bed to provide for withdrawing internal work from the cutters. The brackets upon which the rollers are mounted which run in contact with the copy-plates are secured to the saddles. The copy-plates are milled on the machine. In arranging the machine for milling the profile of any given piece, the first step is to make a model. This model is then used to control the movement of the machine in milling the master cams or so-called "copy-plates." The copy-plates produced in this way are then used for controlling the machine in profiling subsequent pieces. Each of the duplex heads on this machine is independent of the other so that the two heads can be engaged on different classes of work if such a procedure is desirable. The bed of the machine is of rigid construction and is surrounded by an oil tray equipped with a reservoir and strainer. All of the gears are cut from solid blanks, and all gearing is carefully enclosed to provide for the safety of the operator. The equipment regularly provided comprises two counter-

shafts, master plates, cutters, oil pumps and connections, one copy generating attachment and two cutters.

GRANT RIVETING MACHINE

The riveting machine shown in the accompanying illustration is a recent product of the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. This machine represents a departure from the preceding designs which have been brought out by this company in that the riveting is accomplished in a reverse position from that of the regular rivet spinning machines. It will be noted that the riveting rollers are located on the under side instead of at the top, which is the usual practice. This machine was designed for operating on the inside of circular work such as electric light fixtures and a variety of similar articles. The riveting spindle is driven by helical gears which run in an oil-tight case and can be packed with grease or other lubricant. Power is supplied to the machine through a pulley at the rear. Means of adjustment are provided on the countershaft for maintaining a uniform tension on the belt when the table is raised or lowered for work of various thicknesses, thus insuring an efficient transmission of power at all times. The illustration makes the construction and method of operating the machine quite clear.



Grant Rivet Spinning Machine with Rollers on Lower Side

NEWTON CYLINDER BORING MACHINE

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has recently built two large boring mills for machining modern locomotive cylinders, in which the circular valve chamber is bored from the solid cylinder casting. The machine is fitted with a compound table having transverse, longitudinal and vertical adjustment. This enables the circular valve chamber to be bored first, after which the cylinder is bored. While the cylinder is being bored the valve chamber bushing can be fitted, and the final operation then consists of boring this bushing. The adjustments provided by the compound table enable all of these operations to be handled without disturbing the location of the work, and this elimination of the necessity for resetting is the means of effecting a material saving of time. The spindle is 7 inches in diameter and has a continuous travel of 140 inches. There are six changes of geared feed and rapid power traverse in both directions. The capacity of the machine is to bore and finish both ends of cylinders up to 50 inches in length. The cross adjusting table is 54 inches in width by 72 inches long, and the vertical adjustment gives a range of from 39 to 51 inches from the top of the table to the center of the spindle. The maximum distance between the facing arms is 60 inches.

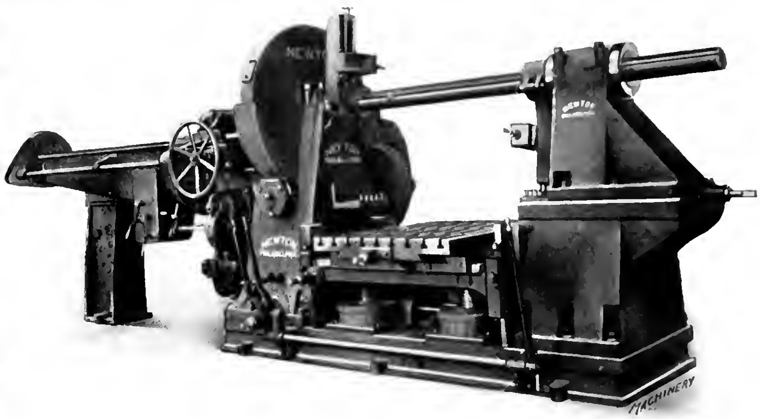


Fig. 1. Front View of Newton Locomotive Cylinder Boring Machine

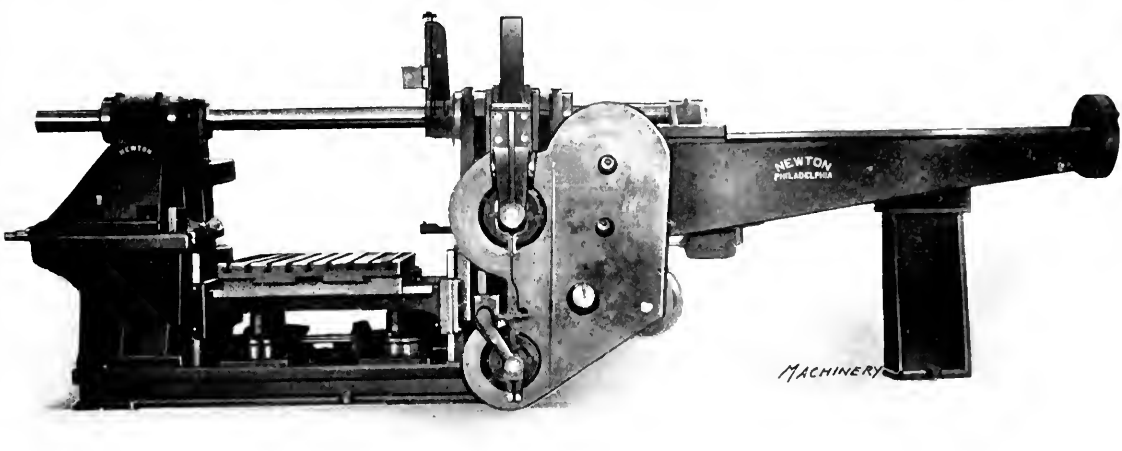


Fig. 2. Opposite Side of Boring Machine shown in Fig. 1

The main drive for the spindle is through a steep lead worm-wheel which engages a hardened steel worm fitted with roller thrust bearings. The worm and worm-wheel are encased and run in oil. The drive is so arranged that the fast power traverse of the spindle may be used while the spindle is not rotating, and this fast power traverse, the rotation of the spindle, and the power elevation of the table

may be disengaged or engaged by levers located at the operating side of the machine beside the main head without stopping the motor. The feed is taken from the gear-box, having eight gears mounted on sliding sleeves. Six feed changes are available without requiring the removal of gears, and the sleeves are easily adjusted by means of latch levers.

The saddle has roller bearings to take the thrust in both directions. The outboard bearing is provided with independent in and out adjustment so that the cylinders may be mounted on the main table and adjusted to come within the range of the facing head on the main spindle sleeve. The outboard bearing can then be adjusted to bring the dependent facing head within range of the adjacent spindle flange. It will be noticed that the facing heads are provided with an eccentric clamp permitting the spindle sleeves to be rotated while the facing heads hang idle.

VALLEY CITY WHEEL-GUARD

The illustrations show a new adjustable wheel-guard which the Valley City Machine Works, 12-16 Campau Ave., Grand Rapids, Mich., has added to its line of grinding equipments. While primarily developed for use in connection with Valley City grinders, this hood is applicable for use in connection with any type of emery wheel stand. An important feature is that it protects the nut on the arbor as well as the wheel.

Fig. 1. Small Size of Valley City Grinding Wheel Guard

Fig. 2 shows a 24-inch guard which has been adjusted to fit over a grinding wheel 18 inches in diameter. It will be evident from this illustration that the hood has been moved back so that the face of the wheel is available; at the same time adequate protection is provided. Guards of this type are made in sizes for grinding wheels ranging from 8 to 24 inches in diameter.

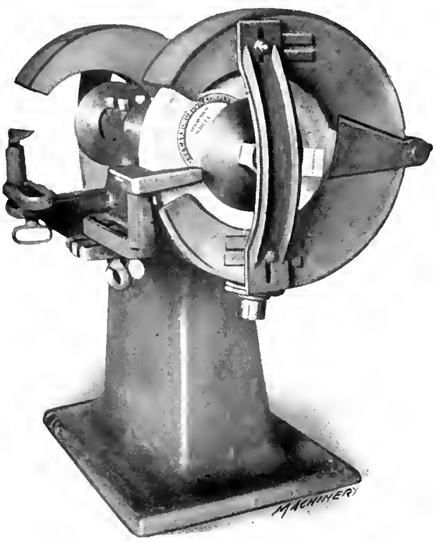


Fig. 2. Grinding Machine equipped with Valley City Wheel Guards

NEW MACHINERY AND TOOLS NOTES

Cutter Head: Joseph Villiger, Dixon, Ill. A cutter head designed for use on rotary slitting machines. The head is clamped to the shaft by means of a square headed collar screw.

Hydraulic Pump: Defiance Machine Works, Defiance, Ohio. A double plunger, hydraulic pump for use in connection with hydraulic presses where the required pressure ranges from 5 to 100 tons.

Hydraulic Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. A 500 ton inverted hydraulic press intended for straightening steel castings. This press can also be used for other heavy straightening operations.

Engraving Machine: George Gorton Machine Co., Racine, Wis. A machine intended for engraving serial numbers on the oval edges of cream separator bowls. Motor drive is provided by a motor carried on a shelf secured to the standard.

Plate Joggling Machine: Hilles & Jones Co., Wilmington, Del. A machine with a capacity for handling plates ¾ inch in thickness at the rate of 10 feet per minute. The machine is driven by a 50 horsepower G. E. motor, taking current from a 220-volt direct-current circuit.

Tapping Chuck: W. L. Procunier, 208 N. 5th Ave., Chicago, Ill. A tapping chuck arranged with a safety friction drive to prevent breaking the taps. One of the features of this chuck is that there are no projecting parts, such as set-screws, which can injure the operator.

Threading Machine: Williams Tool Co., Erie, Pa. A 16-inch pipe threading and cutting-off machine which is known as the No. 6 size. This machine is adapted for the heaviest classes of work that come within its range. Pipe ranging from 7 to 16 inches in diameter can be handled.

Gages: Reed & Prince Mfg. Co., Worcester, Mass. This company has recently brought out an adjustable templet gage provided with a fitting pin to keep the gage in alignment. Other recent products are a solid templet gage for screw stock, a thread limit gage and a screw thread micrometer.

Diamond Holder: Thomson Tool & Supply Co., Indianapolis, Ind. A diamond holder for use in dressing grinding wheels. The diamond is held in place against the pressure of a spring and in case of shock the spring absorbs the excessive pressure and greatly reduces the possibility of breaking the stone.

Friction Socket Wrench: Allen Wrench & Tool Co., Providence, R. I. This wrench consists of three working parts, designed in such a way that it grips the socket head and turns it by the action of a friction drive. The wrench can be made to grip at any point and is available for use in very limited spaces.

Portable Geared Electric Hoists: Detroit Hoist & Machine Co., Detroit, Mich. A line of geared electric hoists which is quite similar to the line of pneumatic hoists made by this company with the exception of the motive power. The hoist is of simple and compact design and is said to be essentially "fool proof."

Disk Grinders: Gardner Machine Co., Beloit, Wis. Two styles of patternmaker's disk grinders. One of these machines is equipped with direct connected motor drive and is only adapted for wood-working. The other is a combination machine which can be used by patternmakers and is also suitable for grinding metal.

Pneumatic Drill: Ingersoll-Rand Co., New York City. A pneumatic drilling machine built in five sizes. A feature of this machine is that the entire motor apparatus may be assembled or taken apart through the crank case by simply removing the cover. The motor is of the angular, four-cylinder, single-acting reciprocating type.

Cylinder Boring Machine: Moline Tool Co., Moline, Ill. A multiple spindle machine equipped with a cross adjustable table to adapt it for milling ports in the cylinders of Knight engines, the design of the head being carefully worked out to secure a degree of accuracy in machining that makes a subsequent grinding operation unnecessary.

Vertical Saw: Newton Machine Tool Works, Inc., Philadelphia, Pa. A vertical spindle cold metal saw, designed for cutting off risers from relatively flat castings such as driving wheels, large gears, etc. The casting is placed on the table of the machine and bolted in place, after which the riser is cut off by feeding the work up to the saw.

Speed Regulator: Standard Engineering Works, Woonsocket, R. I. A speed regulating device where the speed variation is obtained by adjusting the relative sizes of the driving and driven pulleys. The rims of these pulleys are made in sections and provided with means for expanding or contracting them to adjust the diameters to the required sizes.

Cutter and Reamer Grinder: Matson Machine Co., Concord, N. H. A machine with a range that enables it to handle grinding operations on all types of milling tools up to 11 inches in length by 8¾ inches in diameter. Tools with either straight or spiral flutes may be sharpened and the machine is also capable of handling end mills with straight or taper shanks.

Gang Drill: Rockford Drilling Machine Co., Rockford, Ill. A vertical chucking gang drill designed for handling work requiring considerable power but where a great amount of swing is not necessary. The machine is provided with a simple type of positive geared feed providing a wide range

for boring, drilling and reaming operations. Hand feed is also available.

Screw Driver: Benjamin Electric Mfg. Co., Chicago, Ill. A friction screw driver which combines the features of an ordinary and a ratchet screw driver. The handle of the screw driver is insulated, making it particularly suitable for the use of electricians. The friction drive is obtained by a V-bearing between the two parts of which the hard rubber handle is composed.

Heat-treating Furnace: Industrial Furnace Co., 671 Atwater St., Detroit, Mich. A line of furnaces for use in the heat-treatment of high-speed steel. These furnaces are provided with an exceptionally large burner capacity to adapt them for furnishing the high temperatures required for high-speed steel treatment. The lining is particularly heavy to enable them to withstand the intense heat.

Plain Grinding Machine: Brown & Sharpe Mfg. Co., Providence, R. I. A variable speed mechanism is the chief feature of this machine. This device consists of multiple friction disks located at the rear of the machine. By adjusting two levers at the front of the machine a wide range of table feeds and work speeds is obtainable. A dial provides for setting the levers for the required speed and feed.

Boring Mill: Pratt & Whitney Co., Hartford, Conn. A boring mill equipped with a side head. With the side head in operation, the machine is capable of turning, boring or facing work up to 38 inches in diameter. With the side head lowered below the surface of the table, work up to 44 inches in diameter can be faced with the vertical turret. Both turrets are provided with independent feed and rapid traverse.

Upright Drill: W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y. This machine has a geared feed box and dial for regulating the feed changes. There are three changes of positive geared feed ranging from 0.007 to 0.017 inch per revolution of the spindle. The dial shows at a glance the feed that is in use. The back gears on the machine are thrown in and out of engagement by the movement of a single lever.

Countersinking Machine: Chicago Pneumatic Tool Co., Chicago, Ill. This machine has been developed with the view of eliminating the necessity of employing rigging, back stops and feed-screws that were formerly necessary for drilling and countersinking holes in the flanges of channels, I-beams and similar work. This countersinking machine is intended for use in connection with the "Little Giant" drill built by this company.

Four-spindle Boring Mill: Newton Machine Tool Works, Inc., Philadelphia, Pa. Each of the four spindles of this machine is provided with individual drive. Two of the spindles are driven by 7½ horsepower G. E. motors running at 400 to 1200 R. P. M. and giving spindle speeds of 6 to 54 R. P. M. The other two spindles are driven by 5 horsepower G. E. motors running at 400 to 1200 R. P. M. and giving spindle speeds of 18 to 54 R. P. M.

Radial Drill: William Sellers & Co., Inc., Philadelphia, Pa. A high power radial drilling machine built in 60, 72, 84 and 96-inch sizes. The drilling head is designed to bring the spindle close to the face of the arm to eliminate torsional strains as far as possible. The drill head is moved on the arm through a spiral pinion and steel rack, the handwheel being placed directly on the head. The machine is driven by a 20 horsepower variable speed motor.

Alligator Pipe Wrench: Shaw Propeller Co., Boston, Mass. This wrench is composed of a single piece of metal and is capable of doing any work that can be handled by a Stillson-, monkey-, alligator- or flat-wrench. Work can be done rapidly with it, and a sure grip is obtained, the wrench being of ample strength for work that comes within its range. No adjustment is required to adapt the wrench for different classes of work. The grip is proportional to the effort which is required to loosen a nut or fitting, being automatically adjusted by the effort applied by the operator.

Die Casting Machine: Indiana Die Casting Development Co., Indianapolis, Ind. A semi-automatic rotary type die casting machine. A Bellevue gas-fired soft metal melting furnace is used to melt the metal, which is delivered to the machine pots as required. Sheet metal covers are provided to protect the operator from danger resulting from the liability of the metal to spurt out if the pressure is applied before the die is properly closed. The machine is of the non-plunger type. It is operated under high air pressure and the metal is drawn from the bottoms of the pots, which insures obtaining dense castings.

Boring Mill Pressure Compensator: H. D. Bennett, Baltimore, Md. A device intended for reducing frictional resistance of the table of boring mills. This compensating device was designed to eliminate the difficulty experienced in a shop where the lineshaft was driven by an engine that was occasionally subjected to severe overloads. At such times the frictional resistance of the boring mill table was sufficient to put the machine out of action. The use of this pressure compensator has proved a means of eliminating this difficulty, and it is capable of saving a considerable amount of power in the operation of boring mills.

Rack Cutting Machine: Gould & Eberhardt, Newark, N. J. A rack cutting machine designed for use on medium sized work. This machine is made up of parts of the 36 by 12 inch vertical cutter type of gear cutter built by Gould & Eberhardt. The work table is indexed automatically and while the indexing is being performed the cutter slide is locked so that it cannot feed down until the indexing has been completed. Single or gang cutters may be used and the machine may be arranged to index automatically for the number of cutters that are in use. The capacity of the machine is for racks up to 36 inches in length by 10-inch face width, and it will cut teeth of 1½ diametral pitch in cast iron or 2 diametral pitch in steel.

* * *

HIGH-SPEED DRILL USAGE

The Cleveland Twist Drill Co., Cleveland, Ohio, states that the cutting ability and hardness of drills are not the same thing, especially in high-speed drills. The apparent hardness which varies with the composition of the steel is no indication of its power to stand up under cut. A high-speed drill that cannot be filed may be made to drill extremely hard material by exercising great care, but it is so brittle as to be worthless for softer material. Numerous tests have proved that files vary in hardness quite as much as other hardened tools, and for this reason file tests are unreliable. No drill that files hard or soft should be condemned for this reason alone, but should be first given a drilling test in material of known hardness.

The recommendation is made that high-speed drills be warmed before using, especially where the conditions of service are severe. Any hard piece of steel is brittle when cold, and high-speed drills are no exception. They work better when warm, often giving good results when the chips are turned blue by the heat generated. Never turn cold water onto a high-speed drill, as it is very likely to crack. It is also bad practice to plunge a drill into cold water after the point has been heated in grinding. The drill may be impaired by starting a number of fine cracks in the point.

The following lubricants are recommended for the given materials: Turpentine, kerosene or soda water for hard and refractory steel; lard oil or soda water for soft steel and wrought iron; soda water for malleable iron; a flood of paraffine oil, if any for brass; kerosene or soda water for aluminum and soft alloys. Cast iron should be drilled dry or with a jet of compressed air.

* * *

The Bullard Machine Tool Co., Bridgeport, Conn., has issued a catalogue and treatise on the Bullard vertical turret lathe which is not only unusual typographically but a decided departure from the conventional catalogue. In fact, the idea in the preparation of this book was, first of all, to make it of practical value to shop superintendents and others interested in the efficient production of what is commonly known as faceplate work, and to subordinate the catalogue feature. For this reason, a large amount of space is given to illustrations showing many typical as well as unusual machining operations. It is pointed out that the cutting time only is productive in machine tool operation and that the design of the machine tool is only effective in so far as it reduces the waste time between cuts hence, the significance of the title of this treatise, "Cutting Time Between Cuts." It contains 103 pages, 8½ by 11¼ inches, is printed on heavy paper and is beautifully illustrated. The fore part of the book contains large halftone illustrations, showing in detail the adaptability of the Bullard vertical turret lathe and its application to various classes of faceplate and chuck work. Beneath each illustration the operation is briefly described. Following, there are about twenty-four pages filled with diagrams showing the tool equipment and successive order of operations on a great variety of vertical turret lathe work. These diagrams are interesting as well as instructive, and show graphically the most modern practice in the boring and turning of many different machine parts. The latter half of the book relates to the turret lathe with its accessories and attachments. Various noteworthy features of the machine are described and illustrated, including such important parts as the table spindle, the bed, the cross-rail, the turrets, feeding mechanism, the lubricating system, the thread cutting attachment, the forming attachment, etc. The specifications for vertical turret lathes of various sizes and designs are also given. This book should be of value to every machine shop manager and superintendent, and every mechanical man, no matter what his position, should find a study of its pages instructive and interesting to an unusual degree.

DEVELOPMENT IN PLANER TYPE MILLING MACHINES

The modern superintendent or foreman who is responsible for the maintenance of the rate of production of a factory or shop is apt to take the most efficient forms of manufacturing equipment for granted. Such men make it their business to know the rates of production that are possible with different types of machine tools, and when a new job comes up they carefully consider the merits of the different machines

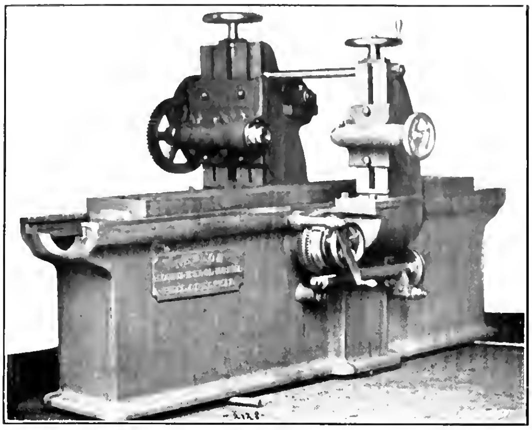


Fig. 1. First Heavy-duty Milling Machine built in the United States

on which it could be performed in order to select that type which they believe to be best suited for the requirements of the work. But the time of these men has been so fully occupied by their work that they have had little time to watch the development which has taken place in the machines that they use, unless such machines have been the product of the particular factory in which they are employed.

Although of little practical value, it will doubtless be of interest to look back upon the progress which has been made in machine design—for instance, in the planer type of milling machine. The accompanying illustrations give an idea of the progress which has been made in this particular type of machine in the last thirty years. Fig. 1 shows what is said to be the first heavy-duty milling machine built in the United States. This particular machine is a product of the Newton Machine Tool Works, Inc., Philadelphia, Pa., and was built for the Stearns Mfg. Co., Erie, Pa., in 1884. Referring to the illustration it will be seen that the outer end of the cutter arbor was supported by a center, and the intermediate driving gears were supported by links. Later machines of this design were furnished with simultaneous vertical adjustment. Unfortunately, no records are available to show the rate of production obtained by this machine, which had a weight of about 10,000 pounds.

Previous to 1905 very few records were kept showing the output and cost of production of work on different types of machine tools, but in the opinion of the Newton Machine Tool Works a feed of about 1 inch per minute on slabbing operations is the best rate that was obtainable at this period with planer type milling machines. At about this time the Newton Machine Tool Works contracted for two machines for use in a large locomotive shop. These machines were built under a guarantee to take feeds of 2 inches per minute on slabbing operations; this was regarded as considerably in excess of average practice and was felt to be quite a risk. After the machines were shipped, the user reported that slabbing operations were being performed with feeds of from 6 to 8 inches per minute. Upon receipt of this advice an investigation was made and it was found that the increase in feed was made possible by the invention of the spiral inserted tooth high-speed milling cutter by Mr. C. D. Peck. This type of cutter is now known as the Taylor-Newbold cutter.

Fig. 2 shows a 50-inch size planer type milling machine which is one of the modern designs of the Newton Machine Tool Works. A comparison of this machine with the one antedating it by thirty years will show the wonderful progress which has been made. This machine is equipped throughout with steel or bronze gears. The table is of exceptionally heavy box-type construction, and the feed is obtained through an angular steel rack and spiral bronze pinion. The feed is obtained from a 50 horsepower motor shown at the left of the machine and the elevating of the rail is provided for by a special 3 horsepower motor mounted on the tie-beam. The spindle is driven by a steep lead bronze worm-wheel meshing with a hardened steel worm fitted with roller thrust bearings. The spindle has 12 inches cross adjustment by hand; it is $7\frac{3}{8}$ inches in diameter and the minimum distance from the center of the spindle to the top of the table is 5 inches. The spindle speeds range from 15 to 31 revolutions per minute, power being obtained from a 50 horsepower General Electric 220 volt motor. The net weight of this machine is 70,000 pounds.

This machine is shown channeling to full depth and full width, in one operation, two large size rods at a table advance of $2\frac{3}{4}$ inches per minute. The maximum cut for channeling would probably be two channels 5 inches wide by $1\frac{3}{4}$ inch deep, milled to the full depth and full width with a table advance of $2\frac{1}{2}$ to $2\frac{3}{4}$ inches per minute. Although the exact power required for this kind of work has not been determined, the thrust on the cutters is considerably greater than in slabbing operations on account of the resistance offered by the depth of the cut. For slabbing operations this machine would be capable of removing $1\frac{1}{4}$ cubic inch of metal per horsepower per minute. These rod milling operations are cited because they are among the most severe work that is encountered in milling practice. In order to stand up under such work, it is important to have all shafts and gears subject to opposed stresses with bearings in a common

Fig. 2. A Modern Planer Type of Milling Machine

casting, in order to prevent the possibility of chatter or misalignment. Responsible builders are now producing machines capable of driving the best grade of cutters to the limit of their capacity. Efforts toward increased production will now be in the direction of securing continuous operation.

* * *

Electric iron ore smelting is making decided headway in Sweden, where during the past year some of the most prominent concerns in the iron industry have adopted the process.

SAVING OPERATIONS ON TURRET LATHES

BY CONRAD

In the September number of MACHINERY "Albion" contributed an article entitled, "Turret Lathe Set-up for a Small Screw," in which he explains how to save time in machining a conical headed screw. He points out the necessity of cutting down the number of operations to a minimum, owing to the heavy turret of the Herbert No. 2 turret lathe, so that

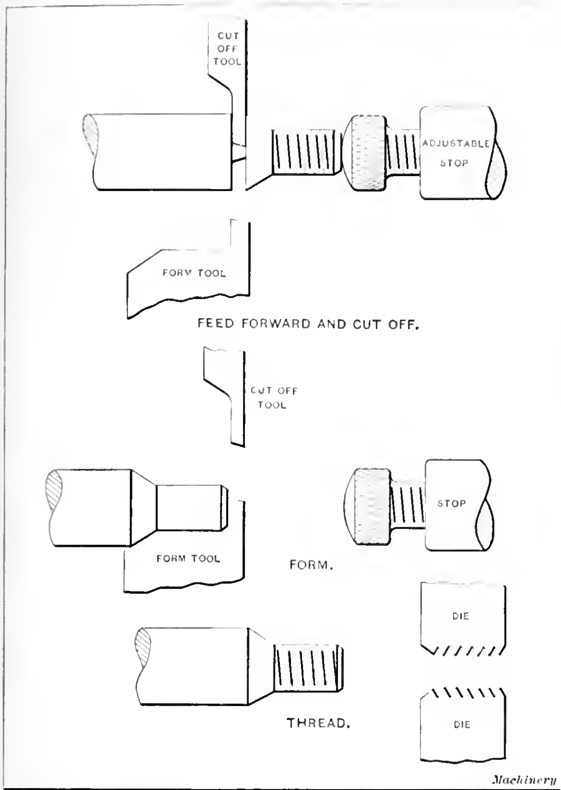


Fig. 1. Method of producing Screw of the Form shown

the fatigue caused by advancing, withdrawing and rotating the turret may be cut down as far as possible. The method advanced by "Albion" reduces the number of operations from six to three, the process being as follows: 1. Cut off and feed bar forward. 2. Turn and round end. 3. Thread.

If it is merely a question of simplicity and saving a few seconds on each piece, the writer suggests an even simpler method, which is illustrated in Fig. 1. This illustration shows the screw to be manufactured, with a slight difference in shape, the end being made flat and chamfered. The order of operations is: 1. Feed the bar forward to the stop held in a hole of the turret, with a screw finished by the preceding operation still to be cut off. 2. Cut off the finished screw with a tool in the back-rest of a tool-holder bolted onto the same face of the turret, and form the next screw with a tool in the front of the holder. These two operations are performed without rotating the turret. 3. Thread the work with a die-head held in the turret. In this way the whole job is finished with only two movements of the turret instead of three, as necessitated by "Albion's" method. Moreover, the die-head and the tool-holder may be located in two adjacent faces of the turret so that it is only necessary to move the turret through 1/6 of a revolution forward and back instead of having to revolve it all the way around. It will also be evident that as the outline of the forming tool is composed entirely of straight lines, it is quite simple to make.

It may not be out of place to state at this point that the question of the fatigue of the operator has evidently received due attention by the builders of the Herbert turret lathes, as all of their machines are now provided with a patent quick traverse motion for the saddle. With this arrangement it is only necessary to press down or lift up a small lever to start the mechanism, which automatically advances or withdraws the turret at a quick rate.

As a further example of how operations can be saved on automatic and semi-automatic machines, a brief description will be given of the method of procedure followed in producing pieces of the form illustrated in Fig. 2. This illustration shows a brass piece which was made on a full automatic machine. The machine was formerly arranged to make one of these pieces at a time, the order of operations being as follows: 1. Drill. 2. Form from front slide. 3. Countersink hole. 4. Tap. 5. Cut off from back slide. By speeding up, the best output that was obtainable by this method was three pieces per minute, but this was found to be insufficient.

In order to increase production, it was decided to make two pieces at a time, according to the method illustrated in Fig. 2. Working on this principle, the order of operations is as follows: 1. Drill through the depth of two pieces. 2. Form two pieces from front slide. 3. Countersink first piece. 4. Tap two pieces. 5. Cut off first piece from back slide. 6. Countersink second piece. 7. Cut off second piece from

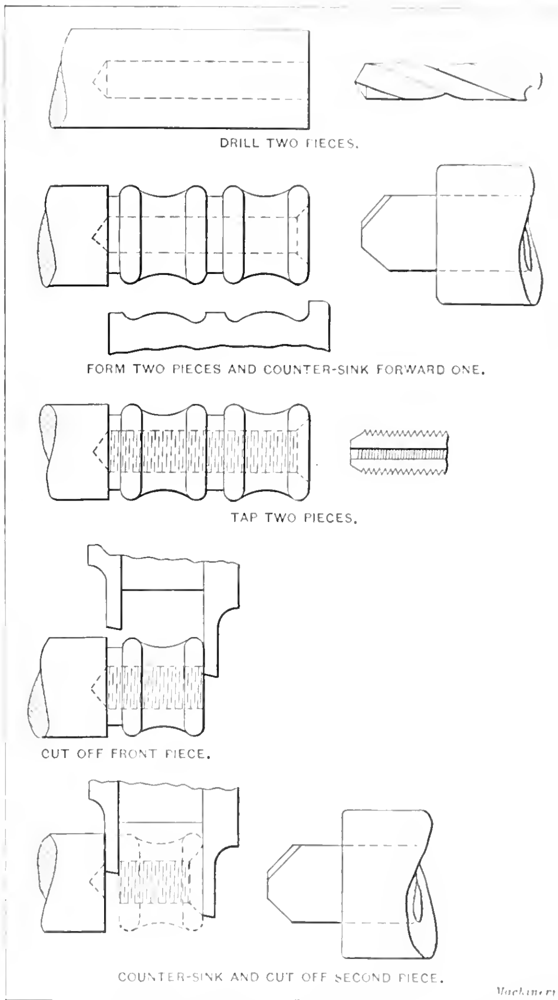
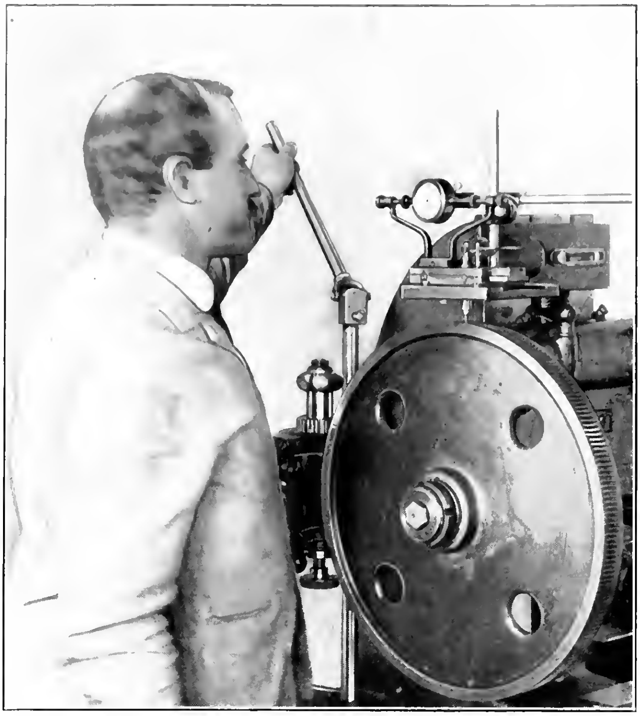


Fig. 2. Operations involved in producing Pieces Two at a Time

back slide. In this way two pieces were made in seven operations, requiring one complete revolution of the turret; whereas, the original method made it possible to produce only one piece in practically the same length of time. The change in the method of procedure effected an increase of output of about 30 per cent

From the foregoing it will be evident that although automatic and semi-automatic machines are generally run by un-



A Final

To Insure Accuracy of the Index Wheel and its Mounting—Inaccuracy Here Causes Incorrect Gear Teeth.

Inaccuracies in the index wheel of Automatic Gear Cutting Machines show at once in gears cut by it as thick or thin teeth. B. & S. Index Wheels are cut with special machinery having master wheels which are as exact as skilled methods can produce. Each wheel is held to very close limits, ten hours being required to cut the index wheel of the machine shown opposite. Great care is also taken in finishing the bearings of the index wheel and spindle and in mounting the wheel to avoid error at this point. The cut above illustrates the careful manner in which we test every index wheel after it is mounted, with a special device for instantly detecting the slightest error in the teeth. Inaccuracy in the indexing mechanism is another cause of incorrectly cut gears, even with an accurate index wheel. To detect such errors, we apply another special testing mechanism capable of locating any error in the various positions of the wheel when rotated by its own power.

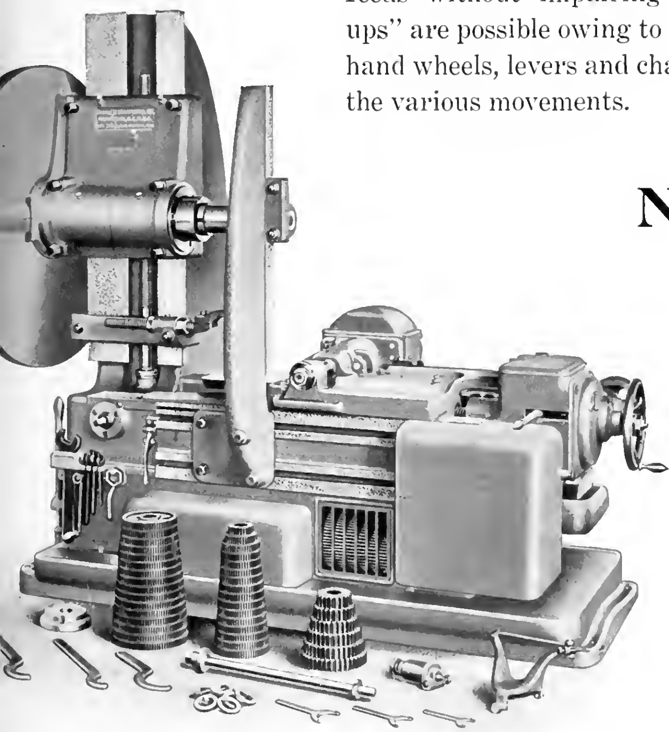
Brown & Sharpe Mfg. Co.

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

Test For Each Machine

B. & S. Automatic Gear Cutting Machines are designed for rapid production, in addition to their accuracy of workmanship. They have the three features which insure this point — a rapid, powerful drive, rigid design and convenient arrangement of parts. Ample power is delivered by the large diameter driving pulley to the cutter spindle through a worm drive, giving rapid yet smooth cutting action. A glance at the cut below shows the lines and proportions of the machine as a whole, the rigid, compact base, the massive column and work slide, the long bearing surface of the cutter slide, the unusually large cutter and work spindles and the correct relation each part bears to the other. These are the features that allow maximum speeds and feeds without impairing accuracy. Quick "set-ups" are possible owing to the accessibility of all the hand wheels, levers and change gears for controlling the various movements.



No. 6 Automatic Gear Cutting Machine

Capacity:

Spur Gears to 72" in diameter, 13" face.

Cast iron, 1 3-4 diametral pitch; steel, 2 diametral pitch.

Providence, R. I., U. S. A.

CANADIAN: The Canadian Fairbanks Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia. Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; The F. W. Horne Co., Tokio, Japan. L. A. Vail, Melbourne, Australia; F. L. Strong, Manila.

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skilled labor, it is of great importance to have such machines in charge of a competent superintendent who is up to all sorts of "kinks" and methods of cutting down the time of production. The greatest savings in work of this kind are effected by reducing the idle operations as far as possible. It is not possible to go on increasing speeds and feeds *ad infinitum*, but it *is* possible to cut down the number of operations and the time which elapses between them, and this is the point that should receive attention when an endeavor is made to increase production.

* * *

LARGE OUTSIDE MICROMETERS

BY WILLIAM S. ROWELL*

Much has been done in recent years toward providing both inside and outside micrometers, but a more plentiful supply, especially in the large sizes, could be used to advantage in almost any shop. Doubtless first cost has much to do with keeping the stock down to its slender proportions. Consideration of the following may prove helpful to those who would help themselves.

The commercial inside micrometer up to about thirty-six inches is so good and cheap that it leaves little to be asked; above that size the writer has used a number of designs. Providing additional and longer rods to be used with the same head is usually a satisfactory solution. Solid rods may be used for almost any length but tubes are better adapted to the larger sizes.

Fig. 1. Large Micrometer for making Outside Measurements

There are a number of reasons for the scarcity of larger outside micrometers, but when the merits of sheet aluminum for the bow or frame become better known more of it will be used for this purpose. To use it, as is often done, by cutting as many and as large bows as can be laid out on a sheet of the metal without making use of its high ductility, is a waste of time and material. The proper way is to lay out the sizes wanted directly on the sheet metal and saw along the lines with a band saw. Kerosene is a good lubricant. The illustration Fig. 3 will give an idea of how a sheet of aluminum can be cut with a minimum of waste. The parts that come from the saw needing shaping can be easily forged into shape at a low heat. The smith should, if not familiar with the materials, experiment with a waste piece and note the proper forging heat. Sheet aluminum 3/8 inch thick is easily obtained and is generally conceded to be thick enough for all sizes up to thirty-six inches without any stiffening against side flexure. For larger sizes a thicker sheet, or perhaps better, an approximation of an I-beam section would provide the necessary stiffness.

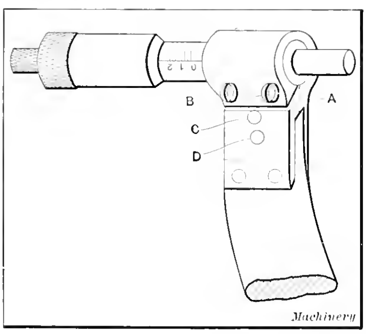

Fig. 2. Arrangement of the Clamp for holding the Micrometer Head

* Address: 1026 Dayton St., Hamilton, Ohio.

Tail-pieces should be drill rod steel 5/16 inch diameter if they are to extend six inches. The measuring points of both screw and tail-piece should be slightly rounded. This is more important than might at first appear. Such bows are not stiff enough to insure the flat ends remaining parallel. With both contact points slightly rounded a little lack of alignment makes no difference.

The illustration Fig. 1 shows an instrument of about thirteen inches capacity. The tail-rod shown is the short rod from an eight- to thirty-two-inch inside micrometer. The micrometer screw is held in place by two clamping screws *B* shown in Fig. 2. The steel clip that holds the micrometer screw was not originally intended for a removable screw and was held to the aluminum bow by the three rivets *D*. When the saw cut *A* was made, a rivet was added at *C* to stiffen the clip. In this way one micrometer screw may serve two or more large size bows. Bows as small as eighteen inches and under should usually each have its own screw, as small size instruments are generally in use.

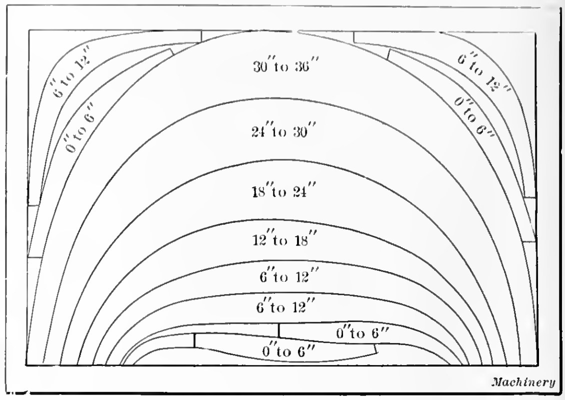

Fig. 3. Method of cutting up a Sheet of Aluminum for a Set of Micrometer Frames

Of course it is understood that such instruments are never standards. They are transfer instruments as strictly as were the two-leg calipers of our fathers, but when provided with a micrometer screw of one-inch run eighteen standard gages will suffice to set such calipers for all sizes from zero to thirty-seven inches.

* * *

ADVERTISING WITH MOVING PICTURES

The possibilities of the moving picture as an advertising agent is fully realized in Europe as well as in America. A firm in London has prepared an exhibition of moving pictures illustrating British manufactures and industries, and films dealing with this subject are to be shown in the leading cities of the European continent, North and South America and the British colonies. The first tour will be one of northern Europe, during which exhibition the films will be shown in some sixty cities. These exhibitions will be held during the daytime and will be free, invitations being issued to the leading business men in each city, the cost being defrayed by the manufacturers whose products or methods are shown. In connection with this tour, a commercial reference book in English, German and French will be published and about sixty thousand copies will be distributed to the visitors to the exhibitions. It is expected that this method will do much to bring the names of British manufacturers before foreign buyers.

* * *

The following mixture is, according to *Foundry*, suitable for cores for aluminum and brass castings: Silica or lake sand, 28 parts; molding sand, 12 parts; and linseed oil compound, or plain linseed oil, 1 part, by weight. The lake and molding sands are first thoroughly mixed, water being added until almost damp enough for use, when the linseed oil is thoroughly mixed into the sand. It is very important that there is a complete mixture of the oil and sand. The cores should be baked in a hot oven.

LONGEST RAILWAY BRIDGE IN WORLD

The longest railway bridge in the world will be constructed shortly for the improved line between Berlin, Germany, and Stockholm, Sweden. At present, the railway trains are carried by large ferries a distance of about seventy miles from a point in southern Sweden to the island of Rügen, in Germany. The trains then pass across the island of Rügen, but must again be ferried from this island to the German mainland, a distance of about two miles. The bridge will connect the island of Rügen with the German mainland and make the second ferry trip unnecessary. The length of the bridge will be 10,725 feet, divided into twenty-two spans. The height of the bridge from the water level will be 105 feet.

* * *

PERSONALS

J. L. Peden, general manager of the Universal Screw Cutting Co. of America, Philadelphia, Pa., has resigned his position.

D. Walker Wear, formerly purchasing agent of the Chicago Tunnel Co., has been elected vice-president and director of the Stow Mfg. Co., Binghamton, N. Y.

Henry M. Leland, general manager of the Cadillac Motor Car Co., Detroit, Mich., was elected president of the Society of Automobile Engineers at the January meeting in New York City.

H. H. Robertson, president of the Asbestos Protected Metal Co., Beaver Falls, Pa., has been elected vice-president of the Pittsburg branch of the National Council for Industrial Safety.

L. G. Daniels has been made general manager of the Rockford Drilling Machine Co., Rockford, Ill., succeeding S. H. Reck, who sold out and withdrew from the company a few months ago.

C. R. McCullough, who has been connected with the Detroit office of Manning, Maxwell & Moore, Inc., for the past two years, has entered the employ of the Lees-Bradner Co., Cleveland, Ohio.

John Becker, Jr., was elected treasurer and general manager of the Becker Milling Machine Co., Hyde Park, Mass., following the resignation of his father, John Becker, who has retired from business.

E. A. Muller of the King Machine Tool Co., Cincinnati, Ohio, has been appointed receiver for the Modern Machine Tool Co. of Cincinnati. The company is said to be solvent, having $50,000 assets and $20,000 liabilities.

S. Wolff, former manager of the Cleveland office of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., has been appointed Chicago manager for the DeLaval Steam Turbine Co., Trenton, N. J., manufacturer of steam turbines, centrifugal pumps, etc., with offices in the People's Gas Bldg.

E. M. Chadwick, formerly of the Fairbanks Co., has been appointed manager of the Buffalo branch of Manning, Maxwell & Moore, Inc., and D. A. Hamilton, formerly of the Reed-Prentice Co., Worcester, Mass., has been appointed assistant at the Detroit branch of Manning, Maxwell & Moore, Inc.

W. H. Shafer, formerly with the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, and recently with the Rochester Boring Machine Co. of Rochester, N. Y., has again become associated with the Cincinnati-Bickford Tool Co. as special representative in connection with the company's selling organization.

Albert A. Dowd, formerly in charge of the estimating department of the Bullard Machine Tool Co., Bridgeport, Conn., is now in business for himself as a production engineer. He is prepared to furnish details of horizontal and vertical lathe tool equipments as a specialty. His address is 84 Washington Terrace, Bridgeport, Conn.

C. U. Scott, Davenport, Iowa, has resigned his position at the Rock Island Arsenal, where he has been for the past ten years in charge of the hardening and heat-treating department, in order to devote all his time to his own business of tool hardening, heat-treating, casehardening, galvanizing, tinning, brazing, bluing and manufacture of furnaces.

A. D. Pentz is the inventor of the toolroom boring machine built by the Newton Machine Tool Works, Philadelphia, Pa., and illustrated and described in the November, 1913, number of MACHINERY. Mr. Pentz, who is with the General Electric Co., West Lynn, Mass., received the John Scott medal from the Franklin Institute in 1891, for machines in which the same principles that make this machine distinctive and unique were embodied.

Prof. David N. Camp, president of the Skinner Chuck Co., New Britain, Conn., was the guest of honor at an annual banquet tendered by the company to its employes at the New Britain Club, December 23. There were about one hundred and twenty men present and Prof. Camp was the principal speaker and honored guest of the evening. He will soon be ninety-four years old, a fact that made his presence at the banquet the more notable.

* * *

OBITUARIES

Herman C. Meinholtz, vice-president of the Heine Safety Boiler Co., St. Louis, Mo., died in St. Louis December 24, aged forty-five years. Mr. Meinholtz entered the employ of the Heine Safety Boiler Co. at the age of nineteen as a draftsman and was continuously connected with that company up to the time of his death. He was made superintendent in 1895 and vice-president in 1907. He had entire charge of the company's shop when it was established in 1899, and under his general direction the new factory was designed and built in 1909. He is survived by his widow and five children.

COMING EVENTS

April 4-11.—First National Efficiency Exposition and Conference, Grand Central Palace, New York City. Walter H. Tallis, director, Efficiency Society, Inc., 41 Park Row, New York City.

May 1-October 31—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

Annual Report of the Secretary of Commerce—1913. 150 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

Educational Directory, 1913. 159 pages, 6 by 9 inches. Published by the United States Bureau of Education, Washington, D. C., as Bulletin 557.

Kansas Fuels: Coal, Oil, Gas. By P. F. Walker and Walter Bohnstengel. 40 pages, 6 by 9 inches. Published by the University of Kansas, Lawrence, Kans., as Engineering Bulletin No. 3.

Tests of Permissible Explosives. By Clarence Hall and Spencer P. Howell. 313 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 66.

Metal-Mine Accidents in the United States, 1912. Compiled by Albert H. Fay. 76 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 61.

Special Studies in Electrolysis Mitigation. By E. B. Rosa and Burton McCollum. 55 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards 27.

The Use and Misuse of Explosives in Coal Mining. By J. J. Rutledge and Joseph A. Holmes. 54 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Miners' Circular 7.

Windage Resistance of Steam-turbine Wheels. By Edgar Buckingham. 44 pages, 7 by 10 inches. Published by the Bureau of Standards, Washington, D. C., as Reprint 208 of the Bulletin of the Bureau of Standards, Vol. 10.

Electrolysis in Concrete. By E. B. Rosa, Burton McCollum, and O. S. Peters. 136 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 18 of the Bureau of Standards.

Metallurgical Coke. By A. W. Belden. 48 pages, 6 by 9 inches. Illustrated. Map showing location of coke oven plants in the United States. Published by Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 50.

Melting Points of Some Refractory Oxides. By C. W. Kanolt. 19 pages, 7 by 10 inches. Published by the Bureau of Standards, Department of Commerce, Washington, D. C., as Reprint 212 from the Bulletin of the Bureau of Standards, Vol. 10.

Analysis of Alternating-Current Waves by the Method of Fourier. By Frederick W. Grover. 77 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 203 from the Bulletin of the Bureau of Standards, Vol. 9.

A Comparative Study of American Direct Current Watthour Meters. By T. T. Fitch and C. J. Huber. 30 pages, 7 by 10 inches. Published by the Bureau of Standards, Department of Commerce, Washington, D. C., as Reprint 207 of the Bulletin of the Bureau of Standards, Vol. 10.

Foreign Publications for Advertising American Goods. 236 pages, 6 by 9 inches. Published by Bureau of Foreign and Domestic Commerce, Department of Commerce, as No. 10 of the Miscellaneous Series.

This publication will be useful to American manufacturers who wish to advertise their wares in foreign journals. It gives the foreign publications, advertising rates, circulation, subscription prices, etc., for Canada, Mexico, West India, South America, Europe, Asia, Oceania, Africa, etc.

Bureau of Supplies of the Department of Water Supply, Gas and Electricity, New York City Report. To Henry S. Thompson, commissioner. By Elihu C. Church, secretary. 6½ by 10 inches. 93 pages. Illustrated. Published by the City of New York.

This report is of much interest to municipal officers in general. It outlines the plan and scope, the organization and administration of the Bureau. Details of purchasing and inspection are given, and storage and issue of supplies, methods of keeping records and accounts are described.

Mechanical World Electrical Pocket Book for 1914. 311 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England. Distributed in the United States by Norman & Remington, Baltimore, Md. Price 25 cents.

This book is similar in plan and scope to the well known Mechanical World Diary and Year Book in the mechanical field. It treats of the electrical units, magnetic laws, characteristics of dynamos and motors, direct and alternating current systems, transformers, accumulators, wiring, electrical measuring instruments, electric lamps, electric lighting, electromagnets, electricity in coal mines. Tables of logarithms and other useful tables are included, and a diary for every day in the year.

Bulletins of the Engineering Experiment Station, University of Illinois. Vol. 9. Comprising Bulletins 63 to 67. 6 by 9 inches. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

This volume comprises bulletins which have been previously noticed in MACHINERY as follows: "Entropy Temperature and Transmission Diagrams for Air," by C. R. Richards; "Tests of Reinforced Concrete Buildings Under Load," by Arthur N. Talbot and Willis A. Slater, "The Steam Consumption of Locomotive Engines from the Indicator Diagrams," by J. Paul Clayton; "The Properties of Saturated and Superheated Ammonia Vapor," by G. A. Goodenough and William Earl Mosher; "Reinforced Concrete Wall Footings and Column Footings," by Arthur N. Talbot.

Mechanical World Pocket Diary and Year Book for 1914. 143 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England. Distributed in the United States by Norman & Remington, Baltimore, Md. Price 25 cents.

This well known compilation of useful engineering notes, rules, tables and data has been issued consecutively for twenty-seven years. The low price of the publication, the large amount of valuable data contained, and the small size have made it justly popular. It treats of steam and steam engines, steam turbines, condensers, boilers, etc., gas engines, gas producers, steam generators and materials of construction, shafting, gearing, machine shop practice, belting, micrometers, hydraulics, gages, weights and measures, logarithms, trigonometrical tables, etc. A diary for every day in the year is included and a complete index makes easy reference to the matters contained.

Investigating an Industry. By William Kent. 126 pages, 5 by 7½ inches. Published by John Wiley & Sons, Inc., New York City. Price $1.

In the introduction, written by H. L. Gantt, the purpose of the book is outlined as based on the old saying, "Look before you leap," or in other words, "Find out all possible facts about an industry before drawing conclusions." The contents by chapters are: General Considerations, A Business Diagnostician, The Diagnosis—The Factory, The Accounting and Sales Department, The Doctor's Preliminary Report, The Salesmen's Conference, The Doctor's Opinions and Recommendations, Proposed Reorganization of the Board of Directors, Duties of the Functional Committees of the Board of Directors, A New Kind of Factory Expert—The Leak Hunter, Locating an Industry. The author likens a run-down business to a sick man and the efficiency expert to the doctor. It is the doctor's function to diagnose the ailment of the patient and to prescribe the remedies.

Bulletins of the Engineering Experiment Station, University of Illinois. Vol. 8. Comprising Bulletins 58 to 62. 6 by 9 inches. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

These bulletins, which have been previously reviewed in MACHINERY, are as follows: "A New Analysis of the Cylinder Performance of Reciprocating Engines," by J. Paul Clayton; "The Effects of Cold Weather Upon Train Resistance and Tonnage Rating," by Edward C. Schmidt and F. W. Marquis; "The Coking of Coal at Low Temperatures with a Preliminary Study of the By-products," by S. W. Parr and H. L. Olin; "An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries," by L. P. Breckenridge and G. A. Goodenough; "Characteristics and Limitations of the Series Transformer," by A. R. Anderson and H. R. Woodrow; "The Electron Theory of Magnetism," by Elmer H. Williams.

Work, Wages and Profits. By H. L. Gantt. 312 pages, 5 by 7½ inches. Published by the Engineering Magazine Co., New York City. Price $2.

The second edition of this work which appeared in 1910 has been thoroughly revised and much enlarged, the first edition containing only 194 pages. The work contains twenty-seven illustrations, including charts in two colors. The new material includes an extended treatment of the task idea and a new chapter on the results of scientific management. The contents by chapter heads are: The Application of the Scientific Method to the Labor Problem, The Utilization of Labor, The Compensation of Workmen, Day Work, Piece Work, Task Work With a Bonus, The Task Idea, Training Workmen in Habits of Industry and Cooperation, Fixing Habits of Industry, Results, Prices and Profits, A Practical Example. A pleasing feature of Mr. Gantt's work as an efficiency expert is his sympathy with all concerned. He regards greater efficiency from the standpoint of the true economist and not from the merely selfish viewpoint of an employer who would increase his profits without consideration of the effect on the workman or on humanity as a whole.

Practical Patternmaking. By F. W. Barrows. 347 pages, 5¼ by 7¼ inches. 159 illustrations. Published by Norman W. Henley & Son, New York City. Price $2.

The first edition of Barrows' work on patternmaking was published in 1906. New material has been added and incomplete sections filled out. The number of specific examples has been increased. The contents comprise: Patternmakers and Patternmaking, How Some Folks Make Patterns, Some Methods, Patternmakers, Lumber, Varnish, Miscellaneous Materials, The Bench and Its Attachments, Hand Tools, Bench Work, Machine Tools for Patternmakers, The Band-saw, The Circular Saw, The Lathe, Fillets, Stavework, Cant or Segment Work, Patterns for Belt Pulleys, Patterns for Cable Pulleys, Making Patterns for Chain Wheels, Patterns for Steam Cylinders, One Way of Making a Crosshead, Making Gear Patterns, Propeller Wheels, Patterns for Screws, Traction Wheels for Farm Engines, Globe-valve Patterns, An Example in Projection, Common Practice, Some Patterns, A Stripping-plate Job, A Vibrator-plate Pattern, The Evolution of the Globe Valve Core-box, Multiple Core-boxes, Cost of Patterns, The Marking and Record of Patterns, Pattern Accounts.

Heating and Ventilation. 335 pages, 6 by 9 inches. Published by the B. F. Sturtevant Co., Hyde Park, Boston, Mass.

This book forms part of the advertising literature of the company and bears the catalogue number 215. It is, however, a textbook and work of reference on heating and ventilating for engineers and all others concerned with any phase of the problems of heating and ventilating buildings. The first edition of the work was published over twenty-five years ago and new editions have been frequently published since. The advancement of the science of heating and ventilating has been rapid, and in the present edition the work has been revised in such a manner as to make it equally useful to both engineer and layman. The work is divided into two parts, the first part containing the text matter and the second a collection of tables for the use of engineers, etc. The contents by chapter heads are as follows: Theoretical Considerations; Ventilation; Heat, Heating and Cooling; The Sturtevant System; Heating and Ventilating Apparatus; Heating and Ventilating Calculations; Testing; Special Problems of Application; Typical Installations; Sturtevant Apparatus; Tables. While the book is intended for wide circulation, its cost makes general free distribution prohibitive.

Compressed Air Practice. By Frank Richards. 326 pages, 6 by 9 inches. 94 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price $3 net.

The author published a small book called "Compressed Air" about twenty years ago, and this work forms part of the present volume. The advance in compressed air practice and the many developments of its use during the twenty years elapsed are great and varied. The contents comprise: Atmospheric Generalities, Definitions and General Information, The Compressed Air Problem, Tables and Diagrams for Computations in Air Compression, The Indicator on the Air-compressor, Single-stage Compression, Two-stage Air Compression, Two-stage and Three-stage Compression, Air-compressor Regulating Devices, The Drive of the Compressor, The Turbo Compressor, The Taylor Compressor—The Humphrey Pump, Power Cost of Compressed Air, Power from Compressed Air, The Air Receiver, Pipe Transmission, Re-heating Compressed Air, Compressor and Receiver Fires and Explosions, Side Lines for the Air-compressor, Gasoline by Compression—Liquified Natural Gas, Rock Drill Developments, The Electric Air Drill, Compressed Air for Raising Water, The Air Lift, Air for Large Steam Hammers, Diving Bell and Caisson, Air Jet—Sand Blast—Cement Gun, Liquid Air—Oxygen from the Atmosphere. The work will be welcomed by all who appreciate clear common sense treatment of an engineering subject.

Machinery's Handbook. Compiled by Erik Oberg and Franklin D. Jones. 1400 pages, 4½ by 7 inches. Published by the Industrial Press, New York City. Price $5.

In 1898 MACHINERY began the publication of data sheets in supplement form. These sheets comprised a great variety of tables, diagrams and data for the machinist, toolmaker, draftsman, designer, mechanical engineer and others in the mechanical engineering field. As time passed the data sheets grew in volume until they formed a mass of material difficult to index and handle. Recognizing the need of putting this valuable material in convenient form for general use, MACHINERY'S editors have compiled a Handbook using the best of the material published in MACHINERY and the data sheets during the past twenty years. Much additional matter has been included in order to round out a complete work of reference, for the user, and it is believed to be the most condensed and best arranged work of the kind ever published for the mechanical man in any position, whether it be that of a machinist, toolmaker, draftsman, designer, foreman, superintendent or general manager. Special pains have been taken to present the mathematical tables and formulas in attractive and convenient form. In many cases the formulas are accompanied with examples worked out, and with such illustrations the practical man is able to use formulas that he would shrink from otherwise. The sections on heat-treatment of steel, strength of materials, motor power of machine tools, broaching and screw threads are exhaustive. Within the covers of the book are included a complete treatise on spur, bevel, helical and worm gears, and the section on springs is believed to be the best treatment of the subject extant. Space does not permit of reviewing the contents in full, and the heads of sections only are quoted to give a general idea. They are as follows: Mathematical Tables; Principal Methods and Formulas in Arithmetic and Algebra; Logarithms and Logarithmic Tables; Areas and Volumes; Solution of Triangles and Trigonometrical Tables; Geometrical Propositions and Problems; Principal Methods and Formulas in Theoretical Mechanics; Strength of Materials; Riveting and Riveted Joints; Strength and Properties of Steel Wire; Strength and Properties of Wire Rope; Formulas and Tables for Spring Design; Torsional Strength—Shafting; Friction; Plain, Roller and Ball Bearings; Keys and Keyways; Clutches and Couplings; Friction Brakes; Cam Design and Cam Milling; Spur Gearing; Bevel Gearing, Worm Gearing, Spiral and Herringbone Gearing; Epicyclic Gearing; Belts and Pulleys—Machine Tool Drives; Rope Transmission; Transmission Chain and Chain Drives; Crane Chain and Hooks; Belts, Nuts, Screws, Wrenches, Handles, Handwheels and Other Machine Details; Speeds and Feeds for Machine Tools—Tool Grinding; Automatic Screw Machine Practice; Tapping and Threading; Lubricants for Machining Operations; Running, Shrinkage and Forced Fit Allowances; Measuring Instruments and Gaging Methods; Change Gears for Spiral Milling—Leads and Corresponding Angles; Milling Machine Indexing; Jigs and Fixtures; Grinding and Grinding Wheels—Polishing and Lapping; Punches, Dies and Press Work—Drop-forging Dies; Broaches and Broaching Operations; Classification, Testing and Application of Files; Screw Thread Systems and Thread Gages; Taps and Threading Dies; Milling Cutters; Reamers; Twist Drills, Counterbores and Boring Bars; Heat treatment of Steel—Hardening, Tempering and Annealing; Testing the Hardness of Metals; Principles of Iron and Steel Manufacture; Foundry and Pattern Shop Practice; Extrusion of Metals; Die Casting; Forge Shop Equipment; Forge Shop Welding Methods; Autogenous Welding; Welding with Thermit; Electric Welding; Soldering and Brazing; Etching and Etching Fluids; Coloring Metals; Horsepower Required for Machine Tools and Forging Machinery—Electric Motor Drive; Care of Electrical Machinery—Dynamo and Motor Troubles; Properties and Weights of Materials; Composition of Alloys; Information Relating to Heat—Comparison of Thermometer Scales; Pneumatics—Air Compression—Flow of Air; Water Pressures and Flow of Water; Pipe and Pipe Fittings; Lutes and Cements; Weights and Measures; Metric System of Measurements and Conversion Tables; Manufacturing Plant Appraisal; Drawing, Tracing and Blueprint Papers; Principal Patent Law Regulations.

NEW CATALOGUES AND CIRCULARS

Cincinnati Iron & Steel Co., Cincinnati, Ohio. Circular of the "Cisco" eighteen-inch engine lathe.

General Electric Co., Schenectady, N. Y. Bulletin No. A 4199 illustrating and describing railway motor gears and pinions.

Deane Steam Pump Co., 115 Broadway, New York City. Bulletin D 224 on horizontal double-acting single-cylinder power pumps.

Brown Instrument Co., Philadelphia, Pa. Calendar for 1914 illustrated with a view of a twelve-inch gun in action at Fort Wadsworth, New York City.

General Electric Co., Schenectady, N. Y. Bulletins A 4143 and A 4148 on belt-driven alternators Form B and small plant direct-current three-wire switchboards of 125 and 250 volts and 10 to 100 K. W. capacity, respectively.

Noble & Westbrook Mfg. Co., Hartford, Conn. Catalogue of Dwight Slate marking machines, dieholders and dies. The company is prepared to make steel marking dies for all purposes.

Morse Chain Co., Ithaca, N. Y. Circular of Morse chain drives, showing applications to motor-driven machine tools, engine drives, textile machinery, rubber mills, calender rolls, etc.

Stow Mfg. Co., Binghamton, N. Y. Circular of portable tools comprising emery grinders, light drilling machines, toolpost grinders, electric hand buffers, electric breast drills, etc.

Challenge Machine Co., Inc., Philadelphia, Pa. Catalogue of "Challenge" floor grinders, illustrating a variety of grinders, details of construction, wheel guards, belt polishing attachment, etc.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin No. 1002 on Shepard electric cranes and hoists, illustrating their use in steel car plants and on the docks of New York Harbor.

Allen-Bradley Co., 495-497 Clinton St., Milwaukee, Wis. Circular describing "Type H" alternating-current motor starters. Special emphasis is laid on the motor protective features of the rheostats on these starters.

Wheelock, Lovejoy & Co., 23 Cliff St., New York City. Circular of the Keen impact ball tester for testing the softness of steels and other metals. The tester was illustrated and described in the July, 1913, number of MACHINERY.

Watson-Stillman Co., 192 Fulton St., New York City. Catalogue 89 on heating, chilling and die presses of the hydraulic type. Die sinking presses, both power and hand operated are illustrated. The hand die sinking presses include the four-column and open-jaw types.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City. Circular of the "Yankee" bench drill, hand-operated, and "Yankee" vise for same. The "Yankee" bench drill weighs fifty-seven pounds and is intended for small shops, farm use, etc. The vise may be used on the drill or on a bench.

Chicago & Northwestern Railway Co., Chicago, Ill. Safety Bulletin No. 4. These bulletins show the dangers of railroading and how accidents happen, and illustrate the rules provided for avoiding accidents. A slogan of the company is, "Remember that it is better to cause a delay than to cause an accident."

National Malleable Castings Co., Sharon, Pa. Circular of electric steel castings, illustrating a Heroult furnace installed at the company's Sharon works and typical castings made from it. The advantages of steel castings made from the electrical furnace are enumerated and records of fatigue tests are given.

Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y. Circular of Doehler babbitt-lined bronze bearings for internal combustion motors. These bearings were used by the Moline Automobile Co. on the engine recently tested at the Automobile Club of America laboratory, running two weeks without a stop.

Edward Wilbur, 125 Summer St., Boston, Mass. Card advertising and illustrating the Greenerd belt pole for facilitating the shifting of belts while standing on the floor. The pole is 9 feet long, made of hard wood and steel, and is provided with a

MACHINERY

MARCH, 1914

DRAWING CARTRIDGE CASES*

MACHINES, DIES, TOOLS AND METHODS USED BY THE FRANKFORD ARSENAL

BY DOUGLAS T. HAMILTON†

THE difficulties met with in producing cartridge cases from sheet brass are the same as those encountered in practically all drawn sheet metal work. Admitting this, and considering the advances made in cartridge making, it would seem that a description of the methods and tools used for this work should be of general value when modified to suit the various requirements. In this article the data given refer more particularly to the drawing of cases for 0.30 caliber cartridges, the tools and methods used being taken up in detail. The practice followed by the Frankford Arsenal, Philadelphia, Pa., is interesting and presents some novel ideas in this class of work. The writer is indebted to Colonel George Montgomery for the material contained in this and subsequent articles.

Making the Cups from which Cartridge Cases are Drawn

The first operation in the making of a cartridge case is to produce a cup, then by successive redrawing operations this cup is reduced in diameter and extended to the required length. Fig. 1 shows the various steps in the sequence of redrawing operations following that of making the cup. From this illustration it can be seen that five operations are necessary to bring the case to the required length—these are called redrawing operations because the work accomplished consists in reducing and redrawing a piece that has already been drawn to cup form. The press used for making the cups from which cartridge cases are made is shown in Fig. 3. It is of the double-action type, and carries four punches and dies, thus making four cups at each stroke. This punch press operates at 100 revolutions per minute, producing 400 cups a minute, or 24,000 cups per hour. The type of blanking and cupping dies used in this machine are shown diagrammatically in Fig. 2, and also in Fig. 10 together with the tools required to make them. Fig. 2 shows the shape of the die more clearly, and gives a comprehensive idea of the action that takes place in the formation of the cup. At *A* the blanking punch is shown in contact with the top face of the brass sheet. At *B* the blanking punch has cut out a disk of the required size and carried it down to the first shoulder in the combination blanking, cupping and drawing die. At *C* the combination cupping and drawing punch has come into operation and has started to form the blank to cup shape; whereas at *D* the blank has been forced completely through the die and has been given the first drawing operation.

The sheet stock is held on the roll *A* located to the right of the machine shown in Fig. 3, and is drawn into the press under the blanking and drawing punches by means of feed rolls. After the stock passes through the rolls *B*, it is oiled by means of a rag saturated with lard oil that is contained in the tank *C*. The sheet is fed a distance equal to the diameter of the blank plus the width of the web for each stroke of the press (see Fig. 5), and after it has been started by the operator, who uses the handwheel feed illustrated, it is carried on automatically by the feed rolls located at both ends of the throat of the press. As the sheet from which the blanks have been sheared protrudes from the left-hand end of the machine, it passes through a shearing die, which in conjunction with a knife operated by a crank and connecting lever held on the extreme end of the crankshaft, cuts off the scrap, enabling it to be packed in boxes. The chief reason for cutting up the stock in this manner is to avoid having it pile up around the machine and also to enable it to be more easily removed.

The manner in which the dies and punches are laid out in order to economize in stock is shown in Fig. 5. By referring to the upper diagram in this illustration it will be seen that

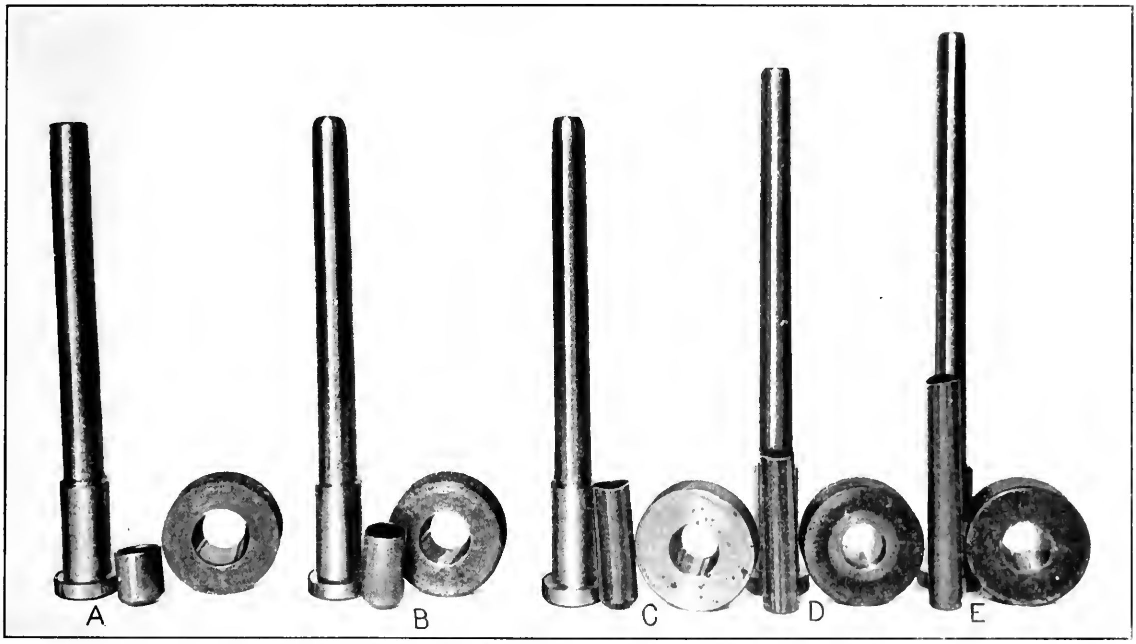

Fig. 1. Sequence of Redrawing Operations on a 0.30-caliber Cartridge Case and Tools used

* For articles on cartridge making previously published in MACHINERY, see the series on "Cartridge Making," in the March, April and May, 1911, numbers, and articles there referred to.
†Associate Editor of MACHINERY.

the centers of the four dies are located in a "diamond" shape, thus reducing the width of the sheet required and securing the most satisfactory layout for the punches and dies. The condition of the sheet after the press has made four strokes is shown in the lower portion of the illustration, which indicates the progression followed in cutting out the blanks.

Setting Drawing Punches and Dies

To set drawing punches and dies properly, requires considerable experience, as this is a difficult task under the most favorable conditions. The dies and punches are usually aligned with each other by setting them in the approximately correct position, then running through a few cups and noting the results. In the type of die-holder shown in Fig. 4, it is not necessary, of course, to reset the dies when they have been removed for grinding, if proper attention has been paid when they were first set up. This is not the case, however, with redrawing dies, as will be explained later. One peculiar point in making cups that causes considerable trouble is that it is practically impossible to produce a cup with a straight top; that is, one in which the metal is drawn to the same extent on one side as it is on the other.

The reason for a cup drawing irregularly in this manner is not due in all cases to inaccurate setting of the punches and dies, but generally to a variation in the thickness of the sheet from which the blank is cut out. It is a peculiar fact, but nevertheless true, that it is practically impossible to roll sheet metal uniform in thickness; that is to say, the sheet is thicker in the center than it is at the outer edges. The reason given for this is that the rolls, even though they be 8 or 10 inches in diameter, spring to a slight extent in the center—where they are unsupported except by their inherent strength—and thus produce a sheet of varying thickness throughout its width. Another difficulty experienced in making cups is the striking of hard spots in the metal. It is obvious, of course, that if the stock is not of a uniform hardness, the softest spot or portion will draw much more than the harder portion, and hence, a cup having one side longer than the other will be obtained. Not only will the top edge be irregular, but the walls will also be of uneven thickness. It is claimed by those who have had experience in this work that it is impossible to rectify any defect of this kind in the succeeding redrawing operations. When a cup is once started with a wall of unequal thickness, this condition prevails until the final drawing operation, so that it will easily be seen that great care must be exercised in making the walls of the cup of uniform thickness if a satisfactory product is to be obtained.

Annealing and Redrawing Operations

After the cups are made it is the general practice to anneal, wash and dry them as was described in an article on this subject in the March, 1911, number of MACHINERY. Then they are ready for the first redrawing, or second drawing operation. The temperature to which the cup is heated for annealing varies from 1200 to 1220 degrees F. The manner of handling the cups after they have been annealed, washed and dried, is to carry them in trucks, which are lifted from the floor of the annealing room to a track located above the drawing presses. These trucks are provided with false bottoms and are run along the track until they are directly over the hopper which feeds the cups to the punch press. The false bottom is then removed, allowing the cups to drop from the chute into the hopper *A* of the drawing press, Fig. 6, from which they are removed by a feeding device consisting of a wheel in which pins *B* are set at an angle of about 45 degrees with its horizontal axis. These pins are pointed, enabling the shell to be located on them, mouth first. The pins are rotated inside the hopper so that they catch the cups and deposit them in close-wound spring tubes *C*.

These tubes pass from the hopper down to the feeding slides of the drawing press (see Fig. 6) and as the shells drop out of the tubes they are caught by fingers held on the slides and carried over into line with the dies and punches. When the slides have advanced to their extreme forward positions, the punches descend and force the cups through the drawing dies, depositing them in a box located under the press. The slides are operated from the crankshaft through bevel gears and a connecting-rod that transmits power down to a horizontal shaft carrying a series of four cams. These cams contact with rollers held in the feeding slides and thus transmit the desired movement to them. The rolls are held in contact with the cams by coil springs. The machine shown in Fig. 6 operates at 100 revolutions per minute, and as four cups are drawn per stroke, it is evident that this machine has a productive capacity of 24,000 cups per hour. The drawing press shown in this illustration is used for performing the second and third redrawing operations, shown with the die and punch used at *B* and *C* in Fig. 1.

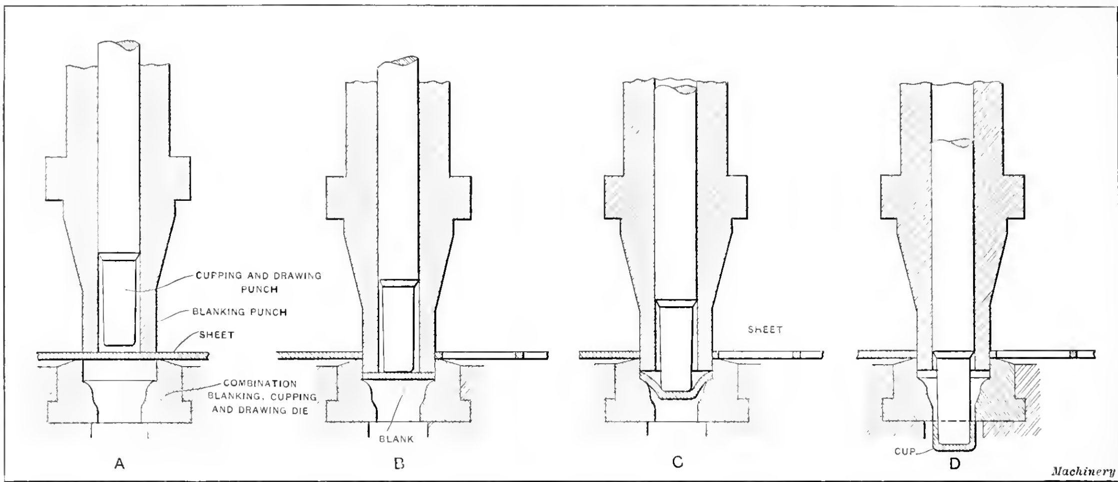

Fig. 2. Progressive Steps in the Blanking, Cupping and First Drawing Operations on the Cartridge Case

First, Fourth and Fifth Redrawing Operations

The first, fourth and fifth redrawing operations are handled in machines of a type similar to that shown in Fig. 7, which are provided with only two punches and dies instead of four, as was the case with the machine shown in Fig. 6. The feeding of the shells to the slide that carries them to the dies is practically identical with that shown in Fig. 6, but the slide is operated in a different manner. In this particular machine the slides *A* which serve as a means for carrying the cups from the feeding tubes *B* over into line with the drawing dies are actuated in their movement by means of a bellcrank lever receiving power from a cam held on the crankshaft *C* of the press.

While the shells are fed to the punch with the mouth up, it sometimes happens that one will pass down the feeding tubes to the slide the wrong way, that is with the bottom up. Now should such a shell be allowed to pass over into

line with the die, it would mean that the punch would be broken and the die either broken or damaged to such an extent that it would be unfitted for use. It is not uncommon also to have shells pass down to the slide that are dented or otherwise defective which would prevent them from feeding into the die properly. Should such a shell pass down the feeding tubes and stick in one of the slides, it would mean that the punch would come down on the slide and break, not only putting the machine out of commission for a time, but perhaps causing serious damage to the attendant as well.

In order to provide against such accidents, Mr. August A. Plate, general foreman, invented an ingenious tripping device

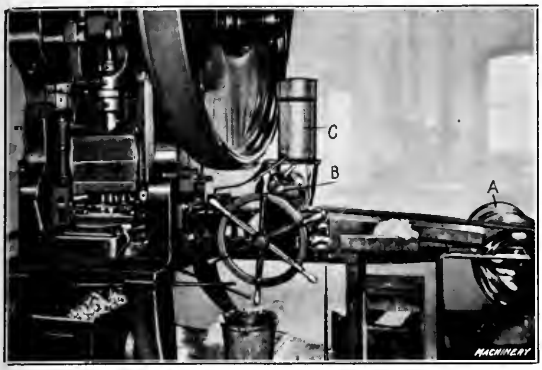

Fig. 3. Making the Cups, Four at one Stroke of the Press, at the Rate of 24,000 per Hour

that is applied to this machine and works very satisfactorily. This device, while comparatively simple in construction, is positive in its action, and has been the means of saving a lot of money in the cost of dies and tools. It also enables one attendant to run four instead of two machines. Essentially, this device consists of a projecting stud held in the crankshaft of the press, and which when the feeding slide is operating normally passes through a slot cut in a lever that is connected with the bellcrank lever operating the slide.

Now, if for any reason the slide should be prevented from making a complete forward or backward stroke, this projecting pin would not pass through the slot in the lever mentioned, but would force the lever out, knocking out the lever *D*, which transmits a movement through the links *E* and *F* and bellcrank *G* down to the tripping lever *H*. This knocks the clutch operating lever *I* off the catch—throwing in the clutch and stopping the operation of the press. It can therefore be seen that this tripping device is of simple construction, but is effective, owing to the fact that when the slide does not complete its movement the clutch is thrown in before the ram of the press reaches the top of the stroke so that the machine is stopped before it has a chance to complete another stroke.

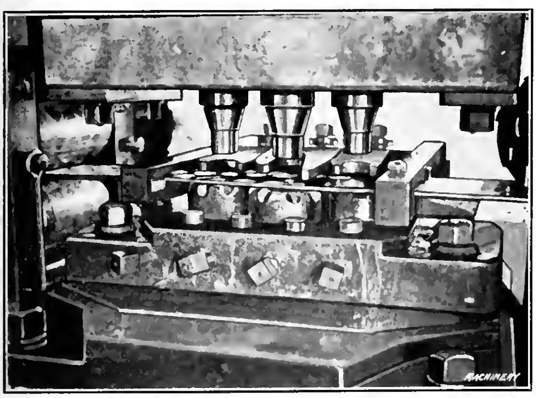

Fig. 4. A Closer View of the Machine shown in Fig. 3

Final Redrawing Operation

The fifth redrawing operation is accomplished in a press similarly equipped to that shown in Fig. 7. These presses operate at 100 revolutions per minute, and turn out 12,000 cups per hour. Several annealing operations take place between the time when the cup leaves the first redrawing operation and the time when it is ready for trimming, but as these have been described in the article mentioned no reference need be made to them here. Before the fourth redrawing operation is accomplished the shells are taken to a heading machine of the horizontal type where they are "bumped." This operation is accomplished in order that in the successive redrawing operations the head of the shell will not be reduced too much in thickness.

The 0.30 caliber cartridge case has what is known as a solid head; that is, the top portion of the shell that contains the primer is not indented to form a pocket for the primer, the pocket itself being simply a hole forced into the head. This type of cartridge has been found necessary for use with smokeless powders. The former method used in making 0.30 caliber cartridge cases was to form the pocket by forcing in the head which was very little thicker than the sides of the shell near the head. This construction, however, was found to be too weak for smokeless powders, as the head would blow off. The "bumping" is a very simple operation and is somewhat similar to heading except that the punch is perfectly flat and simply gives the shell a blow, upsetting it slightly and flattening it so that in the two final

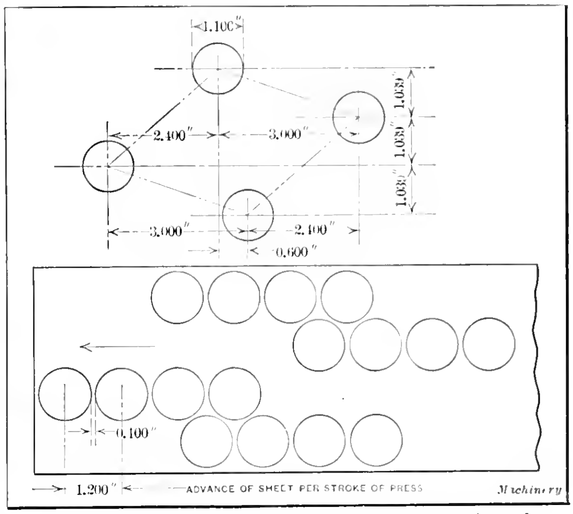

Fig. 5. Manner of laying out Combination Blanking, Cupping and Drawing Dies in order to economize in Stock

redrawing operations—fourth and fifth—the metal at the head is not stretched to any appreciable extent.

Trimming a Cartridge Case to the Exact Length

As was previously mentioned, it is practically impossible to draw a shell that will not have an irregular top edge and also that will not become distorted or cracked to some extent. This makes it necessary to draw the case much longer than actually required and to trim off the surplus material. The removal of this excess amount of stock is accomplished in machines that are operated automatically. A battery of these trimming machines at work on 0.30 caliber cartridge cases is shown in Fig. 8, while Fig. 9 shows a closer view of one of the machines and gives a clear idea of its working mechanism. As will be seen upon reference to Fig. 8, these trimming machines are arranged in such a manner that the various hoppers can be filled from an overhead conveying system. This arrangement consists of a track similar to that used in the drawing press department previously referred to, and enables one man to attend to an entire line of presses. The track accommodates a truck in which the shells are carted along the line and from which they are ejected through a false bottom, dropping into the hoppers located over the machines. The feeding of the shells down to the trimmer is accomplished by the same type of hopper as previously described, but the subsequent handling is somewhat different. As the shell descends from the hopper it passes through a

locating cage *A* from which it is carried forward by a plunger *B* and is located on the cutting-off punch *C*. Here it is held by friction while a circular trimming tool *D* advances and trims off the surplus stock. The shell and trimming are then ejected from the cutting-off punch by a sleeve *E* operated from the left hand end of the machine, the shell being

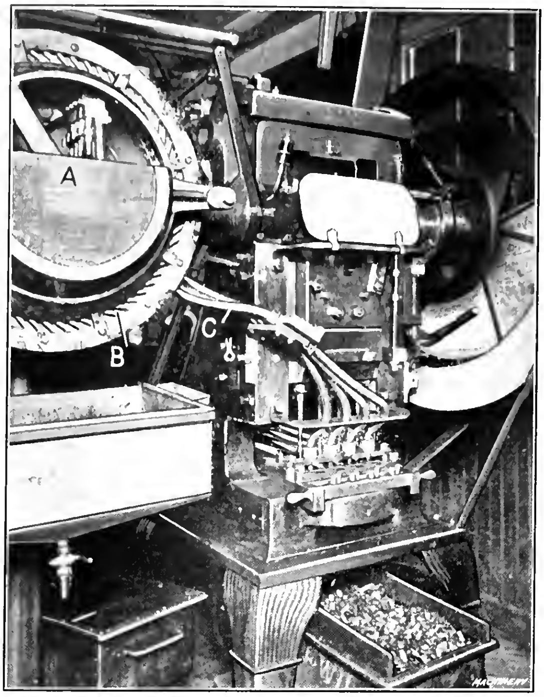

Fig. 6. Drawing Press used for Second and Third Redrawing Operations—Four Cups per Stroke at the Rate of 24,000 per Hour

deposited in one box and the trimming in another; two separate channels are provided as shown clearly in Fig. 9.

Making Combination Blanking, Cupping and Drawing Dies

While the making of combination blanking, cupping and drawing dies does not differ materially from ordinary tool making, there are a few points in connection with this work that it might be well to explain. The die blank is made from a special grade of Firth-Sterling steel containing from 1.11

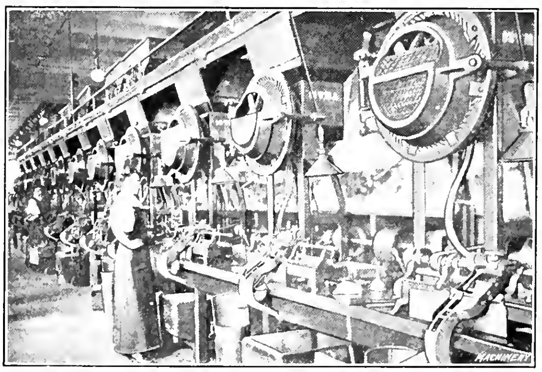

Fig. 8. A Battery of Automatic Trimming Machines at work on 0.30-caliber Cartridge Cases

to 1.30 per cent carbon. This is an extremely high carbon steel, but has been found satisfactory for this class of die owing to the great wear that it is subjected to when in use. The first step, of course, in making one of these dies is to cut off the blank from a bar of stock, and then by means of drills, reamers, etc., to shape the hole in the die to the correct form. Fig. 10 shows one of these dies at *C* together with a blank and a cup made from it, while *D* is the combination cupping and drawing punch and *E* the blanking punch.

Fig. 11 shows a toolmaker completing one of these dies, and Fig. 12 shows a close view of the chuck used for holding it. The manner in which the die is held while being drilled, counterbored and reamed is identical with that used when it is set up in the press, so that in this way the conditions in both cases are as nearly alike as possible. The chuck consists of a female center *A* in which a recess is provided that

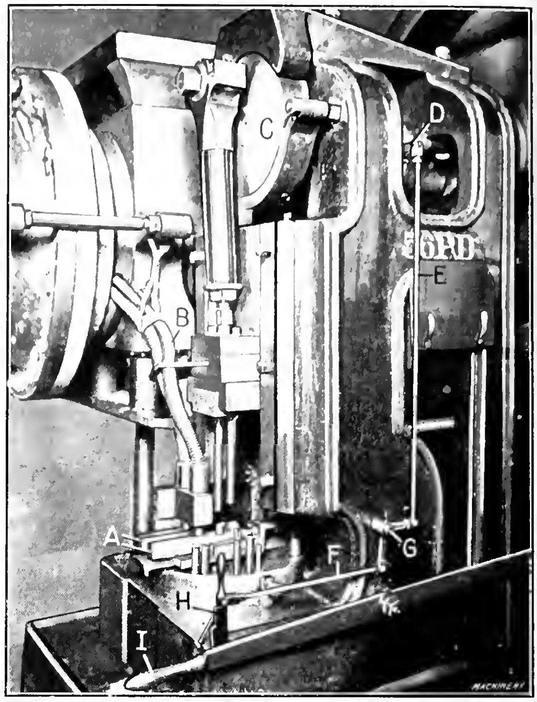

Fig. 7. Duplex Drawing Press performing Fourth Redrawing Operation and turning out 10,800 Cups per Hour

fits the external body of die *B*. The outer end of this center is turned and threaded to fit a cap *C* that is machined to correspond with the other end or smallest diameter of the die *B*. This cap holds the die rigidly in position while it is centered with the female member *A*. In addition to a drill, and, of course, a boring tool to true up the hole, two tools are used for finishing the hole in this die. The first or roughing tool *B*, Fig. 10, is of the flat type, having one cutting edge,

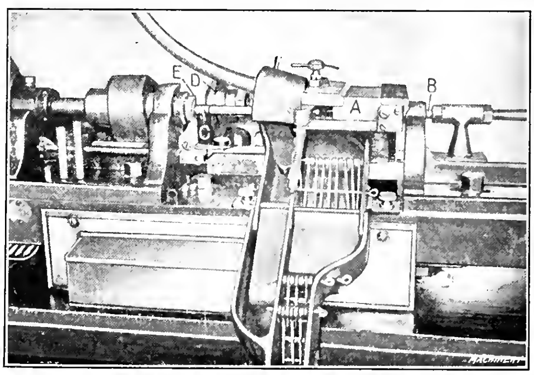

Fig. 9. Close View of One of the Automatic Trimming Machines shown in Fig. 8

while the finishing tool *A* is of somewhat similar shape but has considerably more circumference so that a rounder hole will be produced. The first tool is used merely for roughing out purposes and for bringing the hole to its approximate shape.

Making Redrawing Die Blanks

The blanks for redrawing dies are turned out in Cleveland automatic screw machines and are ready for the final reaming operation when they drop from the machine. This method is commendable in that it reduces the cost of the dies

o a minimum. The steel used for making these dies is a pecial grade of Firth-Sterling steel containing from 1.11 to .30 per cent carbon, and for the particular die G illustrated n Fig. 13 a bar 1¾ inch in diameter is used. This die is a econd redrawing operation die for a 0.30 caliber cartridge ase, and is 1 23/32 inch in diameter by 1/2 inch thick. In rder to have the hole true with the external diameter, great

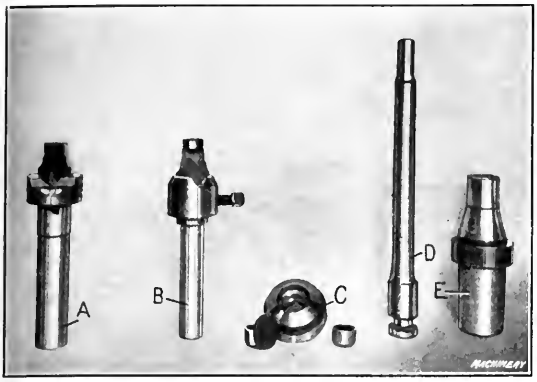

Fig. 10. Combination Blanking, Cupping and Drawing Punch and Die, and the Tools used for making the Die

are is taken in spotting the work and then removing the ole entirely from the next blank, using a fairly wide cut-off ool. The order of operations accomplished in the proper equence is as follows. First, feed stock to stop A; second, urn external diameter with box-tool B held in turret and pot with a drill C retained in the same holder; third, drill ith drill D; fourth, ream straight portion of hole with

Fig. 11. Making Comlination Blanking, Cupping and Drawing Dies

eamer E; fifth, bell-mouth with reamer F, and face with tool held on the rear cross-slide; sixth, cut-off with a tool eld on the front cross-slide.

The drawing dies, after being rough-formed in the manner llustrated, are then taken to the tool-room where they are eamed out to the exact diameter and bell-mouthed to the orrect shape, after which they are ready for hardening. For ardening, the dies are heated in a muffle furnace to a emperature varying from 1400 to 1450 degrees F., and are hen "spouted" as illustrated in Fig. 14. The spouting of the ie consists in directing a stream of water through the hole n order to harden it and at the same time leave the external iameter practically soft. The reason for this is that the ie, after hardening, is not drawn, and if the entire blank were hardened it would break very easily. Having the external diameter soft increases the strength to a considerable extent, and the dies wear much longer and do not break as easily.

When spouting, the die is held in a cage formed in the base of the bracket A and then the funnel B (which is similar in shape to an ordinary oil funnel except that the lower tapered tube is left off) is placed over it, the water being directed through this funnel and thence to the hole in the die. The funnel is provided with a handle to enable the operator to place it quickly in position over the die after the latter has reached the proper temperature, and has been placed in the fixture. The operator removes the die with a pair of tongs, holding the tongs in one hand and the funnel in the other.

Great care must be taken in heating this grade of steel because of its high carbon content. A variation of 10 degrees F. one way or the other from the temperature found most satisfactory will in many cases make the die defective for the operation that it is to accomplish. It has also been found necessary to heat the dies for various operations to different

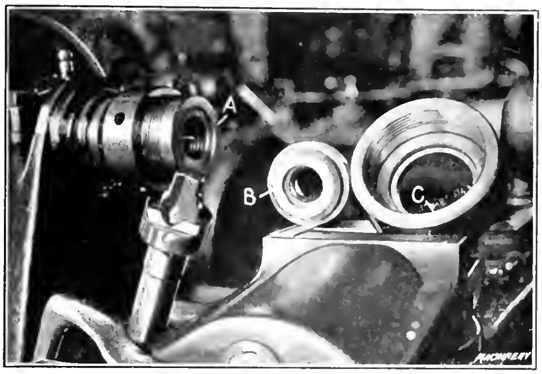

Fig. 12. Chuck used for holding Combination Blanking, Cupping and Drawing Die Blank when machining the Hole

temperatures; that is to say, the die that would be used for a first redrawing operation would be heated to a different temperature from one that would be used for the fifth redrawing or final drawing operation. The reason for this is that the pressure exerted on the die, by forcing the cup through it with the punch, on the first drawing operation, is much greater than that for the final drawing operation, and hence the die cannot be as hard and must have a more porous grain to withstand the additional pressure.

Lapping Redrawing Dies

After hardening, redrawing dies are lapped in the manner illustrated in Fig. 15. The die is held in a holder, resembl-

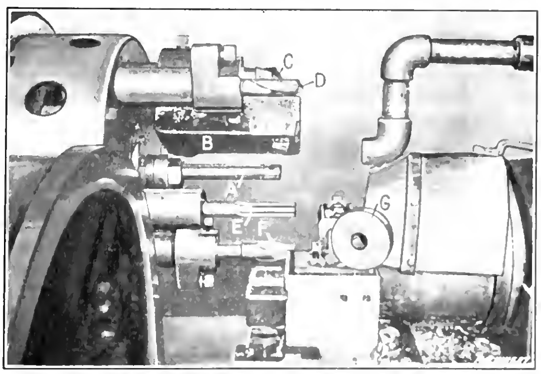

Fig. 13. Making Redrawing Die Blanks in a Cleveland Automatic Screw Machine

ing somewhat in shape that used in the drawing press, which is held in the chuck of the speed lathe. For lapping, a lead lap is used. This is held on a steel plug provided with a handle driven through it at right angles to the lapping portion, so that the operator can grip it with both hands and thus hold the plug in the proper position in relation to the

hole in the die. The speed lathe in which the die is held is operated at from 2000 to 2400 revolutions per minute, and the spindle is always kept a snug fit—also there must be no end play. A mixture of lard oil and No. 10 emery is used for lapping, this being found best for both the roughing and finishing operations. The mouth or bell-mouthed portion of the die is lapped with emery cloth of the same grade No. 10. The lapping of a drawing die is an operation that must

Fig. 14. "Spouting" a Redrawing Die—hardening the Hole and leaving the Exterior comparatively Soft

be very carefully handled. Not only must the hole be of the correct size, but the radii of the bell-mouthed portion must be exact. The correct lapping of the die is more a matter of experience than anything else, and it is practically impossible to give any definite information on the subject. One point, however, that should never be ignored is the fact that the lap should always be presented in a line parallel to the axis of the die. If it is tilted over the least bit to one side or the other a hole will be produced that will not only be out of round, but that will not be straight; that is, if the die were placed on the arbor it would be found to run untrue because the hole would not be exactly in the center of the blank on both sides.

After the dies are lapped to the correct size and shape, they are ready for use in the press and are then turned over

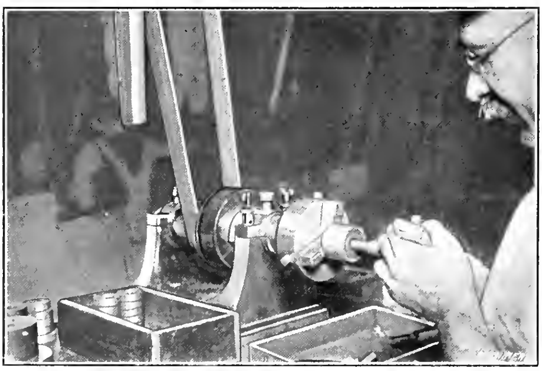
Fig. 15. Lapping a Redrawing Die

to the drawing press department. Drawing dies for all redrawing operations up to the final operation are used until they have worn approximately 0.0017 inch large. When they have become worn to a size this much greater than the actual diameter of the cup required, they are taken out of the press and annealed. The dies are then reamed out to the next size larger—that is for the previous redrawing operation than that for which they were originally made—and used over again. This is repeated until the dies have been used five times. Redrawing dies made from Firth-Sterling steel of the carbon content previously given are good for making 40,000 cups before they have become worn too large. The peculiar point about this steel is that it does not warp out of shape in hardening and also does not produce any scratches on the work. It is of extremely fine grain, hardens well and produces a shell free from scratches and other imperfections. The only thing that makes it unfit for use is when it becomes worn too large. Otherwise the condition of the hole in the die is as good at the completion of 40,000 cups as it was when first used.

Making Redrawing Punches

Redrawing punches are also made from Firth-Sterling steel, but the carbon content for the punch is considerably lower than that used for the die, and never should exceed over 0.60 per cent. There are a few points that require careful consideration in making drawing punches. In the first place, the stock should be centered as true as it is possible to get it. There is a good reason why this operation should be carefully done. If the piece of stock from which the punch is to be made has not been centered true, the finished drawing punch when hardening will be bent out of shape. The reason for this is that when a bar that has been incorrectly centered, so that it runs eccentric, is turned, more stock is removed from one side than the other, and the turning, instead of being parallel with the grain, cuts across it; hence the ability of the steel to resist deflection in hardening is not as great as it would be had the support not been removed from one side.

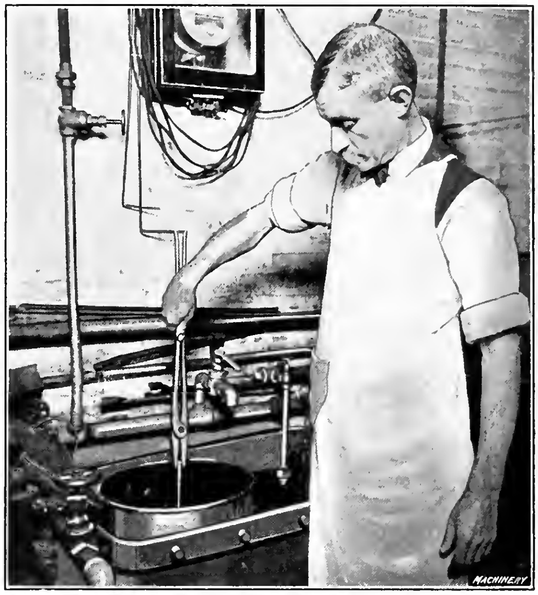

Fig. 16. Hardening a Redrawing Punch—Note Method of Dipping

The explanation given for this is that in rolling bar stock the fiber or grain of the metal is drawn out in practically a straight line and when this condition does not exist in the finished article distortion takes place, because, in cooling, the fibers of the stock revert to their original positions parallel with the axis of the bar.

Another point that is of considerable importance is that never less than 1/32 inch of material should be removed from the bars if the finished piece made from it is to be hardened. There is a certain decarbonizing portion surrounding a bar of stock that prevents the steel from hardening properly, and this decarbonizing portion should always be removed from those parts of the punch that must be hardened; if not, soft spots will be experienced.

The drawing punch should be heated in a muffle furnace very slowly until it has obtained the correct temperature, and while being heated it should be constantly rotated to prevent warping. The temperature to which drawing punches are heated varies from 1400 to 1425 degrees F. They are quenched in a bath consisting of 15 parts water and 1 part common potash, and are dipped in a vertical position as illustrated in Fig. 16.

METHODS OF CHUCKING BEVEL GEARS

ACCURATE AND EFFICIENT METHODS DEVELOPED BY THE HEALD MACHINE CO., WORCESTER, MASS.

The Heald Machine Co., Worcester, Mass., has given the problem of chucking both spur gears and bevel gears, preparatory to grinding, a great deal of study during the past few years, and has devised, at different times, what have been considered very accurate and efficient methods of chucking. There is a great diversity of opinion among the users of internal grinding machines in regard to what seems to be the most desirable method of holding or chucking gears for grinding; furthermore, a device that is very successful in one shop does not always appeal to the man in charge of another shop doing similar work. It seems to be very difficult, in many cases, to get the men responsible for results in different shops, to appreciate the advantages of a method which is different from what they have used in the past, or, in some instances, even to consider carefully the exact advantages of one scheme as compared with another, for securing the accurate results required in grinding operations.

Some of the successful methods of chucking gears which have been developed by the Heald Machine Co. are shown in the accompanying illustrations. Fig. 1 shows an excellent method of holding crown gears or ring gears such as are used in automobile transmissions. An unhardened master gear *A* is mounted on the faceplate so as to run true, and certain teeth are cut away at the inner ends as shown at *B*, leaving three sets of three or four teeth each as at *C*, which are longer than the others. When a gear to be ground is set into this master gear it will be centered with great accuracy and run true. The gear can be held in position very easily by two or three spring clips *D*. There is only one position that the gear to be ground can take with this method of holding, and as the master gear has contact points practically 120 degrees apart, the gear will not rock on its support, and extremely accurate work may be produced.

Fig. 2 shows a standard draw-in collet fitted with special jaws for holding bevel gears, these jaws being arranged to bear at the bottoms of the tooth spaces. Jaw *A*, as will be seen, has a slight projection *B* which extends over the outside of the gear to prevent it from sliding out as the jaws are closed; hence, by simply opening and closing the jaws of this collet the gear is clamped and released and no straps or yokes are necessary to hold the work in position. An objection to this design is that if the chuck teeth do not have a good bearing surface at the bottom of the tooth spaces, a chance of error will be introduced.

Fig. 3 shows a method of holding bevel gears by the use of taper rolls which enter between the teeth, giving a pitch-line control method of chucking. This illustration shows a chuck having six rolls arranged in three pairs. These rolls, for gears of other sizes, may have one or possibly two teeth between them, according to the number of teeth in the gear to be chucked. This gives practically a six-point contact, and yet the rolls are so disposed that the gear will be held solidly in the chuck with less tendency to rock than if they were evenly spaced around the circumference. The use of six rolls in three pairs, instead of three rolls evenly divided around the gear, gives superior results because the double rolls furnish a sort of check on each other in locating the gear. They also provide additional wearing surface, thus increasing their durability, and, according to the experience of the Heald Machine Co., gears that run very accurately are produced when this form of chuck is used.

The chuck has a faceplate *A* which screws onto the nose of the grinder spindle *B*. In front of the faceplate *A* there is a second plate *C* recessed to a suitable angle for receiving the gear *D* and rolls *E*. The rolls are held by triangular shaped plates *F* and cap-screws. These plates and the cap-screws hold the rolls back firmly against the chuck plate *C*, which prevents dirt from getting under the rolls, but allows a slight freedom for the rolls so that they can adjust themselves slightly with relation to the gear teeth. The gear is held in place by a yoke *G* and thumb-screw as shown. This yoke exerts a pressure in a line parallel with the axis of the gear, and assists in forcing the gear back to a solid and concentric location.

It will be noted that the surface on part *C* is marked "Finish for indicator," and it has been suggested that after the angular surface is accurately ground true as to size and position, this outer surface also be ground true; then if it should be necessary to remove the fixture from the machine or exchange it for another size, when the fixture was replaced it would be a simple matter to test its accuracy by applying an indicator to the finished surface previously referred to. If any error were observed, the clamping screws which hold parts *A* and *C* together would allow for whatever adjustment might be necessary to enable part *C* to run true, without going to the trouble of re-grinding the surface for locating the rolls. While it would cost a little more to make this division between parts *A* and *C*, this cost would be

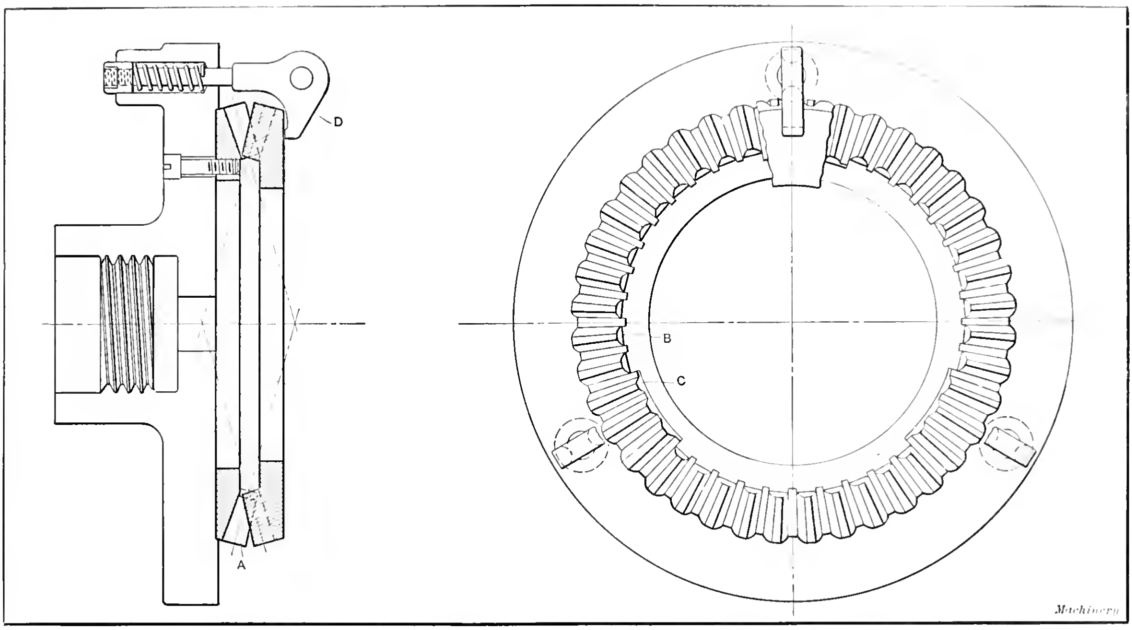

Fig. 1. Chuck for Bevel Gear having a Master Gear against which the Work is clamped

saved many times over because plate *A* could be arranged to receive many different types of chucking devices, if the user of the grinding machine had a variety of gears differing as regards the number of teeth and pitch.

According to the experience of the Heald Machine Co., the rolls used for chucking bevel gears should be tapering because they make contact with curved surfaces, the elements of which converge at a common vanishing point. Some mechanical men who stand high in the profession of making gears claim that cylindrical rolls are just as satisfactory as tapering rolls, although this company considers the tapering roll superior, and is inclined to believe that those who consider cylindrical rolls satisfactory, are using them in connection with gears having a face width that is small in proportion to the gear diameter, as, for example, ring gears used in automobile transmission. In such cases the error does not seem to be as pronounced, but with miter gears, especially when the face width is say one-quarter to one-fifth the gear diameter, there appears to be a most decided tendency for the gear to rock on a cylindrical roll at a point about midway of the face of the teeth.

The method of calculating the diameter and taper of the rolls is to select for the large end of the roll a diameter which will bring the surface of the roll about 1/16 inch above the outside diameter of the gear teeth. The taper of the roll should be approximately that which would cause the roll, if extended, to converge at the apex of the pitch cone. If these rolls are to make proper contact with the tooth surfaces, the points of contact must lie in a line running from the large end of the tooth to the vanishing point of the pitch cone, and if two elements in the surface of the roll meet in a common vanishing point, all other similar elements must apparently meet at the same point, indicating that these rolls should be part of a true cone. Experience seems to show this to be true, although the center of the roll is slightly outside the pitch circle of the gear. Working on this basis, it is not difficult to lay out, with considerable accuracy, the included angle of the rolls and obtain the angle of the surface in the chuck plate against which the rolls bear. In actual manufacturing, this angle can be checked easily by simply inserting the taper rolls between the teeth on opposite sides of the gear, thus forming a temporary gage.

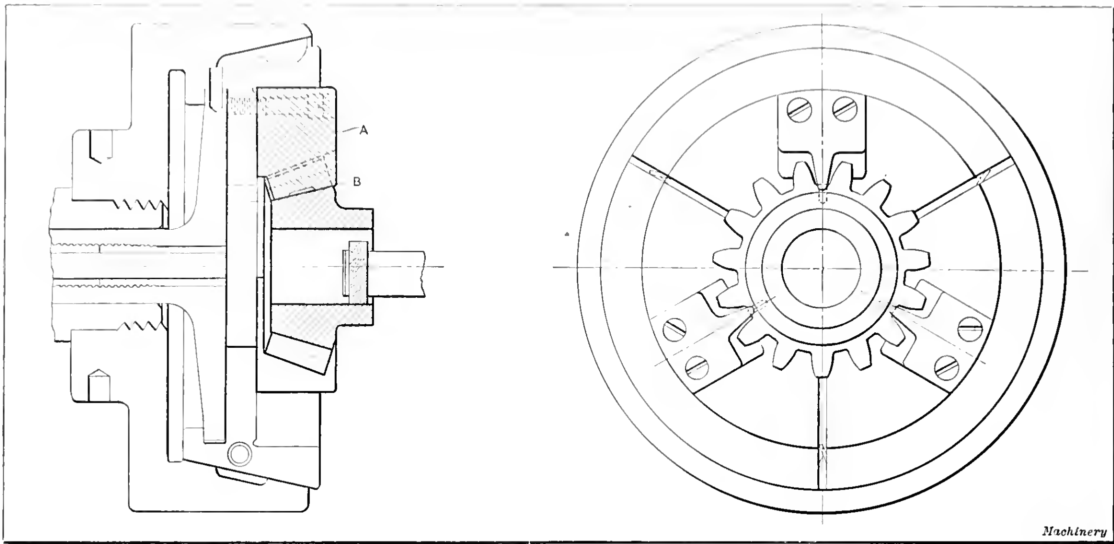

Fig. 2. Bevel Gear Chuck with Jaws which engage Bottoms of Tooth Spaces

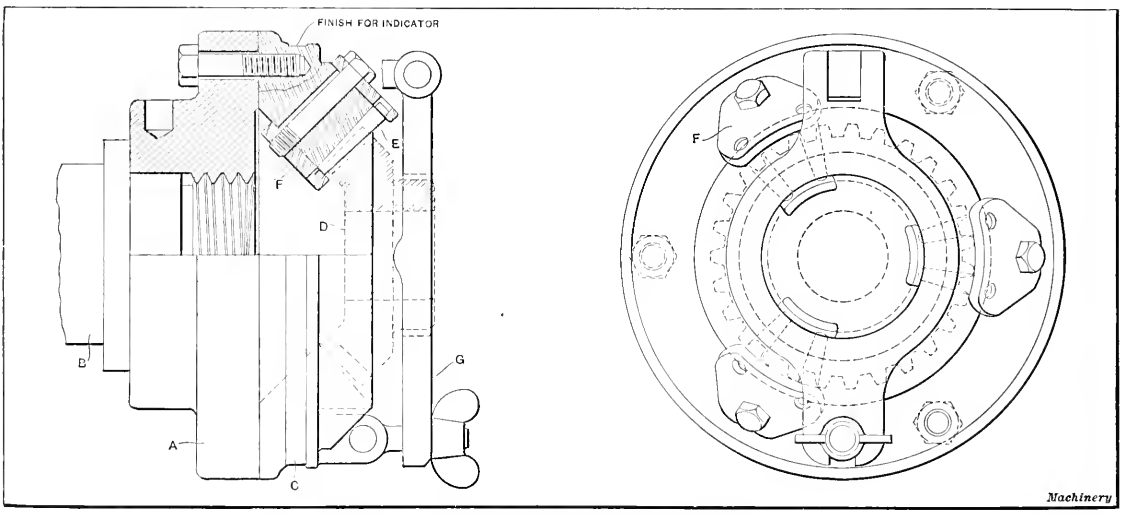

Fig. 3. Bevel Gear Chuck with Tapering Rolls which bear against Sides of Teeth

The best method of holding the rolls in place has proved to be more of a problem than would be supposed after the solution has been found. These rolls could, of course, be riveted to the conical surface, but the rivets would be quite small and rather frail for everyday service, and this arrangement would not provide the lateral adjustment that is desirable to compensate for minute variations in the gear teeth, due to cutting or hardening.

SOME SOURCES OF LEAKAGE IN THE ENGINEERING INDUSTRY

IMPORTANCE OF EFFICIENT TOOL EQUIPMENT, LAY-OUT OF PLANT, ADAPTABILITY OF DESIGN, AND AMOUNT OF STOCK

BY A. A. PEEBLES*

It is impossible in the scope of a brief survey of the subject to treat adequately all the different sources of leakage which may arise in the running of an engineering plant. Each individual case which is examined has its own leakages, some of which may be peculiar to itself, and due to an inherent fault of original planning or to a defect in the management or discipline of the organization. Yet there are some phases of the question under consideration so common, but so seldom emphasized, that a brief summary of the various leakages most frequently met with may not be out of place.

For the purposes of this article leakage may be defined as all unproductive expenditure of time or effort on the part of either the men or the machinery employed in an industrial undertaking, and may also embrace the unprofitable expenditure of capital. It is, moreover, one of the most prevalent and insidious diseases which attack efficiency—prevalent because there are so very few of even the most modern plants into which leakage in one form or another does not creep; insidious because those who suffer from it so rarely know of its presence. To become aware of a source of leakage is frequently to overcome that leakage. It is the loss which is unnoticed that eats into efficiency and consumes dividends.

There are not a few engineers—owners or managers of engineering plants of one kind or another—who blame competition for the loss of business and the decrease in profits which their organizations experience. To a certain extent this may be the cause, but only to a certain extent. If a business loses contracts because other firms underbid its quotations, or if it can secure contracts only by quoting prices which permit of no profit, it is a sure sign that other firms can do the work more cheaply. They are out for profit also, and under normal conditions will not quote prices that do not yield a fair return. Any firm which cannot compete with such prices is operating inefficiently. In other words, the aggregate of its leakages is high, for efficiency is merely the absence of leakage.

It is, perhaps, no exaggeration to say that of the total money expended in the engineering workshops of the world, one-fourth is wasted on unproductive effort of one kind or another, and that of this fourth at least a half is conservable. Such items as loss of time and power, and the wear and tear of machinery involved in the return stroke of slotting, planing and shaping machines are examples of wastage which cannot well be eliminated at the present stage of machine tool development, although the day is not far distant, to judge from present indications, when even such losses as these will be avoidable. It is our aim, however, to deal here only with such of the more common leakages as are at the present moment wholly or partially remediable.

Unsuitable and Poor Equipment

One of the most prevalent sources of leakage in the engineering works is poor equipment. Too much stress cannot be placed upon the importance of up-to-date machine tool equipment. Any efficiency expert in the engineering field will endorse the statement that old or unsuitable tools are responsible for more inefficiency than is any other cause. Factory managers and owners seem to be reluctant to invest in a new plant while the old can, by any means, be made to suffice. When a machine is worn out they will scrap it, but very few will scrap a comparatively new tool merely to make room for a more efficient one. Yet, in deciding when to throw out an existing machine to make room for a new one, the question of the condition of the former should not be the determining factor. The question should be looked on purely as one of business. The operating cost of the existing machine should be computed, and also the operating cost of the proposed new one. The output of each should be carefully estimated, and the final decision based purely upon the results thus obtained. If the installation of the new tool is going to return a reasonable interest on the capital invested, the new tool should be put in. In estimating operating expenses, such items as a percentage of rental and rates proportional to the floor space occupied by the tool, and also a percentage of the interest on the capital invested in the building and of the depreciation thereof, should be considered in addition to such items as interest on capital invested in the tool itself, depreciation, operator's wages, and power used.

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The only occasion upon which there is room to question the advisability of installing a more efficient machine tool in place of one of smaller capacity is when the demands of the plant are such that they can be conveniently coped with by the existing machine. In such a case the only saving effected by a change is in the operator's time, the overhead charges of interest, depreciation and floor-space, rental being the same in each case. Such instances are, however, rare, and in most cases the progressive policy of scrapping out-of-date equipment for that of a more modern nature will be found to pay.

The writer recalls one instance which illustrates the effects of wholesale scrapping. In the north of England there is a small general engineering and millwrighting shop which, until a few years ago, was still operating an equipment composed of old, slow-speed tools. It was a busy shop, and in order to do all the work considerable overtime was necessary. It never paid. Work had to be taken at prices that would not permit of the extra cost of overtime in addition to the high cost of production due to inefficient equipment.

A change of management, however, put things on an entirely different basis. The new man raised money and put in a practically new equipment consisting of powerful high-speed tools. He also installed a new power plant with electrical distribution, and speeded things up all around. The result was that the capacity of the plant was augmented to such an extent that its output was materially increased without the necessity of any overtime, and the cost of production was so reduced that the firm was able to quote lower prices than formerly and realize a useful profit in the bargain.

Instances parallel to the foregoing could be multiplied at will. There are many shops operating at a low efficiency simply because the management is reluctant to throw out machines until they are worn out. It is comparatively rare to find an instance where the reverse is the case. That such a contingency is possible, however, will be illustrated by another experience. In this case the shop (also a small one) specialized in valves and steam fittings. Among other machinery was a battery of three hollow spindle capstan lathes which were employed in turning out spindles for a patent valve from the bar. These machines were quite capable of meeting current requirements and were rarely required to do overtime work. It happened, however, that while visiting a machinery exhibition the manager saw some new machines of the same type, but of a more powerful and improved design, and was so impressed by them that he ordered three and had them put in place of the old ones. The approximate net cost of the change was $3500. The saving effected was the money previously paid in overtime, which rarely exceeded $10 a month, and was usually less. This represents a saving of considerably less than 3½ per cent—a poor investment from a business point of view. Yet against this it must not be forgotten that the maximum output of the plant had been increased against possible future demands.

Inefficient Power Generation

Apart from the machine tool equipment of an engineering works, considerable loss may arise from inefficient power generation and distribution. It has been estimated that the average cost of power in the different industries amounts to only 5 per cent of the total cost of production, and for this reason it is sometimes regarded as immaterial. Yet in these days of keen competition, even the smallest source of leakage is of importance, and in the progressive shop, obsolete and inefficient power arrangements are no more to be tolerated than obsolete machine tools. The writer knows of

two cases which show what can be done in the way of improving power facilities. Both are extreme, perhaps, and consist in replacing a plant of exceedingly wasteful nature by the most efficient available. In one instance the saving in power paid the whole cost of the work of installing the new plant in three years. In the other all the machinery of the factory was driven, and the building lighted with electricity, for a cost approximately equal to that of lighting the place with town gas, as had been done previously.

The lay-out of a plant is a very important factor in the equation of efficiency. This should be carried out on lines calculated to reduce the amount of handling to a minimum. Repeated and unnecessary handling of material during the process of manufacture is a potent cause of costly production and one which is very frequently found. Material should be made to pass, in so far as is possible, through the different departments in order. The disposition of traveling cranes is an important consideration, as is also the method in which the different classes of machines are grouped according to their purposes and in relation to the other parts of the plant.

Where an engineering works has been originally laid out along lines which are not the best, it may not always be advisable to go to the heavy expense of entirely remodeling the whole plant. Yet much can be done in many directions to reduce the unnecessary handling, if a little thought be given to the matter, without undue expense. An example of this is afforded by a large Tyne-side shipyard in the "old country." Two cupolas were operated in connection with the foundry and were kept constantly busy. At one time these cupolas were fed by means of hydraulic lifts. Fuel and pig iron were loaded from the cars on a neighboring siding onto the lifts and were then fed to the cupola—two handlings only being required, but when the quantity of material is considered the second handling constitutes an item of some importance. By building a trestle incline from grade level to that of the charging platform, and running the cars up directly to the latter, the second handling was obviated at a relatively small expense. The direct saving effected in laborers' wages was considerable and, in addition to this, the time saved in charging increased the efficiency of the whole foundry.

Up-to-date equipment in the way of machine tool fixtures and accessories, special tools, jigs and small tools, is scarcely less important than the efficiency of the tools themselves. A good tool-room foreman and staff are among the most valuable assets of the modern engineering works. To have a complete and well kept stock of tools and accessories stored in such a way that any particular one can be found at the shortest notice is to increase the efficiency of the whole plant. Good store-keeping is also an important factor and the reverse a prolific source of small leakage. When men have to wait several minutes while the storekeeper is looking for a certain tool or some stock material, there may be a considerable waste of time, particularly when such waiting is a general thing. It is important that material, both in the tool and stock stores, should be so disposed that anything asked for can be produced without delay.

Accumulation of Scrap

There is another source of leakage which, though usually small, is found in a large number of engineering establishments and is rarely reckoned with. The accumulation of scrap is a source of small leakage in nine out of every ten shops and it is one which is most easily overcome. Scrap in a shop or in a yard takes up valuable space; it is in the way and is generally a nuisance. It also represents so much capital lying absolutely idle. It has a cash value and its value, if realized, might be used to advantage. In the majority of engineering works, far too much scrap is allowed to accumulate before it is disposed of or put to useful purposes in the cupola. The writer was once called on to make a valuation of the entire plant of one of the largest ship-building concerns in the north of England. The estimated weight of the scrap which littered the yards and the different departments was 1000 tons, much of which had obviously been lying around for years. Cast iron, steel and wrought iron were all piled together, with a considerable proportion of brass and gun metal in the form of bearing bushes, stuffing-boxes and the cylinders of old feed pumps. Our estimated value of the whole of the scrap was $21,000, which sum, invested at the rate of five per cent, would give an annual income of $1050. A small item, perhaps, in view of the size of the plant, but one which counted. It was a dead and unnecessary loss, and in addition to this, the scrap was in the way and was occupying valuable space.

The leakages previously dealt with have been those most commonly met with in the operation of the works department of an engineering firm. There are others which have their origin in the offices, and which are not without their importance in the matter of efficiency. Among the chief of these is the matter of adaptability in the designing department. Let us consider a firm that manufactures steam fittings on a large scale as an example. In such a firm it will often be found that every valve or other fitting is designed with no regard for existing types, or for types undergoing contemporaneous design. The result is that for every type of valve or other fitting, an entirely new set of details has to be made. By a little adaptability in design it would be possible very often to utilize, in new designs, existing patterns for the main castings and existing types of spindles, seating and other details. The saving effected in manufacture would be considerable if in the new design the same patterns used in an existing design could be employed. This principle applies with more or less force in many other lines of manufacture. The secret of the success of the manufacturers of the Ford automobile has been duplication—the making of all their engines alike. This has rendered possible the production of an efficient car at a price unheard of previously.

There is still one other point to touch on in connection with the executive end of the engineering business before this cursory review of the matter of leakage is brought to a conclusion. That is concerning the matter of stock. From the engineer's point of view stock can be divided into raw material and finished product, and a careful adjustment of both these divisions is essential to efficiency. In buying raw material, under which head may be included pig and bar iron, and often studs, bolts and other material not produced in the works, the markets must be carefully watched, and purchases made in so far as is possible when the market is favorable. Sufficient stock must be carried in all lines to avoid the possibility of running short unexpectedly, with its attendant holding up of work and waste of time; on the other hand, too much stock should not be purchased. Stock in the shop is capital idle, and it takes up space, which is also true of finished stock. A sufficient quantity should be kept on hand to meet possible demands, and to guard against loss of business on account of inability to give early delivery, but an excess of stock above this quantity is inadvisable. It represents an unprofitable investment of capital, and there is the risk that some of it may become out-of-date before it is disposed of. This adjustment of stock, both in regard to raw material and finished product, is one which demands nice judgment. In quiet times manufacturers not infrequently continue to run their plants at or near capacity, with the result that a surplus stock is accumulated which is difficult to dispose of. Stock should be kept within reasonable limits even if it means a shut-down for a time. It is the best policy in the end.

* * *

An interesting application of the vacuum cleaner as a foundry tool is told by a contributor to *Foundry*. When making a three-part mold, six spikes were inserted to secure the sand, but one spike passed through the sand into the pattern, and after rolling over and drawing the main part of the pattern it pulled through the core and about a handful of sand dropped down underneath. In this case, either the mold had to be destroyed or the loose sand had to be removed. The only feasible manner in which the latter could be done was by the use of a vacuum cleaner, by means of which the loose sand was readily sucked from underneath the core. The resulting casting was sound, which showed that a device of this kind may be utilized to advantage in foundry work.

DESIGN AND CONSTRUCTION OF BORING TOOLS

VARIOUS TYPES OF BORING TOOLS FOR ENGINE LATHES, HORIZONTAL AND VERTICAL TURRET LATHES OR BORING MILLS

BY ALBERT A. DOWD*

A boring tool or boring-bar is, in itself, a very simple tool and yet, in its various applications, it may require considerable forethought in order to obtain a tool which will be exactly the right one for the job. In order to properly design any kind of a cutting tool, an intimate knowledge of the actual working conditions which are met with in using the tool is a valuable asset. There are a number of factors which influence the design of boring tools and there are also many types of machinery to which boring tools may be applied. In some cases the bar revolves with the spindle of the machine, while in others it is held rigidly and the work revolves around it. These things affect the design and must be considered. The work naturally controls the size of the bar and also its shape, while the material which is to be cut makes a difference in the shape of the tool and determines the amount of "chip clearance" necessary.

The tools described and illustrated in this article must be considered as representative types of the many varieties to be met with in the general course of manufacturing. Points in design and construction will be noted and faulty tools will be discussed and criticised.

General Points in Boring Tool Design

Some of the important points in the design and construction of tools for single-point boring are here given, and while some of these may seem obvious, they may be of assistance in calling attention to matters which would otherwise be overlooked.

1. Chip clearance must be very carefully looked after when the tool is to be used for cutting steel, as an accumulation of chips caused by insufficient clearance is very annoying to the operator and also injures the work by tearing or scratching it, and finally ruins the bar itself unless it is hardened. The amount of clearance between the bar and the work should be as great as possible without sacrificing strength, and in this connection it should be noted that in addition to the necessary chip clearance at the point where the cutting action takes place, provision must also be made to get rid of the chips themselves. For this reason the portion of the bar beyond the cutting tool should be so proportioned that chips will not wedge. In cutting materials other than steel the clearance is not so important, as the chips are short and do not curl up or cling to the bar, so that they practically take care of themselves.

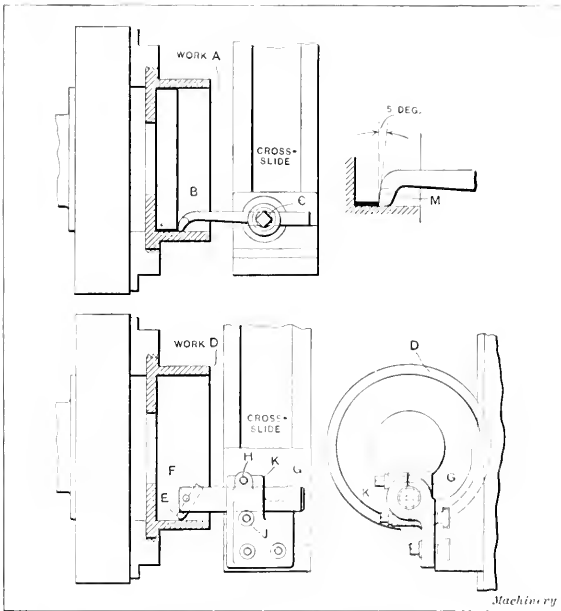

Fig. 1. (Upper View) Forged Type of Boring Tool; (Lower View) Boring Tool with Inserted Cutter

2. The method of holding or clamping the tool in position should be such that the thrust of the cut comes against the solid body of the bar and not against the set-screws or clamps. It is advisable to use square-head set-screws instead of the headless type whenever possible.

3. Boring-bars should be provided with some means of adjusting the tools for diameters, by the use of "backing-up" screws or wedges. The so-called "sledge hammer adjustment" type of bar should never be used when there is room enough to put in adjusting screws.

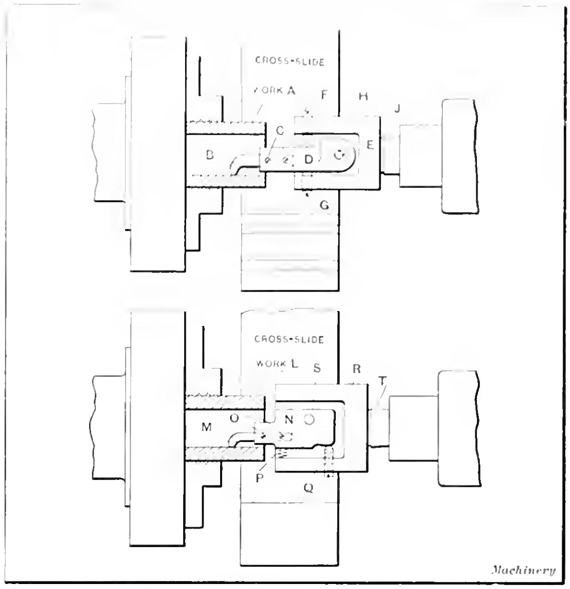

Fig. 2. Two Types of Adjustable Boring Tools for Tool-room Work

4. Boring-bar tools should be made as large as the diameter of the bar will permit without sacrificing strength, in order to assist in carrying away the heat generated by the cutting action, and to permit the use of heavier feeds without burning the tool. The rake of the tool should be such that it will turn the chips to the best advantage.

5. The bar should be so designed that micrometers can be used over the bar and tool in order that the operator may be able to set his diameters closely without resorting to the usual "cut-and-try" method used by our forefathers.

6. In the design of multiple boring-bars which are to be used to bore up to a shoulder, it is not good practice to set the tools in the bar at an angle. They should be located in a plane perpendicular to the axis of the bar. If set at an angle it will be found a very difficult matter to grind the tools so that diameters and shoulder distances will remain constant.

7. Bars designed for use on turret lathes should have the tools set in a plane perpendicular to the rotation of the turret. By this means variations in the indexing of the turret are minimized in their relation to the cutting tools, so that diameters can be held much closer to size than if the tools are arranged in a plane parallel to the turret rotation.

8. When the work is of such a nature that a cutting lubricant is required, provision should be made so that an ample supply of the fluid can be carried directly onto the face of the cutting tool. This result can be accomplished either by means of a hole in the bar with outlets at the proper places, or oil grooves covered with a strip of sheet brass. In either case a good connection must be made with the cutting lubri-

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cant system on the machine. This may be arranged by a distributing collar on the turret or by means of a special oiling device through the spindle.

Boring Tools for the Engine Lathe

Boring tools which are designed for use in the engine lathe are generally of a very simple kind, adapted only to light cutting and seldom used for more than one or two pieces of

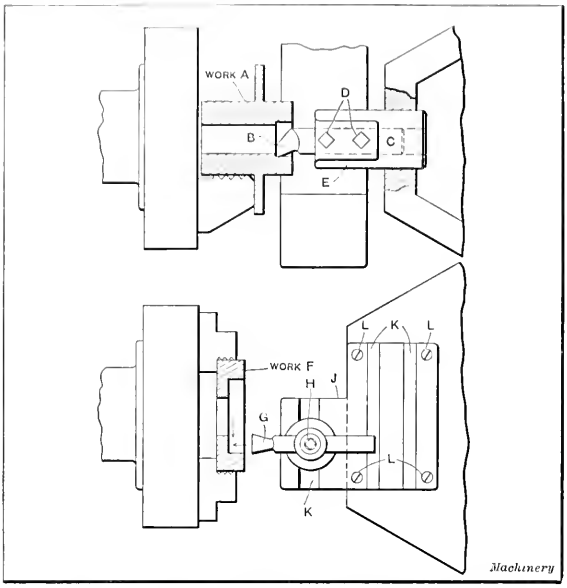

Fig. 3. (Upper View) Single-point Starting Tool; (Lower View) Boring and Facing Tool

work of the same size at the same time. Several varieties are to be found in the average tool-room, although forged tools will be noted in greater numbers than any of the others. Tools of this kind of almost every conceivable shape and size, from a small round "hook tool" for cutting an inside recess, to a a large bar of tool steel bent over at the end for boring some long pieces of work, will be found in abundance. There are

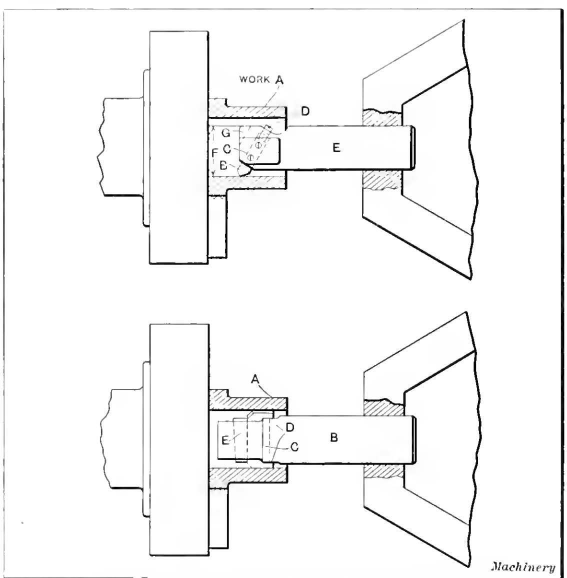

Fig. 4. (Upper View) Boring-bar with Adjustable Cutter; (Lower View) Boring-bar with Double-ended Cutter

square bars and round bars with inserted tools, and, in addition to these, each toolmaker has a special boring tool of his own make which he uses for jig work. These special tools occasionally show considerable ingenuity in their construction, and are usually made in such a way that very fine adjustments can be attained.

The upper part of Fig. 1 shows a piece of work *A* held by the outside in chuck jaws, the machine on which the work is to be done being an engine lathe. A plain forged tool *B* is held in the toolpost *C* on the cross-slide of the lathe. This type of tool is the simplest of all tools used for boring and consists of a rectangular piece of tool steel of suitable size to fit the toolpost. The tool is drawn out and bent over at the cutting end by the blacksmith and is then ground to a cutting edge by the workman using it. Hundreds of tools of this variety can be found in every machine shop and factory in this country. They are suitable only for light cutting and there is a tendency toward "chatter" even when the cut is light; this is due partly to the shape of the cutting end and partly to the overhang of the entire tool. It will be found that less chatter will result if a slight land or flat is stoned on the tool immediately below the cutting edge. The tool should also be set slightly above the center. For casting work where scale is encountered, there is a decided tendency for the tool to ride up on the scale and ruin very rapidly if it is ground as shown at *B*. The enlarged view *M* shows another method of grinding which is useful in cases of this sort. It will be noted that there is a slight back taper to the end of the tool and this assists in preventing any riding up on the scale, as its tendency is to make the cutting point draw in slightly and thus keep under the scale. Care must

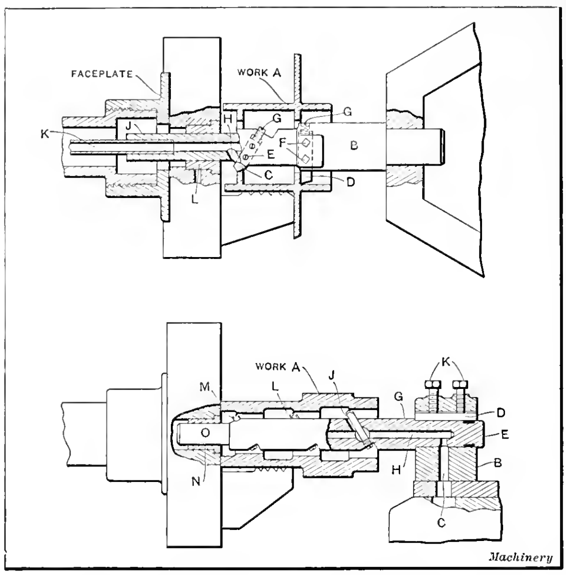

Fig. 5. Boring-bars arranged for lubricating Cutters

be taken not to make the angle too great—5 degrees is ample, and much less than this can be used if desired.

The lower part of Fig. 1 shows the same piece of work *D* with another type of boring tool in action. A cast-iron body *K* is held down on the cross-slide of the lathe by means of the three bolts *J*. A steel bar *G* is longitudinally adjustable in the cylindrical portion of the holder and is clamped in position by means of the binder screw *H*. A round cutting tool *E* is held in place by the taper pin *F*, in a manner familiar to all. A holder of this type will be found a very useful adjunct to any toolroom, and is adaptable to a variety of conditions. A series of bushings can be made to take different diameters of round stock, and tools may be quickly made to suit almost any case. Obviously, adjustment for diameters is made by the cross-slide. Rigidity and adaptability are points in favor of this device.

Adjustable Boring Tools for Jig Work

Fig. 2 represents two styles of adjustable boring tools used mostly for boring small shallow holes or jig bushings. These tools are capable of fine adjustments but are not suited for any kind of heavy cutting. The upper part of the illustration shows how tool *B* is used for boring a part of the bushing *A*, which is held in chuck jaws. The body of the toolholder *H* is made of steel and is turned down and tapered at

J to fit the tailstock spindle. The adjustable swivel *D* is pivoted on the shouldered screw *E*, and is adjusted by the two headless set-screws *F* and *G*. The tool *B* is of round section and fits the end of the swivel, where it is held in place by the two screws *C*. The end of the tool is bent over for the purpose of clearance. A tool of this kind is very convenient and is easily adjusted for diameters within its capacity. It is not adapted to deep holes, but can be made up in several sizes so that it will handle fairly large work.

The lower part of the illustration shows another tool of somewhat similar construction, which is designed for the same purpose as the other. The body is of steel and the shank *T* is turned taper to fit the tailstock spindle. The forward portion of the body *R* is cut out to receive the swivel *N*, which pivots on the screw *S*. The tool *M* is of round section, bent over at the end, and it is held in place by the two screws *O*. One adjusting screw *Q* is all that is required in this tool, as the coil spring *P* takes up lost motion and prevents drawing in. This tool is not as rigid as the one previously referred to, but the spring makes adjusting much quicker, as only one screw is needed. A number of tools of this type, and of various sizes, were made for tool-room use in a large automobile factory and were used on the greater part of the jig work.

Boring Tools for the Horizontal Turret Lathe

Boring tools which are required for use on the horizontal turret lathe are of many forms and their design is somewhat dependent on the type of machine to which they are to be attached. On machines having no transverse movement to the turret slide, the tools are nearly always designed for straight boring, while on the other types of machines, *i. e.*, those having transverse movement, the design is frequently made in such a way that the tools can also be used for facing operations. The form of the turret itself also influences the design to a certain extent, for it is evident that a flat turret would require a different type of tool-holder than one of the vertical face variety.

Single-point Starting Tool for Taper Holes

The work *A* shown in Fig. 3 is a malleable iron automobile hub with a cored taper hole which runs out of truth very badly. Therefore it was necessary to design a starting tool of the single-point variety in order to generate a true running hole, so that the subsequent tool would start properly without being influenced by the wobble of the core. This tool and tool-holder are very simple, the tool itself being a piece of round high-speed steel bent over on the end and ground to cut a diameter a trifle smaller than the large end of the tapered hole. The holder *E* is a piece of machine steel of cylindrical shape, which is ground on the outside to fit the turret hole and on the inside to fit the shank of the tool *B*. Two set-screws *D* are used to hold the tool in position. It will be noted that the end of the cutting point is ground very nearly square so that it will not ride up on the scale. The tool is not made for continuous boring but is merely used to generate a true hole for a short distance into the cored portion of the hub.

Boring and Facing Tool for a Flat Turret

An example of a boring tool which is also used for facing out a pocket on a turret lathe having a flat turret is shown in the lower part of Fig. 3. This tool is of the "shovel nose" type and its cutting action is rather hard on account of the bluntness of the nose and the amount of stock which it removes. The work *F* is a machine steel forging and the shoulder is not recessed at all in the blank. The tool *G* is of rectangular section and it is forged and ground on the cutting end to the shape shown. The tool-holder *H* is supported by the steel bracket *J* which is fastened down on the turret face by screws *L*. The slots *K* are T-shaped and permit various settings and combinations of tools to be made.

Fig. 4 shows a very simple type of single-point adjustable boring-bar for machining the bushing *A* (see upper part of the illustration). Although this bar is simple in its construction, there are several important points in design which should be carefully noted. The bar *E* is of a low grade of tool steel and is hardened and ground to fit the turret hole. The reason for making the bar of tool steel is simply to obtain all the rigidity possible and thereby obviate chatter. The tool *B* is of round section and is put through the bar at a slight angle, being held in position by the two screws *C*. A backing-up screw *D* permits careful adjustment to be made. The bar is cut away where the tool comes through to provide chip clearance, but it is cylindrical on the end except in this one place. By making it this way, it is found an easy matter to use micrometer calipers across the bar and tool as indicated at *F*, so that accurate settings may be readily made without resorting to "cut-and-try" methods. It is very bad practice to bevel the end of the bar at *G* and put the holding screws through at this point, because a calipering point is sacrificed by so doing. A simple formula is here given for setting tools of this type for turning a given diameter:

Let F = required calipering distance for a given size hole;
X = diameter of the bar at the end where the tool is;
Y = diameter of the hole to be bored.

Then

$$F = \frac{X + Y}{2}$$

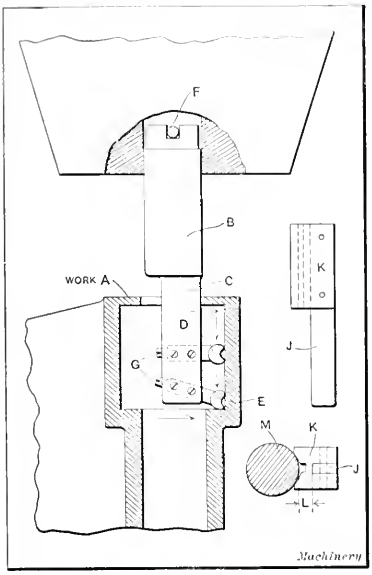

Fig. 6. Bar for Undercutting, Facing and Boring in the Vertical Turret Lathe and Gage used in setting Tools

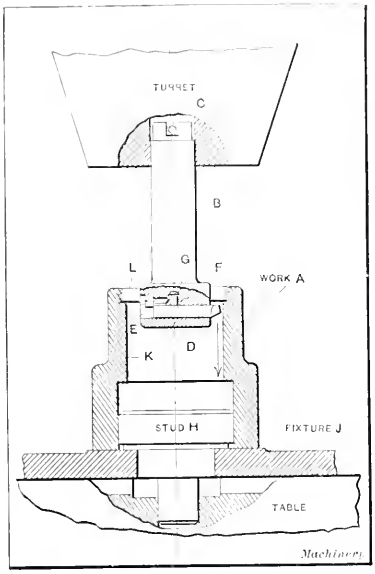

Fig. 7. Bar equipped with a Set of Interchangeable Cutters for Boring and Reaming

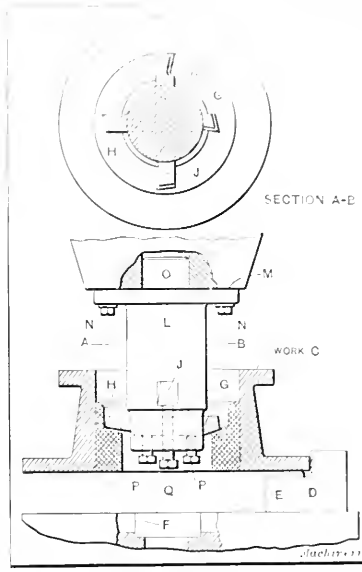

Fig. 8. Bar with Four Cutters set at Different Radii for removing Considerable Stock in One Cut

This formula will be found useful for setting tools very close to the desired diameter, although the spring of the bar will cause slight variations and the amount of stock which is to be removed also makes some difference.

The lower part of Fig. 4 shows a boring tool of an entirely different type. The cutter is double-ended, and a bar of this sort is often used for removing stock rapidly. Although it is a faster cutting tool than a bar having only a single tool or cutting point, it cannot be depended upon to produce a hole which is absolutely concentric with other surfaces machined at the same setting. The work *A* is the same as in the upper part of the illustration, and the bar *B* fits the turret hole. It is flattened slightly on two sides at points *D*, and a rectangular slot contains the cutter *C* and the wedge *E*. It will be noted that the cutter is shouldered so that it is a close fit at the points *D*. Tools of this type cannot be ground radially without changing their diameters, but this is seldom necessary as the cutting edge is at the forward end. A land of about 1/8 inch is usually left just back of the bevel, and the cutter can be ground back to this point without changing the diameter. Beyond this, however, there is a slight back taper for the sake of clearance, so that the life of the cutter does not extend beyond it.

Boring-bar with Provision for Cutting Lubricant

On certain classes of work it is very difficult to supply the cutting points of the tools with sufficient lubrication to make them thoroughly efficient, when the regular supply system is used. Some method must be devised, therefore, to direct the flow to the point or points where the cutting action takes place. An example of a bar arranged to carry the lubricant to inaccessible tools is shown in the upper part of Fig. 5. The work *A* in the chuck jaws is an automobile hub of malleable iron. It will be noted that the portion bored by the forward tool *C* is in such a position that it cannot be reached for lubricating purposes in the ordinary way, but the rear tool *D* can easily be taken care of. The boring-bar *B* is of a low grade of tool steel and fits the turret hole at the rear end; the forward end *J* is a running fit in the chuck bushing *L*. A telescoping oil supply tube *K* enters this end of the bar and is supplied with lubricant from the rear end of the spindle. The hole in the bar at *H* leads the fluid directly onto the face of the cutting tool *C*, thus insuring constant lubrication at this point. The two tools are held in place by the screws *E* and *F*, and they are provided with means of adjustment in the backing-up screws *G*. The writer has used bars of this type in a number of cases with very gratifying results.

Fig. 5 (lower illustration) shows a very different condition, in a multi-cutting boring-bar for generating a series of true holes in the bronze artillery hub *A*. The finished hole is tapered but a starting bar was used in order to prepare the hole properly for the taper tools which followed it, so that they would not be influenced by the irregularities of the cored hole. In this case the turret lathe was one of the flat-turret variety, and provision was made for lubrication through the hole *C* in the turret face. As the turret indexed to the proper position, this hole came directly over another in the slide, which, in turn, was connected with the lubricant pressure supply system, thus allowing the liquid to pass up into the body of the tool-holder. The boring-bar *G* is turned down at the rear end to fit the tool-holder *B*, and has an annular groove *E* which is packed with felt to prevent the escape of lubricant. A shoe *D* is forced down on the bar by the two screws *K* and prevents the bar from turning. The hole *H* in the bar is drilled from the forward end and is tightly plugged so that this end remains closed to prevent the lubricant from passing through. A groove is cut in front of the tools *J*, *M* and *L*, as shown at *J*, and this allows the fluid to flow directly onto the faces of the tools. The end of the bar is piloted at *O* in the bushing *N* which is fixed in the chuck body. An arrangement of this sort has also proved successful in a number of instances.

Bar for Undercutting, Facing and Boring in the Vertical Turret Lathe

A very difficult condition for which to design tools is shown in Fig. 6, as the work itself requires rapidity of handling and is a steel casting weighing about 300 pounds. Only a part of the piece is shown at *A*, but it will readily be seen that it is necessary to make the bar in such a way that the tools can be used to do all the cutting indicated by the arrows; *i. e.*, undercut the upper flange, double-bore the interior, and face the lower shoulder. As the fixture on which the work was held was of the indexing variety and was very much off center, it was not expedient to run at high speed. Therefore, the double boring was of assistance in increasing the production. It will be noted that the hole through which the tools pass is of small diameter, which makes the problem still more difficult. The shank of the bar *B* fits the turret hole at its upper end and is slotted so that the pin *F* in the turret will act as a driver. (This feature is patented by the Bullard Machine Tool Co.) The lower part of the bar is eccentric to the shank in order to obtain the necessary clearance when the tools are in action. Even the tools themselves are considerably out of the ordinary in that they will cut in two directions. The upper tool *D* is used for undercutting the flange and also for boring, while the lower tool *E* is used for facing the lower shoulder and partially boring the interior. Both these tools have backing-up screws *G* and are held in place by the headless set-screws.

As it was necessary to set these two tools so that they would cut approximately the same diameter, the gage shown at the right of the figure was made to assist in the setting. The V-block *K* was slotted to receive the steel strip *J* so that distance *L* would measure the correct distance from the bar shown in section at *M*. It is obvious that the gage could be placed against the bar so that tools could be set out the right amount by means of the backing-up screws. This bar gave fairly satisfactory results although some trouble was experienced with chips, as there was considerable stock to remove. There was likewise a slight tendency to chatter when using a heavy feed, but this was remedied by careful grinding to make the cut as easy as possible. It must be remembered that the conditions were about as awkward as they could be, and the lack of room made it necessary to cut down the bar to such an extent that it was hardly heavy enough for the work. Taken as a whole, however, the action was satisfactory for a roughing tool. It was not used for finishing cuts.

Slip-cutter Bar for the Vertical Turret Lathe

The steel hub shown at *A* in Fig. 7 is held on a special fixture, located by the previously bored and reamed hole which fits the stud *H*. The hole *K* has been rough-bored in the first operation, but enough stock has been left for the final finishing so that it may be finish-bored and reamed and part *L* threaded at the same setting. This type of bar is the product of the Bullard Machine Tool Co., and is designed especially for use in their machines. It is a combination boring- and reaming-bar, and the cutters are of the "slip" variety. One bar can be furnished with a set of cutters for the various sizes of holes within its capacity. A full set of cutters for any one size of hole consists of chamfering, rough-boring, finish-boring, rough-reaming and finish-reaming tools. The first three of these are of square section, carefully ground to fit the broached hole *D*. The rear ends of these tools bring up against the shoulder of the screw *E*, which acts as a stop. The fit in the hole is such that tools can easily be put in and taken out with the fingers.

The two reaming cutters are used in the rectangular hole *F* which is at right angles to the other hole; these tools are allowed to float so that they follow the hole generated by the boring tools. The action against the reaming cutters is in an upward direction, and comes against the hardened steel plug *G* which is inserted in the bar. The bar *B* is of special steel and is slotted at the upper end to fit the driving pin *C* which is located in the turret. Bars of this type have a number of advantages, one of which is that only one turret hole is occupied; other advantages are the cost of maintenance, and the adaptability of the bar with its series of cutters to handle a number of different sized holes. The cost of large sizes of reamers of the fluted type is considerable, while a flat reamer such as that used in this bar is inexpensive. It may be noted that the pressure or thrust of the cut is all

that holds the boring tools in place, so that trouble would be experienced if a cored pocket were to be encountered. This is provided for by a detent screw in the end of the bar, which prevents the tools from coming out. This screw can be put in any time if it is found necessary.

Multi-cutting Bar for the Vertical Turret Lathe

An example of a bar designed to remove a large amount of stock in a very short time is given in Fig. 8. The work shown at *C* is a steel boiler nozzle which is forged, and a 5-inch hole punched in it before it is machined by the vertical turret lathe. The finished hole is 8 inches in diameter and it was desired to remove the surplus stock as rapidly as possible. Accuracy in the diameter of the hole was not essential. The bar *L* is a steel forging which fits the turret face at *M* and is held to it by the screws *N*. The stem *O* is used to center the bar in the turret. Two rectangular holes are broached through the body of the bar, at right angles to each other, and these receive the high-speed steel cutters shown. It will be noted that these cutters are so proportioned that they remove the stock in a series of steps, each tool extending beyond the preceding one and also above it about 1/8 inch.

The section taken at *A*—*B* shows the manner in which the tools extend beyond each other, and the lower view illustrates the cutting action of the tools. One end of the first tool *G* makes the first step, while the other end *H* makes the second. In like manner one end of the upper tool *J* makes the third step while the other end *K* takes out the remainder. The two screws *P* hold the first tool in place, while the other is secured by the screws *Q*. It will be noted that the work is held in jaws *D* and is supported on buttons at *E*; the height above the table is great enough to allow the end of the bar and the set-screws to go through far enough to finish the cut. Regarding the upkeep of these tools, attention is called to the fact that they may be pushed backward or forward to compensate for wear and distribute the cut. For roughing purposes requiring rapid removal of stock and rapid cutting, a bar of this sort has proved very successful, but it is not recommended for work requiring great accuracy.

Other Types of Boring-bars

There are several bars on the market which are adjustable for various diameters by means of micrometer screws and taper wedges. These are useful for many purposes but space will not permit a detailed description nor has it been the writer's purpose to deal with the many varieties but rather with representative types. Special bars for many purposes, porcupine bars and cutter heads of various kinds, I have not

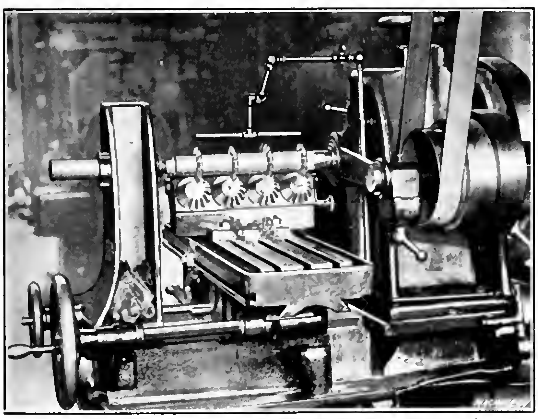

Fig. 1. Multiple Fixture for roughing Teeth of Bevel Pinions, applied to Horizontal Milling Machine

attempted to describe, for these are not single-point boring tools. Neither has mention been made of boring tools such as are used in fixture work on the horizontal boring machine, for these are found in every tool-room, in all shapes and sizes.

In several of the illustrations it may be noted that the tools are shown in a plane parallel with the rotation of the turret. This has been done simply because the details are more clearly apparent when shown in this way. Greater accuracy is obtained by setting the tools in a plane perpendicular to the turret rotation, as previously stated.

MULTIPLE FIXTURE FOR ROUGHING THE TEETH OF BEVEL PINIONS

BY C. BOELLA*

A great many small bevel gear pinions are used as "satellites" in the manufacture of differential gearing for motor cars. In order to increase the production of these pinions and lower the cost, the device shown applied to a horizontal milling machine in Fig. 1 was designed. By using this fixture, gear blanks can be roughed out at a single cut; they are then finished more rapidly by a second operation in a regular bevel gear cutting machine.

The cutter arbor is fitted with four properly spaced cutters. The fixture, which is securely bolted to the milling machine

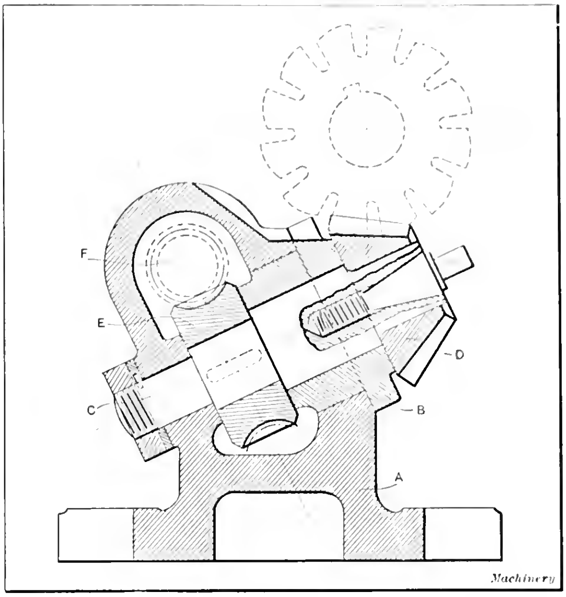

Fig. 2. Cross-section of Multiple Fixture

table, has four small spindles, each holding a bevel pinion at such an angle that the cutters will rough out the teeth at the depth required. When a tooth has been milled in each blank, the table is withdrawn and, by a complete turn of the handle seen on the right side of the fixture, the four pinions are indexed simultaneously one tooth. Then another cut is taken and this operation is repeated until all the teeth are roughed out.

Fig. 2 is a section of the device. There is a hollow base *A* having four plates *B* each fitted with a spindle *C*. The spindles have expansion collets to hold blanks and they are indexed by the worm-wheels *E* which mesh with worms *F* that are turned by the handle previously referred to. The worm-wheels have twenty-eight teeth and the worm is double threaded so that each complete revolution of the worm causes the pinions to rotate 1/14 turn, as they must have fourteen teeth of five diametral pitch. The indexing handle is fitted with a spring knob, the end of which can engage a hole located in the base, thus insuring an exact division. These pinions are made from 5 per cent nickel steel. The time required for each cut is one minute ten seconds, four pinions being completely roughed out in about sixteen minutes. The machine is operated by the same man who runs the gear shaper used for finishing the teeth.

* * *

For an anti-friction metal that can be subjected to pressures up to about 400 pounds per square inch, the *Foundry* recommends the following composition: Lead, 85 per cent; antimony, 10 per cent; and tin, 5 per cent. For pressures exceeding 400 pounds per square inch, the following alloy will prove satisfactory: Tin, 85 per cent; copper, 5 per cent; and antimony, 10 per cent. This alloy can be used safely for pressures up to 1000 pounds per square inch.

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MARCH, 1914

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ENGINEERING QUALIFICATIONS

In three months the engineering colleges of the country will be turning out a few thousand graduates to find places for themselves in the industrial world, and many of them with no practical experience are likely to believe that the mere act of graduation opens the road to success for them. We believe that no greater service could be rendered young men fitting themselves for industrial work than for their teachers to impress them, while at college, with the fact that many other qualities are necessary for success in the engineering field besides mere ability to pass their "exams" successfully. The knowledge and training obtained at school and college are important, but there are other qualifications that count for more in later years. Two of these are reliability and thoroughness; another is tact; others of the greatest value are executive ability, push and initiative; while still another is real enthusiasm and love for the work in hand; and, last but not least, health—moral, mental and physical. One engineer, in stating his requirements for subordinates in terms of percentages, said that he would be satisfied with fifty per cent of technical knowledge and analytical ability, provided the remaining fifty per cent was divided into twenty per cent tact and ability to cooperate, and thirty per cent push, initiative and originality. This combination makes for a well balanced personality, to whom success in the engineering field is well-nigh certain.

Reliability in an engineer should not be confused with what is commonly called "honesty," which is merely the inclination to do one's best. Reliability is a faculty which requires constant training, until mere inclination has been developed into ability to get out of oneself the very best possible from one's mental and physical qualifications. One phase of reliability is the ability to carry out definite instructions. This cannot be done without continual training of the mind, and the lack of such training is shown by the inability or unwillingness of many people to carry out a given piece of work according to given instructions. Another evidence of reliability is a willingness to acknowledge promptly one's inability to carry out a certain piece of work in a prescribed way or within a specified time limit. Paradoxical as it may seem, a definite statement of what he *cannot* do may often be the first thing to attract favorable attention to a young man.

GETTING IN TOUCH WITH THE FOREMAN

Some time ago a manufacturing concern made for stock a number of parts consisting of steel castings bushed with a well-known bearing alloy. The shafts were required to make but a short oscillatory movement in the bearings, and the foreman instructed the fitters to give them a clearance of 0.001 to 0.0025 inch, the diameter being 1½ inch. The parts were ordered out for a repair job a few months after and the workmen discovered that the shafts would not enter the bearings. An investigation showed that the diameter of the holes was 0.005 inch less than the shaft diameters.

The foreman was called to account, and while he was positive that the parts had been fitted with sufficient clearance, he was unable to explain satisfactorily why the change had taken place. A letter to the editor describing the case brought an explanation clearing the foreman of blame and saved his job.

The cause of the trouble was that the alloy bushings had been assembled in the steel parts by pressure. The alloy used is one having excellent characteristics as a bearing metal, but though very strong, it "flows" slightly when subjected for a long time to heavy pressure. The result was that the bushings contracted in diameter, causing the closing of the holes and thus making them too small for the shafts that were originally fitted in them.

The makers of the alloy are fully aware of this characteristic, and issue directions to the effect that when used for bushings it should not be assembled by pressure. Instead, it should be made a close shove fit and held in place by non-bottoming set-screws. When properly fitted according to directions, it gives perfect satisfaction.

This brings us to the practical difficulty met with by some concerns in getting their products treated as they must be treated in order to yield the best results. They deal with purchasing agents who, in some cases, having little appreciation of technical matters, are careless in transmitting important specifications to the men in the shop. Manufacturing concerns should find it to advantage to encourage free intercourse between the representatives of concerns furnishing them supplies and the men responsible for results, especially when the treatment is out of the ordinary. The free circulation of catalogues and circulars among the men has been found advantageous. In some places this literature forms part of a regular circulating library. MACHINERY will gladly publish important details of practice pertaining to new products in its field and invites all manufacturers to use its columns freely as an educational means to reach the foremen and machinists handling them.

* * *

THE OBJECT OF TEMPERING STEEL

In examining recently a great number of books and articles on the subject of tempering steel, we found that almost invariably the authors stated that the object of tempering was the softening of the steel. They said that steel, when heated to the required hardening temperature and quenched, became too hard, and that therefore it was necessary to draw the temper in order to soften the steel so that it could be used for the purpose for which it was intended. This is an erroneous statement which seems to be accepted by the majority of mechanics, because they fail to distinguish between hardness and brittleness, two entirely different qualities. Hardened steel is tempered in order to make it less brittle, but unfortunately the tempering process also softens the steel to some extent. If it were possible to temper steel so as to produce greater toughness and at the same time retain the extreme hardness, the ideal condition would be obtained. That hardness and brittleness are not necessarily synonymous may be seen in the case of cast iron, which is very brittle but not very hard. On the other hand, there are some alloy steels that may be made very hard and at the same time very tough. The object of tempering steel is to reduce the brittleness; the hardness is simultaneously reduced, but this unfortunately cannot be avoided.

PUNCH AND SHEAR FRAMES

The article "Punching Machine Frames," to be found in another part of this number, is one of the most interesting contributions of a practical nature that has ever been published on this important subject. The author shows the danger of using the commonly accepted method for calculating the design of machine frames of the curved type, and gives a method which can be used without difficulty by any one familiar with the rudiments of the use of formulas. In the deduction of the formulas, the author has made use of calculus, but it is by no means necessary to be versed in calculus in order to appreciate the important facts brought out and profit by the results of the calculations.

Probably many readers of technical journals are deterred from reading certain articles because they find that they contain mathematical treatment of a kind with which they are not familiar. As a rule, this is a mistaken idea, because even if the reader is not able to follow the writer's mathematical proof of his theories, he can nevertheless profit by digesting the results obtained, taking for granted the accuracy of the writer's deductions. Of course the value is still greater to the man who can follow the author through the mathematical treatment, but this is not necessary to understand the article.

In the specific case referred to, the fact that the stresses in machine frames, when calculated according to the more modern theories evolved, may be from two to three times the stresses found by the older methods of calculation, is sufficient to indicate the importance of the subject. It is true that accurate analytical methods that can be easily applied have not as yet been developed, but the method explained in the article referred to is so nearly correct in the light of modern investigations that it might well be adopted as a standard for curved machine frame calculations until a better and simpler method giving the same accuracy is proposed.

* * *

THE SMALL POWER PLANT

The power problem confronts every factory manager in one form or another. Small shops in cities can *sometimes* buy electric power cheaper than it can be generated with small power units, but unfortunately this is not always true. The fact that the large power companies cannot or will not uniformly furnish electric power at rates cheaper than it can be supplied by small private plants is a standing reproach to the good sense and business management of these so-called public utilities. Manifestly, the large power plant managed on scientific principles, generating steam in boilers fired with the cheapest coal and utilizing it in turbines of great size and high efficiency, can produce a kilowatt at the plant at a far lower price than can the small concern. The overhead charges are less proportionately and the efficiency of production much higher. Many manufacturing plants have in self-defence put in power plants in order to get reasonable rates from the electric companies. It becomes an idle investment but a necessary one, if reasonable rates are to be had.

But aside from urban conditions are those where power must be generated at the shop with small units. What shall the prime mover be? The steam engine and boiler is expensive to maintain. A fireman and engineer must be in constant attendance. A gas engine using illuminating gas is likely to make big gas bills. Small gas producers are successful, but require more technical knowledge to operate satisfactorily than is available many times. The gasoline engine is out of the question now with gasoline at twenty to twenty-five cents a gallon. The kerosene engine is far more economical, but of yet greater economy is the Diesel engine. This motor burns fuel oil, distillates and other cheap liquid fuels. The engine is simple in construction, but must be well built to give long service. It is highly economical, the thermal efficiency running above twenty-five per cent and the fuel consumption being as low as one-half pound of oil per indicated horsepower. The high compression necessary in the Diesel engine is the greatest disadvantage. It makes necessary a power starting device for even the smallest units, but compressed air furnishes the means for it without serious complications.

THE ADVANTAGES OF MANUAL TRAINING HIGH SCHOOLS

BY FRANCIS L. BAIN*

The demand for the teaching of manual arts in the high school is founded upon the need of the pupil. It has grown out of the dissatisfaction of the people with the narrow, one-sided curriculum of the secondary school. The old measure of culture, training in the classics, has given way to broader lines of development. Today that man is considered cultured who can ably utilize the forces of civilization of his own time, not of a few centuries back.

We have come to realize that the disciplinary value of work which makes for vocational training may be greater than that which comes from the so-called cultural studies. The skilled artisan contributes more to the prosperity of the country and the uplift of his community than the college graduate without the adaption to any line of work. The one goes straight to the mark; the other flounders hopelessly in trying to find himself and his work. The world never needed leaders more than now—leaders of education, of skill, of honesty and of courage, and real leadership is as necessary in the trades as in any department of commercial activity.

The study of the manual arts in the high school has four distinct values:

1. It helps the student to find himself. Nearly two-thirds of the pupils in our public schools leave school at the age of sixteen or earlier. This is due to lack of inclination to study further or the necessity of bread-winning. They usually enter and remain in the ranks of unskilled labor, at the lowest wages and in most unstable positions. These pupils need the stimulus of courses that lead to quick or greater efficiency in wage earning. Many students have no definite aim at entrance to or even at graduation from high school. Chance determines their vocation, and usually chance makes a mistake. Manual arts help the uncertain boy to determine his bent and to choose more intelligently his vocation.

2. It enables the high school to adapt itself to the needs of the community. That high school is best that best meets the needs of its immediate locality. Communities may be divided into commercial, manufacturing and agricultural, and vocational courses may be so shaped as to meet the needs of any or all.

3. It vitalizes the teaching of mathematics and science by showing and using their practical application. Algebra and geometry, physics and chemistry no longer appear simply as studies in a course, but they become a means to an end; as useful tools, they provide studies of living interest.

4. It furnishes direct vocational training. A high school course in manual arts does not aim to make a foreman or a journeyman workman of a boy. Such work must be left to the shop. The school should be able, however, to turn out a student who ranks with advanced apprentices, and whose academic and technical training has been such that, if he has otherwise the right qualities, he can forge rapidly to the front in his chosen trade.

Work in the manual arts, undertaken for vocational training, should not be undertaken without well equipped shops and skilled special teachers. To play with manual arts is to invite contempt for them at the start. It may not be necessary or advisable to attempt many lines of work, but what is undertaken should be done thoroughly and as nearly as possible under shop conditions. Every stroke should count toward definite construction. There is more mental discipline, more technical skill, and far greater interest, in making something of mechanical value, than in the doing of "exercises" or in playing with tools. Work must be the key-note of all the arts.

Technical courses should have all the time possible given to their distinctive work. A few hours per week will not develop skill, vocational or otherwise; all the time that can be given will not develop much; that must come from the experience of the work-shop.

All the attendant academic studies, English, mathematics,

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science and drawing can be made to bear directly upon this technical work, and so be vitalized, because the pupil appreciates their use and application.

In all the manual arts courses the work should be so arranged as to give each student in junior and senior years opportunity to choose between additional shop and academic work and to specialize along chosen lines. This allows the student to fit himself for higher technical schools, if he so desires, or to gain additional skill in wood-working, forging or machine-shop practice.

Manual arts is not an educational cure-all. It will not revolutionize the work of high schools. Pupils will not all flock to its study. It will be subject to many of the same defects and limitations as other courses and it will have additional limitations of its own; but it will spell opportunity, educationally and vocationally, to a large class of students who have hitherto received too little attention.

* * *

TAP DRILL SIZES

BY F. W. GATES*

In the January number of MACHINERY, Albert A. Dowd gives an interesting formula for determining the size of drill to use before tapping. Boiled down, he advocates 80 per cent depth of thread in the nut for machine tapping and 90 per cent for hand tapping. In this connection, some of the results obtained in the Wells Brothers Co.'s experimental laboratory may, perhaps, prove of interest.

Using U. S. standard threads, an ordinary cold-punched nut even, reamed out until it has but 50 per cent depth of thread, will not strip. Neither will it strip the tops off the bolt thread—*the bolt always breaks.* In fact, we have never found a metal tough enough to strip a nut thread having 50 per cent of full depth. If, in tapping, we produce nut threads which are stronger than the bolt, with a reasonable margin of safety, nothing is gained by attempting to make fuller or deeper nut threads. Such attempts only make unnecessary waste in tapping operations. We have demonstrated that a full depth of thread in a nut is *practically* no stronger than 75 per cent depth of thread. We have also demonstrated that 75 per cent depth of thread is only 20 per cent stronger than 50 per cent depth of thread. (Theoretically it might seem to be 50 per cent stronger.) From 75 per cent depth of thread, the power required to tap rapidly increases as a full depth of thread is approached.

The breaking strain of the average ½-inch, 13 U. S. standard commercial tap as found on the market is approximately 700 inch-pounds. Tapping common cold-punched nuts with *new* taps, the *average* power required is as follows, using mineralized lard oil as a lubricant:

75 per cent depth of thread...... 199 inch-pounds
90 per cent depth of thread...... 365 inch-pounds
100 per cent depth of thread...... 575 inch-pounds

Therefore, in attempting to tap out a full depth thread, the strain is too close to the breaking strain of the tap to be advisable. As the tap wears and becomes dulled, the power required fully equals the breaking strain, and "away goes the tap." There is practically no margin of safety. But in tapping 75 per cent depth of thread there is a factor of safety of practically 3.

On a ½-inch tap the difference in cut between 75 per cent and 90 per cent depth of thread is only 0.0075 inch; yet, under the favorable conditions given, the power required to make the deeper thread is nearly double. Tapping dry, or using machine oil, the ratio of increase in power is very much greater than that given above.

Inasmuch as with 75 per cent depth of thread the nut is stronger than the bolt—so much stronger as to break the bolt without even "starting" the nut threads—and, inasmuch as 75 per cent depth of thread possesses practically all the strength of a full depth thread, one can readily see that the 75 per cent depth is much preferable to the full depth. For instance, grit or dirt, in the case of 75 per cent depth, works down to the root of the bolt threads and gives no trouble. In a full depth thread it is forced into the walls, creating unnecessary friction and destroying the smoothness of the threads.

For these and many other reasons, we have for some time been advocating drill sizes for taps which yield 75 per cent depth of thread in the nut or tapped hole. However, as commercial drills do not exactly meet these figures, by using the next larger commercial size, good results are obtained. The use of these sizes of drills is proving a revelation in tapping economy to many shops.

TABLE OF TAP DRILL SIZES

Nominal Size, U. S. S.	Root Diameter, U. S. S.	Drill Sizes Recommended		
		For 75 Per Cent Thread, Exact	Next Largest Commercial Size: In Decimals of an Inch	Next Largest Commercial Size: Commercial Designation
1/4	0.1850	0.201	0.201	No. 7
5/16	0.2403	0.258	0.261	G
3/8	0.2936	0.314	0.316	O
7/16	0.3147	0.368	0.368	U
1/2	0.4001	0.425	0 4330	11 mm.
9/16	0.4542	0.481	0.4843	31/64 inch
5/8	0.5069	0.536	0.5468	35/64 inch
11/16	0.5700	0.599	0.6093	39/64 inch
3/4	0.6201	0.652	0.6562	21/32 inch
13/16	0.6831	0.715	0.7187	23/32 inch
7/8	0.7307	0.767	0.7677	19½ mm.
15/16	0.7929	0.829	0.8437	27/32 inch
1	0.8376	0.878	0.8858	22½ mm.
1 1/8	0.9394	0.986	1.0000	1 inch
1 1/4	1.0644	1.111	1.1220	28½ mm.
1 3/8	1.1585	1.213	1.2187	1 7/32 inch
1 1/2	1.2835	1.338	1.3386	34 mm.

Machinery

It is a fact, readily demonstrated, that 90 per cent of commercial taps break before they have been used long enough to require sharpening. This tremendous breakage is seldom the fault of the taps. Strains are often brought to bear upon taps which no metal can possibly withstand. The most important cause is the use of too small holes. It is not by any means uncommon to find taps used in holes which are smaller than the root diameter of the tap.

It would be a good thing if the manufacturers of both taps and drills would get together and publish uniform tables of drill sizes for tapping. At present there is no agreement, and the sizes recommended vary all the way from 75 to 101 per cent depth of thread. For instance, in one very commonly used table the drill size recommended for ½ inch, 13 U. S. standard, yields 94 per cent depth of thread. On 9/16 inch, the next larger tap, a size is recommended which yields 101 per cent depth of thread. "Somebody" started it, and custom continues it without questioning its advisability.

Just by way of confirming the conclusions we had reached through our own tests, we recently took a poll of leading manufacturing concerns throughout the country, from makers of very fine machine work to farm implements, including electrical fixtures, calculating machines, commercial bolts and nuts, harvesting machinery, etc. With one exception, their practice is to use drills which yield 75 per cent depth of thread in the nut, or less; one very prominent shop uses 50 per cent depth of thread in tool steel with good results. We therefore earnestly advocate 75 per cent depth of thread in the nut as a maximum where standard thread systems are used (such as U. S., S. A. E. and A. S. M. E.), because it gives all the strength of a deeper thread and brings about a much needed economy in tapping operations.

* * *

HIGH-GRADE BEARING METAL

A high-class bearing metal is prepared as follows: Melt 7 parts copper at as low a heat as possible, then add 25 parts antimony and 200 parts tin. This mixture is cast in iron ingot molds. It is then re-melted and to each five pounds of the ingots is added eight pounds of tin. This second alloy is cast in bars to suit the requirements.

* Advertising Manager, Wells Brothers Co., Greenfield, Mass.

THE VALVE PROBLEM ON GASOLINE ENGINES*

UNDESIRABLE EFFECTS OF GRINDING THE VALVES AND DESIGNS THAT ELIMINATE THE DIFFICULTY

BY M. TERRY†

What is the proper size of valves for a gasoline engine of a given bore and stroke? What is their proper lift? These, perhaps, are among the most puzzling questions which confront both mechanics and designers, but the vast majority do not even understand the principles underlying the correct solution of the problem. Not knowing what end to begin with, they invariably fall back on "common practice." Just what common practice is and how it works might be illustrated by an incident which occurred a few months ago. A fellow draftsman who was laying out a new gasoline engine came to consult the writer in regard to several details connected with its design; valve lift was one of them.

"And what would you suggest for the valve lift?" he asked.

"Well," I replied, "that is no easy question to answer offhand; it requires a close study of your engine and, perhaps, considerable figuring." Close study and considerable figuring never did appeal to this gentleman; so, entirely ignoring my reply, he continued:

"Jones Motor Works, on their Model X engine, which is 1/4 inch smaller in bore and 1/2 inch longer in stroke than mine, use 1/4 inch lift; and the Smith engine, which is practically identical with mine except that the stroke is 3/4 inch longer, use 5/16 inch lift. I am going to make my lift 9/32 inch; do you think that will be all right?"

"Well, it ought to be," I replied dryly, fully realizing the uselessness of further argument.

In selecting 9/32 inch for his valve lift he apparently showed excellent judgment, for the chief draftsman heartily approved of his method of procedure. "That's fine," he declared, "but how do you know that Smith and Jones are right?" While the question struck the nail squarely on the head, it was asked more with the object of teasing the man than to seriously question his method.

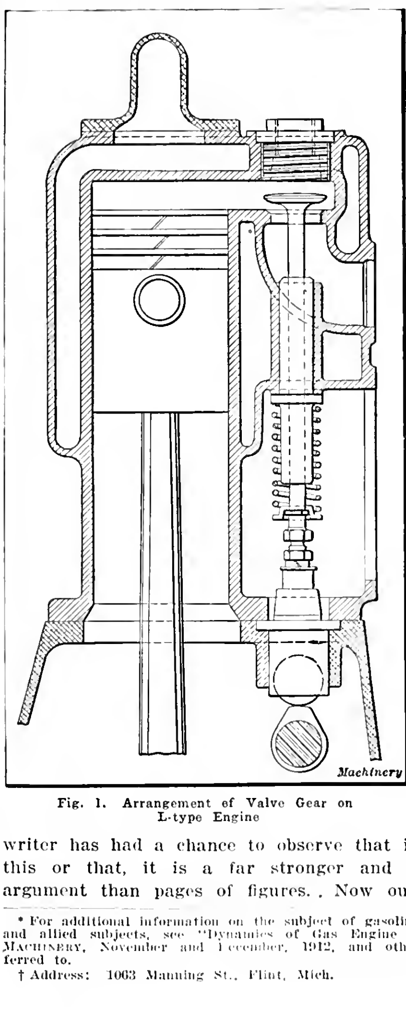


Fig. 1. Arrangement of Valve Gear on L-type Engine

"I do not know whether they are right or wrong," was the reply, "but I do know that their cars sell like hot-cakes."

Time and again the writer has had a chance to observe that if So-and-So does this or that, it is a far stronger and more convincing argument than pages of figures. Now our own firm was by no means a "second-rater," and both the Jones Motor Works and the Smith Motor Car Co. were undoubtedly doing the very same thing with our valve lift.

"Our design follows common practice," said the chief engineer to the general manager in an effort to convince the latter that he had in him a man of safe ideas. This was really a mis-statement; the right name for this sort of thing is the "common practice of designing" and not "designing along the lines of common practice."

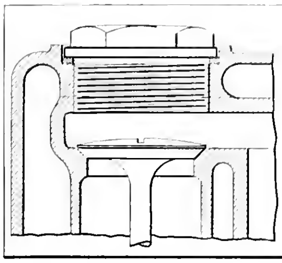


Fig. 2. Enlarged View of Valve Head on its Seat

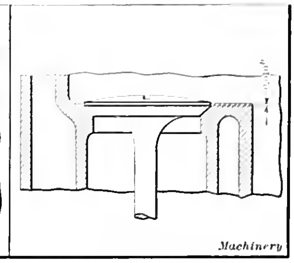


Fig. 3. Result of grinding Valve Seats

Proper Design of Valve Head and Valve Seat

Neglecting for the present the question of valve size and of valve lift, we shall turn our attention to the problem of properly proportioning the valve head and its seat. There is absolutely no theory in connection with this important point; it all hinges on a few practical considerations, and can be easily understood by any man with a mechanical mind. Fig. 1 shows the general arrangement of the valve gear on what is known as the L-type engine, and Fig. 2 shows an enlarged view of the valve head on its seat. The design is wrong. As long as the motor is new, no trouble will be experienced, but as soon as the valve seats pit and wear, the owner of the motor is compelled to grind them, and in doing so the state of things shown in Fig. 3 will result. Assuming that the valves now seat 0.010 inch lower than they did when the motor was new, that the valve lift is 0.250 inch and clearance is 0.005 inch, let us see what happens. The total valve lift, of course, is not changed, as it is governed entirely by the shape of the cam. The effective valve lift, *i. e.*, that part of the total lift during which the gases are free to pass in and out of the cylinder, is now only 0.235 inch—a reduction of 4 per cent. When the motor was new the effective lift was 0.245 inch. This loss of 4 per cent, appreciable as it is, is by no means the end of the story. It will be observed that the exhaust commences later and ends sooner in the stroke; and the incoming fresh charge is similarly affected. The extent of this change of original timing, which is seldom appreciated, will be presently shown.

Let the original timing be as shown in Fig. 4. The base circle of the cam is 1.000 inch in diameter; the roller diameter is 1.000 inch; and the clearance between the valve stem and the valve lifter is 0.005 inch. The writer is assuming a certain amount of knowledge on the part of his readers in regard to the construction and operation of gas engine valve gears. Those who are unfamiliar with it are referred to another article entitled "Dynamics of Gas Engine Cams" published in the engineering edition of MACHINERY for November and December, 1912, where the problem was thoroughly discussed and the relation between the clearance and the clearance angle was fully explained. In Fig. 5, the cam and its roller are shown in position where the latter is just on the point of rising. Therefore:

$$oc = 1.000 \text{ inch.}$$

At c_1 the backlash is closed and the valve is just on the point of rising. Therefore:

$$oc_1 = oc + \text{backlash} = 1.000 + 0.005 = 1.005 \text{ inch.}$$

c_2 is the point where the effective lift of the valve commences, *i. e.*, where the gases are first commencing to leave

* For additional information on the subject of gasoline engine valve gears and allied subjects, see "Dynamics of Gas Engine Cams," published in MACHINERY, November and December, 1912, and other articles there referred to.

† Address: 1063 Manning St., Flint, Mich.

or enter the cylinder, as the case may be. According to our assumption:

$$oc_2 = oc_1 + 0.010 = 1.005 + 0.010 = 1.015 \text{ inch.}$$

$$\text{Now } \cos\alpha = \frac{1.000}{1.005} = 0.995$$

$$\alpha = 5 \text{ degrees } 45 \text{ minutes}$$

$$\cos\beta = \frac{1.000}{1.015} = 0.985$$

$$\beta = 9 \text{ degrees } 45 \text{ minutes}$$

$$\beta - \alpha = 9 \text{ degrees } 45 \text{ minutes} - 5 \text{ degrees } 45 \text{ minutes} = 4 \text{ degrees.}$$

Thus the inlet and exhaust valves start 4 degrees later and close 4 degrees earlier than they did when the engine was new. This loss, of course, is doubled on the crank circle, since the crankshaft of a four-cycle engine revolves twice as fast as its camshaft. The loss, then, amounts to 8 degrees at opening and 8 degrees at closing of the valves, and the modified timing diagram is as shown in Fig. 6. It will be observed

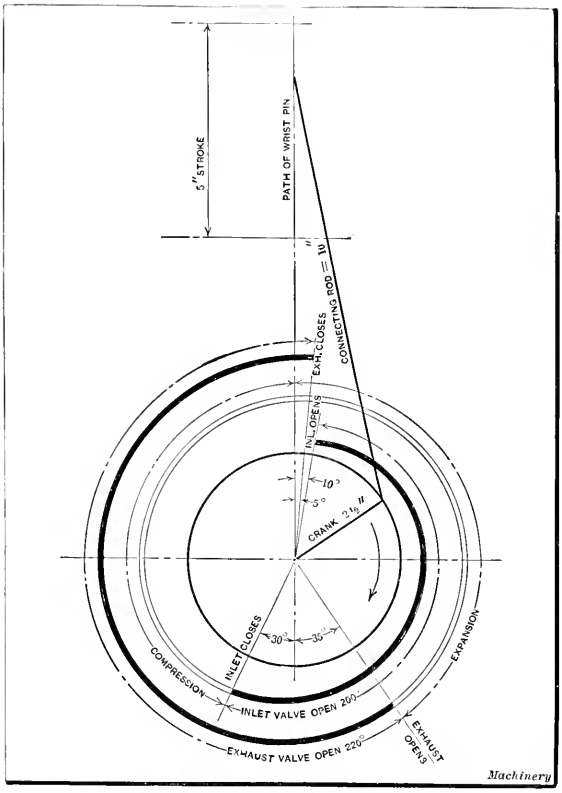


Fig. 4. Diagram showing Original Timing of Engine

that the loss is appreciable, amounting, as it does to $\frac{16 \text{ degrees}}{200 \text{ degrees}}$ or 8 per cent for the inlet valves, and $\frac{16 \text{ degrees}}{220 \text{ degrees}}$ or 7.27 per cent for the exhaust valves. The combined loss due to the shorter effective valve lift and shortened duration of the period of valve opening is shown very strikingly in Fig. 8, which is the time-lift curve of the inlet valve. The area bounded by the curve and the clearance line can be taken to represent the charge admitted to the cylinder when the engine was new, as explained in the article previously referred to. Similarly the area bounded by the curve and the effective lift line represents the charge admitted after the wear of 0.010 inch has taken place. The shaded area represents the volumetric loss which amounts to about 7.65 per cent for the exhaust and 8.5 per cent for the inlet valve; these results were obtained by means of a planimeter. The volumetric loss, as the term is ordinarily understood, occurs only on the inlet or suction stroke; a similar loss, however, which may be termed loss in scavenging action, takes place on the exhaust stroke. Either loss is undesirable, as it results in a falling off of the power developed by the engine.

The preceding discussion will probably account in many cases for the oft-heard complaint that the horsepower of certain automobile engines seems to drop off with their age, in spite of replacing the old, worn piston rings by new ones, and thereby restoring the compression pressure to its original value. The valve seat being comparatively inaccessible, an average repair man is not likely to notice the little ridge formed around it, and of those who would notice it not one in a hundred would realize its significance and attempt to remedy the trouble. As a matter of fact, the trouble in most cases is not very easily remedied, and the reason for it is not far to seek. The plug above the valve (Figs. 1 and 2) is only a plug; it is simply put there to close the hole formed in order to permit machining the valve seat and assembling the valve. Since the performance of any gasoline engine depends

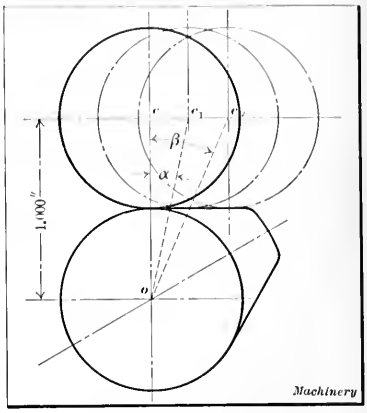


Fig. 5. Valve Lifting Cam with Roller ready to rise

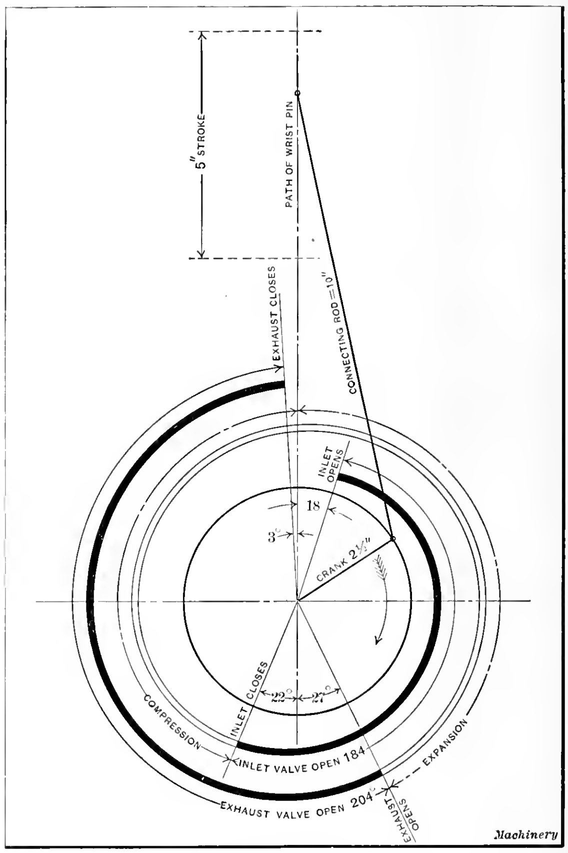


Fig. 6. Modified Timing Diagram showing Result of grinding Valve Seats

to a great extent upon the size of its valves, the latter are invariably made as large as possible, and in the construction shown in Fig. 2 the valve head is made only a few thousandths inch smaller than the threaded hole above it. Evidently the tool for chamfering the valve seat cannot be made any larger

than the valve head, and hence the difficulty which must inevitably face the repair man, should he take it into his head to remove the ridge. There is only one way—so far as the writer knows—of remedying the trouble, and that is by means of a fly-cutter. Care must be taken, however, to center the shank of the cutter properly by means of some special fixture; otherwise the valve seat and the valve stem guide hole will not be concentric, and gas leakage and poor compression are sure to follow. It will be seen from the foregoing that small and insignificant as the question of proper proportioning of the valve head and its seat at first appeared to be, it is far-reaching in its results, and surely deserves some consideration on the part of designers. The trouble we have just been investigating is very easily remedied—if it is recognized—on engines equipped with removable valve cages as shown in Fig. 7, which is the Buick design, and on the L-type engines having a detachable cylinder head like the Ford.

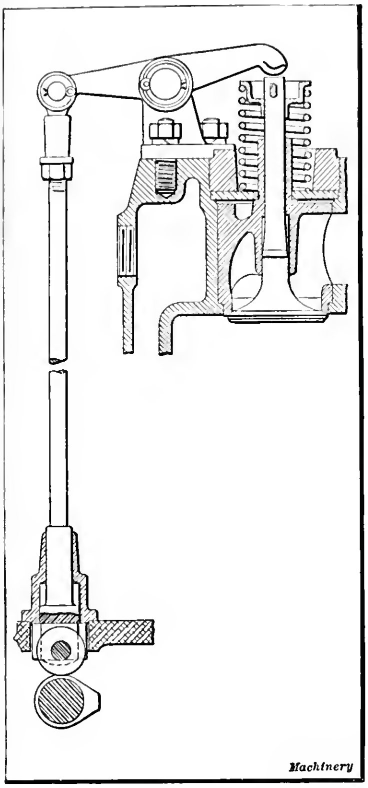


Fig. 7. Removable Valve Cage used on Buick Engine

A correct design is shown in Fig. 9, where the outside diameter of the valve D is made from 1/16 to 3/32 inch larger than D_1—the outside of the bevel seat. The width of the seat W generally varies from 3/32 to 3/16 inch. The diameter at the lower edge of the valve head is made equal to the bore of the throat; occasionally it is from 1/64 to 1/32 inch smaller. This is all right; but under no circumstances should it be made larger than the bore of the throat, for a flat seat will eventually be formed at the inner edge of the bevel seat, thus resulting in a tortuous path for the gases—a condition admittedly undesirable on any gas engine. In addition to this, the contact between the valve head and its seat will take place in two planes with the probability of being far less perfect than it was before.

The Bore of the Cylinder vs. the Bore of the Throat

Any mechanically inclined person surely recognizes the fact that there must be a certain direct relation between the size of any given engine and the size of its valves; the larger the cylinder, the larger the valves. But what is the exact relation between the two? As stated before, the valves are invariably made as large as a given design will permit. This, however, does not settle the problem; on the contrary, the important test of any given design is the size of its valves, and should calculations show the latter to be too small, the design must be changed to permit the use of larger valves. In the absence of extensive experimental data on the subject or even of a simple and plausible theory which would take into account several important factors, the designers of today reduce the whole question of proper size of valves to a simple numerical relation between the bore of the cylinder and the bore of the throat. Let:

D = diameter of cylinder bore in inches;
S_p = average piston speed in feet per minute;
L = length of piston stroke in inches;
t = duration of piston stroke in minutes;
V = piston displacement in cubic inches;
d = diameter of bore of throat in inches;
S_g = average velocity of gases at the throat in feet per minute;

$$V = \frac{\pi D^2}{4} \times L = \frac{\pi D^2}{4} \times 12 S_p \times t \qquad (1)$$

Since the same volume V has passed through the valve throat and neglecting the reduction of the passage area due to the presence of valve stem:

$$V = \frac{\pi d^2}{4} \times 12 S_g \times t \qquad (2)$$

Therefore

$$\frac{\pi d^2}{4} \times 12 S_g \times t = \frac{\pi D^2}{4} \times 12 S_p \times t \qquad (3)$$

$$D^2 S_p t = d^2 S_g t \qquad (4)$$

$$\frac{D^2}{d^2} = \frac{S_g}{S_p} \qquad (5)$$

It is common practice among designers to so proportion D and d that S_g shall not exceed the value of 6000 feet per minute at the time the average piston speed S_p is 1000 feet per minute.

Formula (5) then reduces to the form:

$$\frac{D^2}{d^2} = \frac{S_g}{S_p} = \frac{6000}{1000} = 6$$

$$6\,d^2 = D^2$$

$$d = \frac{D}{\sqrt{6}} = \frac{D}{2.45} \qquad (6)$$

For example, if $D = 3$ inches, $d = \frac{3}{2.45} = 1.225$ inch.

The bore of the throat should not be less than 1¼ inch diameter and this determines the size of the valves. Almost any multiple-cylinder engine may be redesigned to accommodate larger valves, but if this advantage is secured at the expense of spacing the cylinders farther apart, thereby increasing the overall length of the engine and making a corresponding increase in its weight, as well, the procedure is not worth while. This is especially true in the case of automobile engines, where weight is a question of prime importance. It must not be supposed, however, that if an engine with a 3-inch cylinder bore and 1¼-inch valves has its piston moving

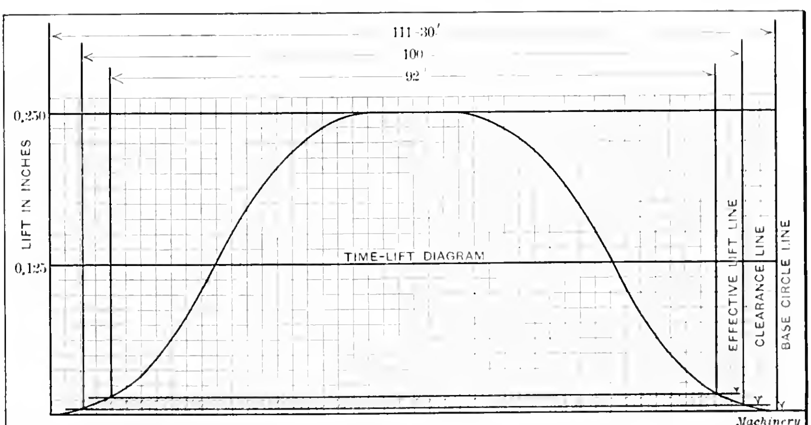


Fig. 8. Time-lift Diagram showing Combined Loss due to Shorter Effective Valve Lift and Shorter Period of Valve Opening

at the rate of 1000 feet per minute the average velocity of gases is actually 6000 feet per minute. It is very unlikely that it is anywhere near this figure. In the first place, Equation (4) is not strictly true, because the suction stroke of the piston lasts through 180 degrees, while the inlet valve, according to Fig. 4 in our case, is open through 200 degrees of the crank circle. In the second place, the statement that the volume V, which is equal to $\frac{\pi D^2}{4} \times L$ = piston displacement, passes through the valve throat, is far from being true. The weight of the gases drawn into the cylinder is equal to the weight of the gases passing through the valve throat, but their volumes are not equal. This inequality in volume arises from two causes: first, the temperature of gases at the instant they fill the cylinder must be considerably higher than at the time of their passage through the throat; second, from the analogy between aero- and hydro-dynamics, we know that, neglecting frictional losses, the total energy of a given weight of moving gas in the cylinder is equal to the total energy of the same weight of gas at the throat. The total energy is the algebraic sum of the velocity and pressure energies; and as the velocities of the gases in the cylinder and at the throat are different, it is clear that the gas pressures cannot be the same. As the gases are in a different state as regards their pressure and temperature, their volumes are more than likely to be different.

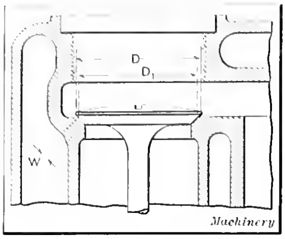


Fig. 9. Design of Valve with Seat that can be properly ground

There is yet another cause which tends to make the actual velocity of gases different from that allowed in the derivation of Formula (6), but its discussion will be postponed for the present. The natural conclusion is that Formula (6) is based on assumptions which are far from actual working conditions. Nevertheless, on account of being simple, it serves the purposes of design as well as any empirical formula. With the accumulation of experimental data in the years to come, this formula will undoubtedly be considerably revised and extended. As an empirical formula, $d = \frac{D}{2.45}$ falls short of meeting the requirements of a thoughtful designer. Let us consider, for example, a 3 by 4 and a 3 by 6 engine; according to our formula the throat opening on both engines should be $1\frac{1}{4}$ inch in diameter. Now, let the pistons of both engines be moving at precisely the same speed, say 1000 feet per minute. Since the stroke of the first engine is 4 inches, its piston will cover 1000 feet in 1500 revolutions of the crankshaft. The piston of the second engine will cover the same distance in 1000 revolutions of its crankshaft. Since the Otto cycle is completed in two revolutions of the crankshaft, there will be 750 cycles per minute on the 3 by 4 and only 500 on the 3 by 6 motor. The column of fresh gases must be started and stopped 750 and 500 times per minute, respectively, on the two engines; the same applies to exhaust gases. Also, the duration of valve opening, and, hence, the duration of gas flow is 50 per cent greater on the 3 by 6 than it is on the 3 by 4 motor. The result is that at the

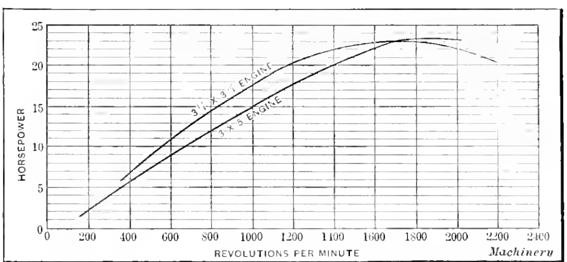


Fig. 10. Power Curves of Engines subjected to a Commercial Test

same piston speed, the former engine is bound to excel the latter. This is one of the causes of the recent remarkable performances of certain long-stroke racing motors, both here and abroad, and of the increasing popularity of the long-stroke engine for pleasure cars. Our formula $d = \frac{D}{2.45}$, failing as it does to take into account the stroke of the engine, cannot give entire satisfaction.

Again, the constant 2.45 in the preceding formula and the gas velocity of 6000 feet per minute on which this formula is based, are not applicable to all engines. Certain types of engines can accommodate valves that will easily permit as low a gas velocity as 5000 and even 4000 feet per minute, while others necessitate a velocity closely approaching 10,000 feet per minute. Yet, in spite of this great disadvantage, an engine with valves in the head having 10,000 feet per minute for its gas velocity, may show a better economy than an L- or T-head engine with 5000 feet per minute for its gas velocity. This phenomenon is generally accounted for by the fact that the combustion chamber of the valves-in-the-head engine has less radiation area per unit volume than that of the L- or T-head engine, and consequently more heat units are converted into useful work and fewer lost by radiation. Whether this generally accepted explanation of the phenomenon is correct or not, the fact remains, and hence, the apparent necessity of having a distinct constant or permissible rate of gas flow, for each type of engine. No better proof of this necessity of differentiating between engines of distinct types can be given than by making a comparison of an L-head and a valves-in-the-head engine, and studying their power curves as obtained from an actual test. The curves as shown in Fig. 10 are the result of an ordinary commercial and not a scientific test; they also represent the brake and

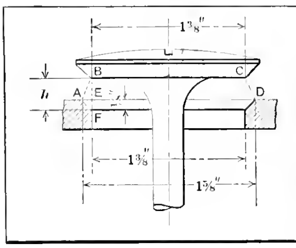


Fig. 11. Diagram showing Method of determining Valve Lift

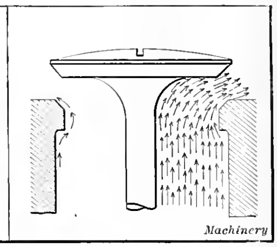


Fig. 12. Diagram showing Effect of "Vena Contracta"

not the indicated horsepower. Strictly speaking, the latter is preferable for our purpose. Also, the two engines happen to have somewhat different piston displacements, this circumstance slightly favoring the larger engine for no other reason than that large engines invariably show better economy or generate more power, displacement for displacement, than the smaller ones. These minor shortcomings, however, detract but little from the value of our comparison. The principal dimensions of the two engines are tabulated in Table I. From a study of this table, particularly items 8, 9 and 14, one would be led to expect greater output, displacement for displacement, from the 3 by 5 rather than from the 3¾ by 3¾ engine. Such, however, is not the case, as can be seen from their power curves (Fig. 10) and Table II which is derived from them.

A more recent test of the two engines conducted with the same size and make of carbureter has brought out a still better performance, displacement for displacement, of the 3¾ by 3¾ engine, which maintained the lead on the 3 by 5 engine up to 1800 revolutions per minute, at which speed their performance curves crossed. By making a comparison on the basis of the same rotary speed we eliminate the factor of cycles and duration of valve opening, thus leaving only two main factors unbalanced, namely: rate of gas flow and horsepower per unit displacement. In engines of the same type, lower rates of gas flow are invariably accompanied by greater horsepower per unit displacement. Referring to Table II and the statement made in regard to it, it will be observed that at low, moderate and even high speed, the

valves-in-the-head engine shows an equal and even better performance than the L-head engine, in spite of its almost 50 per cent greater rate of gas flow. This proves it to be a fallacy to prescribe the same rate of flow, i. e., 6000 feet per minute at the piston speed of 1000 feet per minute for engines of all types.

Valve Lift

Last, but not least, comes the problem of valve lift. Assuming that our valve throat is properly proportioned, it remains—as a matter of common sense—not to lose the advantage thus gained by restricting the passage and thereby choking the gases anywhere along the line—something that can be very easily accomplished by providing an insufficient valve lift. The problem consists of so proportioning the lift (h in Fig. 11) that the area of the frustum of the cone of revolution $ABCD$ be made equal to the net area of the throat.

TABLE I. DIMENSIONS OF L-HEAD AND VALVES-IN-THE-HEAD TYPES OF ENGINES SUBJECTED TO TEST

	Valves-in the-head	L-head
1. Type of engine	Valves-in the-head	L-head
2. Number of cylinders	4	4
3. Bore = D inches	$3\frac{3}{4}$	3
4. Stroke = L inches	$3\frac{3}{4}$	5
5. Area of cylinder bore $= \dfrac{\pi D^2}{4}$ square inches	11.045	7.069
6. Total piston displacement $= 4 \times \dfrac{\pi D^2}{4} \times L$ cubic inches	166	141
7. Revolutions per minute corresponding to piston speed of 1000 feet per min.	1600	1200
8. Number of cycles per minute at piston speed of 1000 feet per minute	800	600
9. Duration of valve opening in per cent assuming same timing	100	133
10. Bore of valve throat in inches	$1\frac{1}{4}$	$1\frac{3}{8}$
11. Diameter of valve stem in inches	$\frac{3}{8}$	$\frac{3}{8}$
12. Net area of valve throat in square inches	1.117	1.375
13. Area of cylnder bore ÷ net area of valve throat	9.9	5.14
14. Rate of gas flow in feet at a piston speed of 1000 feet per minute	9900	5140

Machinery

Net area of throat $= \dfrac{\pi}{4}(1.375^2 - 0.375^2) = 1.375$ square inch.

Area of the frustum $ABCD = AB \times \pi \times \dfrac{1\frac{3}{8} + 1\frac{5}{8}}{2} = 4.71\ AB$.

$AB = \dfrac{1.375}{4.71} = 0.292$ inch.

$BE = \sqrt{AB^2 - AE^2} = \sqrt{0.292^2 - 0.125^2} = 0.264$ inch.

Valve lift $= h = BE + EF = 0.389$ inch.

The valve shown in Fig. 11 was used on the 3 by 5 engine previously described. The lift as actually employed was only 7/32 inch or about 56 per cent of the calculated amount. It may seem absurd, but this dwarfing of the lift is being done on a wholesale scale—in most cases unconsciously—by the followers of the "common practice" theory, who have no sounder arguments to advance than that "they all do it." The true reason for the dwarfing of the valve lift, whenever it is done knowingly, of course, and not in the act of merely copying someone else, lies in the fact that high lifts are invariably associated with increased stresses on the parts comprising the valve gear and their rapid wear. This consideration is of so serious a nature that it cannot be ignored. But apart from this purely mechanical reason there is yet another reason, seldom recognized, but which nevertheless exists. The writer is referring to the presence of what is known in hydraulics as *vena contracta* in the throat passage (Fig. 12) which materially reduces the net area of the throat. Thus, in the case under discussion, the theoretical lift of 0.389 inch is excessive, since our theory did not take cognizance of the existence of vena contracta. But there is also a possibility of increasing the lift from 7/32 to 9/32 or even 5/16 inch and securing better output from the engine without incurring excessive wear of the valve gear. The actual amount of vena contracta, as well as the maximum useful valve lift, can be determined only by experimental means. The existence of vena contracta is the third reason alluded to in the early part of this article when it was stated that the actual gas velocity at the throat differs from the calculated one.

There is one more thing in connection with valve lifts which the writer feels is worthy of mention. Let us take, for example, an engine having $1\frac{1}{2}$-inch valves, with a lift of $\frac{3}{8}$ inch. Now, suppose we desire to redesign this engine and increase its valves to 2 inches. The increase of area at the throat is proportional to the square of its diameter; and, in order to maintain the same advantage at the valve seat, the valve lift must be increased roughly to $\frac{1}{2}$ inch. If the latter expedient be considered undesirable, the lift need not be changed, but the net gain, then, will be proportional only to the increase of the throat diameter. Now, the same engine can be redesigned along somewhat different lines. Suppose that quieter running and reduction of wear on the valve gear is the end aimed at, the power performance being entirely satisfactory. This can be secured, as before, by increasing the valve diameter from $1\frac{1}{2}$ inch to 2 inches, and reducing the lift from $\frac{3}{8}$ to 9/32 inch, thus leaving the passage area at the valve seat practically unaltered.

Judging by the ratio of the cylinder bore to the valve throat alone, as outlined in the earlier part of this article, the performance of the two engines should be identical—something that is very unlikely to happen owing to the great difference in passage areas at their valve seats. It will thus be seen that the valve throat alone does not form a good criterion of the probable engine performance. Indeed, the practice of comparing and designing engines on the basis of the ratio of the two bores alone may be considered as misleading and unfortunate. It should rather be based on the passage area at the valve seat, the exact amount of which depends both on the diameter of valve throat and the valve lift, the latter being so limited by practical considerations that there is absolutely no danger of its being made too large at the expense of the throat. When the usual method of computation is followed, the valve throat might be, and generally is, made too large at the expense of the lift.

In conclusion, the writer wishes to say that, while the formulas cited are somewhat unsatisfactory, they serve as a guide for one's analysis of gasoline motors. Like all inefficient tools and methods, they cannot be discarded until better ones are found to take their places. The use of formulas alone is practically worthless, unless it is accompanied by the two most important elements in all branches of design: a painstaking analysis and a trained judgment.

* * *

The post office department estimates that the gross receipts from the parcel post business during 1914 will amount to $80,000,000, of which $30,000,000 will be profit. This is a conservative estimate based on the results of the past year. The railroads claim that out of the profits $15,000,000 ought to be paid them in addition to the payments now made for carrying the parcel post mail, but even if that were done the profit realized is a fair one, and not at all in agreement with the opinions of leading business men engaged in the express service who claimed that the government could not carry on the parcel post except at a loss.

TABLE II. COMPARATIVE TESTS OF GASOLINE ENGINES

	800 R. P. M.		1200 R. P. M.		1600 R. P. M.	
Engine	3 by 5	$3\frac{3}{4}$ by $3\frac{3}{4}$	3 by 5	$3\frac{3}{4}$ by $3\frac{3}{4}$	3 by 5	$3\frac{3}{4}$ by $3\frac{3}{4}$
Piston speed in feet per minute	666	500	1000	750	1333	1000
Gas velocity in feet per minute	3125	4950	5140	7420	6850	9900
H.P. per cubic inch of displacement	0.085	0.088	0.126	0.126	0.156	0.136

Machinery

THE TESTING OF MATERIALS*

The ever-increasing intensity of the stresses which the materials of engineering, and especially of metals used in machine construction and structural designs, are expected to withstand, or the energy they are required to transmit, has during recent years necessitated a more and more intimate knowledge of the properties of the materials employed. At the present time, also, a great deal of study is given to the laws which determine the distribution of the stresses in the elements of the mechanical details or structures themselves. It is, however, impossible to deny that the architects of the past, who conceived and carried out such designs as are found in Greece and Italy and in the great Gothic cathedrals, possessed a considerable knowledge of the materials they employed and a keen sense of the stresses to which they submitted them; so did also the engineers and builders who launched upon the ocean the war-ships and merchantmen of the eighteenth century. They did not, however, for the most part, possess a knowledge of accurate calculation, nor of the definite laws necessary for the determination of the elastic properties of their materials. They took for guidance structures of a similar nature that had already proved successful, and when it was a question of undertaking entirely new work, either as regards size or shape, the designer was guided by the sense of fitness which practice is so capable of conferring, although it may sometimes be a mistaken one. Thus the designer was frequently led to over-emphasize the strength, or, if this proved inadequate, to employ means of strengthening his structures by making such means contribute to their ornamentation, as, for example, in the flying buttresses of the Gothic architecture.

The First Definite Investigations into the Strength of Materials

It was not until the seventeenth century, in the era of Galileo, that we find the first attempt made by this great scientist to solve the problem of the resistance of materials. Shortly afterward, Hooke enunciated the fundamental law of stability, which has ever since found application. In the eighteenth century renowned scientists and skillful engineers, such as Bernouilli, Euler, Duhamel, Gauthey, Rondelet, Young, Coulomb and Lagrange, ultimately developed the theoretical investigations which fostered the progress of the mathematical analysis and rational mechanics of the elastic properties of materials. The movement once initiated was never allowed to halt. It was, however, especially toward the improvement of the mathematical theory that the early investigators directed their efforts, but experiments were not lacking during this period. Among those who based their researches on experimental results may be mentioned Morin, Hodgkinson, Stephenson, Fairbairn and Napier.

The early development of the railways gave considerable impulse to the investigations into the strength of materials. The steam railways involved bridges of great length, capable of supporting rolling loads at high speeds. Work of this kind had nothing similar in any previous experience, and new methods and new elements of computation were required; besides the question of cost and maintenance came to the front as never before. Although a great deal was done during this period, it may be said that it was mainly during the course of the last thirty years that the activity in experimental work has become accentuated, owing, on the one hand, to the extraordinary increase in the dimensions of the structures themselves and the loads they are expected to carry, and on the other, to the introduction of new methods of testing and of refinements hitherto unknown. In this connection may be mentioned not only the erection of immense bridges, but of roofs of great span, steamships of immense size, the introduction of reinforced concrete, and the development of the automobile and of aerial navigation. It has therefore been necessary to improve experimental methods, to create more powerful and more accurate testing machines, and to study properties to which no regard was previously paid, such as, for instance, the resistance to shock and to rapidly repeated stresses. It has been necessary to look more deeply into the actual study of the structure of materials and to investigate the various forms of treatment to which metals are subjected before being put into use. A new science, metallography, has arisen, which, although of recent birth, has already been the object of a great deal of research which has endowed the metal industries with a fund of valuable knowledge.

Testing Methods

The most conclusive test, from the point of view of the strength of a structure, is obviously that which consists in subjecting the structure to the maximum stresses it is required to undergo, or even to still greater stresses, so as to insure complete security against all possible accidents. This has been done, for example, in the case of ropes, in boilers, and in bridges. Such tests are of extreme interest from the point of view of the confirmation of the accuracy of the formulas employed in the calculations of the dimensions and of the assumptions that it is often necessary to introduce into these calculations; these tests may often be made to yield valuable information for the completing of similar structures. An attempt has been made to introduce such tests into general practice, and methods and apparatus for same have been developed by Mr. Rabut and applied in France; Mr. James Howard has also developed the methods and apparatus adopted by the Bureau of Standards in Washington. These methods permit of measuring with considerable accuracy the deformation in a structural part; or of the plotting of a diagram showing the deflection in a bridge under the influence of moving loads; or of measuring the angular deviation in structures submitted to wind pressure, or in parts submitted to torsion.

Other investigations have made it possible, in many cases, to substitute hardness tests for tensile tests in iron and steel. Such tests, which may be termed "indirect," often justify their adoption by reason of the simplicity of the appliances required, or their small initial cost, and may often play an important part in practice, even if the information obtained is less accurate than that obtained by direct tests. The latter, however, are the most important and are always adopted when it is necessary to ascertain with the greatest accuracy the elastic properties of a metal, apart from the mode in which it is to be employed. These properties are, in particular, the elastic limit, the ultimate breaking stress, the coefficient of elasticity, the elongation, and the percentage of reduction of area at the breaking point. These tests are carried out on test pieces, that is, on samples cut from the materials to be investigated and specially prepared so as to display the properties under investigation. Experience has shown that this very preparation, as well as the methods of carrying out the tests, considerably influences the results obtained. It has therefore been necessary to fix international standards for uniform methods of testing for each class of material, and in particular for iron and steel. This work of standardization has been carried out by the International Association for Testing Materials, which was formed in 1895. The original aim of this association was to introduce uniform methods for the testing of materials, but while this has only been partly accomplished, the meetings of the association have become occasions of learning new facts and of investigating new methods for testing, rather than classifying those already known throughout the engineering world. When these new methods have been thoroughly established, it will be possible to establish standards which will rest on a scientific basis and yield more exact indications as to the nature of the materials than has been possible in the past.

The Work of the International Association for Testing Materials

As the work of the International Association for Testing Materials is, in a measure, a record of what has been done in recent years throughout the engineering field along these lines, a brief review of the work of the association will afford a comprehensive idea of the present status of the testing of materials. In 1906, at the meeting at Brussels, the association adopted and published a set of methods for the testing

* Abstract of a paper read by Prof. H. Hubert of Liege, Belgium, before the Iron and Steel Institute at Brussels.

of iron, steel, cast iron, copper, metal alloys, hydraulic cement, wood and clay, stoneware and cement pipes. The degree of accuracy in measuring permanent elongation should be 0.001 per cent. The "apparent elastic limit" has been reached when there is a permanent elongation varying between 0.2 and 0.5 per cent and the "proportional elastic limit" has been exceeded when the elongation on increasing the load by 100 kilograms per square centimeter (1422 pounds per square inch) differs by more than 0.0005 per cent from the proportional elongation. The association has also fixed rules for the determination of shock-fractures and resilience.

Metals are subjected to three different classes of tests: chemical, physical and mechanical. The chemical tests are more especially carried out during the process of manufacture in order to ascertain the composition and purity of the products. They are also carried out by the purchaser as a check on the specifications.

Physical tests consist of the examination of the exterior of the products and noting their fracture. The superficial examination may yield a general idea to the expert, but it is the examination of the fracture, especially when the surface can be projected under strong illumination on a screen suitably enlarged, that yields definite indications as to the quality of the steel and cast iron, and the defects that may be present. Of late, this method has been improved by polishing the surface of the fracture and etching it with a dilute solution of acid or preferably with a ten-per-cent ammoniacal copper solution, which allows of a micrographic examination being made immediately. This mode of testing often affords the metallurgist and engineer means for ascertaining the cause of discrepancies manifested in mechanical tests. Micrographical research is a branch of the science of testing in which, more than any other, progress has been made in the past few years, and it has become a trustworthy guide in the manufacture if iron, steel and metal alloys. It has been introduced particularly in works engaged in the construction of automobiles.

The variations in the properties of metals, under the influence of changes of temperature, hardening, tempering and annealing, and the study of magnetic and electric properties, all form branches of the physical testing and have given rise to many investigations.

Mechanical Tests

Mechanical tests were, for a long time, the only ones to which recourse was to be had in the study of metals. They still remain among the most important. These are classified into resistance tests on subjection to tensile, compressive, shearing, bending and torsional stresses, either applied gradually or suddenly, and workshop tests, consisting of bending, hammering down, upsetting and punching. The necessity of using, for the resistance tests, accurate and very costly machines, and of subjecting the test piece to the most careful and therefore the most expensive, preliminary treatment, and entrusting the experiments themselves to an expert staff, renders the time and expense for such tests relatively large, and many investigators have sought to supersede them by more rapid and cheaper treatments, even at the expense of accuracy. Among such methods may be mentioned the Frémont punch-test and the various hardness tests. The Brinell hardness test gives a fairly definite relation between the breaking stress and the hardness number and has the advantage of being capable of application to finished parts without injuring them. Many investigators claim that the relationship between hardness, as measured by the Brinell method, and tensile strength is so close that a coefficient may be determined by which the hardness numeral may be multiplied to obtain the tensile strength. Other observers claim that the results sometimes are very erroneous, and the Brussels congress, in 1906, would not consent to the substitution of the ball hardness test for the tensile test in specifications, but it recognized the value of the process by recommending its use in testing supplies. Later investigators, however, have credited the method with close accuracy. At the meeting of the International Testing Association in New York, 1912, the subject was again discussed, but no definite conclusions were arrived at.

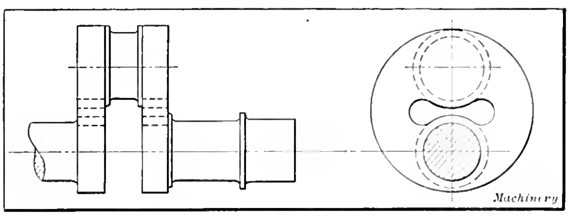
An interesting subject of investigation, relating to the testing of materials, is that of "fatigue" in metals, that is, the giving away of structural parts after they have been in use for a long time under a stress not exceeding that to which they have been continuously exposed. The earliest investigations of this subject were those made by Wöhler between 1857 and 1870. Many methods have been developed for carrying out these tests. It is claimed that 80 per cent of the fractures that actually occur in structural designs are due not to over-stresses, but to fatigue, and much importance, therefore, should be paid to methods of testing metals for continued stresses. The ability of a metal to resist fatigue may be denoted by a "factor of quality" which would indicate not its absolute strength, but the relative number of times that the material could be subjected to a given stress before it would actually break under that stress.

The brief review in the foregoing gives a general outline of the present status of the science of testing materials, for such it might well be termed. The great importance of the work of the International Association for Testing Materials to the engineering field is evidenced by the fact that the association now has about 2700 members from some twenty-five different nations, and that ten governments officially give financial aid to the work of the association. In the United States alone there are nearly 500 members and about as many in Germany. These two countries apparently lead in the interest taken in this important subject.

* * *

IMPROVEMENT IN CRANK AXLES

The illustration shows an improvement which has been applied to crank axles having circular webs, by M. C. Frémont, a French engineer. The stresses in these circular webs are most severe at the center, where the ingot from which the axle is forged is the weakest, and therefore cracks often start at this point, continuing to the periphery. In order to obviate this difficulty, the metal in the center is cut away in the form of the figure 8, thus preventing the starting of cracks. Axles made according to the Frémont



The Fremont Crank Axle with Portion at Center of Web removed

system have been in use in France for four or five years and have given entire satisfaction. In fact, crank axles which showed cracks in the center and were condemned have had the faulty portion cut away and then been put back into service, and have given no further trouble. Axles with circular crank webs have been tested to destruction and have been found to resist greater stress when the webs are cut away in the center, as described, than when the webs are solid.

* * *

An analysis by the *Railway Age Gazette* of the statistics of locomotives ordered during 1913 indicates that the superheater is being applied to nearly all locomotives, except those of the smaller size, and that engines of very large size are much in demand. Specifically stated, 79 per cent of all new steam locomotives of moderate and large size are equipped with superheaters, while in 1912 the percentage was 63. Nearly 63 per cent of the total number of locomotives ordered during 1913 were of the consolidation, Mikado or Pacific type, the consolidation being in the lead of all other types, forming 23 per cent of the total. The Pennsylvania R. R. leads in the use of these engines, 435 having been built for this railroad alone.

THE DIESEL ENGINE*

PRINCIPLE OF OPERATION—CHARACTERISTICS—EFFICIENCY—FUEL

The development of the internal combustion engine has made tremendous strides in the last few years. This is especially true of one type in particular, the Diesel engine. The unparalleled progress of this prime mover, due primarily to the expiration of the basic Diesel patents, has created a wave of enthusiasm. To the careful observer, however, signs of an ebbing of this wave are apparent, and more sober views are rapidly gaining ground. The application of the engine to marine work, especially to vessels of certain classes, has been especially noticeable, and the marine interests of the country have been watching closely the work of the Diesel engines. Other applications of the engine are common, and the Diesel engine of today is likely to be found in almost any line of work.

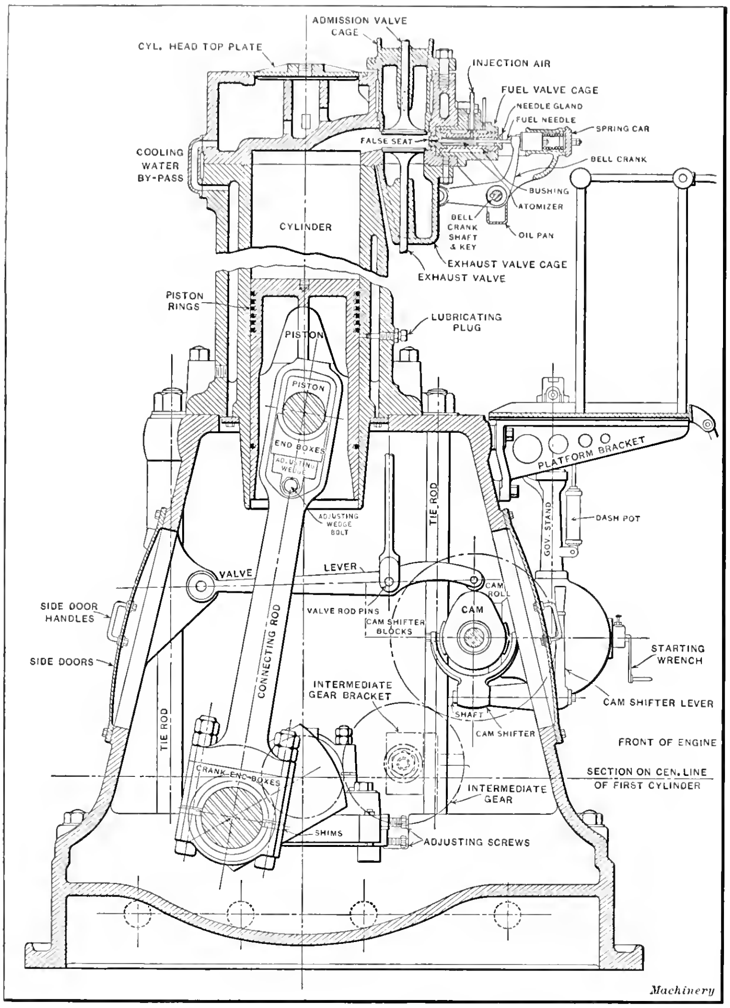


Fig. 1. Sectional View of Typical Diesel Oil Engine

In spite of the fact that the name Diesel has spread over the entire world, but few engineers in fields other than combustion engineering have ever taken the time to thoroughly study the movement of the engine and to learn of its proved practical application and use to the engineering world. The purpose of this article is, therefore, to present an idea of what the Diesel engine is, and to show in what fields the greater possibilities of the engine lie.

This type of engine may be defined in a few words as follows: An internal combustion engine which takes its fuel—crude, lowest grade fuel oil, or the residues from oil refining—into the cylinders, raw, without any previous transforming, and there converts it into energy, exerting that energy directly on the crankshaft through pressure on the piston head, without any intermediaries, thus producing the simplest, most direct and economical operation.

Principle of Operation

The cycle of operations of the Diesel engine operating on the "four-stroke cycle," comprising the Diesel ignition compression is as follows:

Stroke 1. Admission. The piston travels down or out, allowing the cylinder to fill with pure, fresh air from the inlet valves.

Stroke 2. Compression. The piston travels up or in, compressing air in the cylinder. The compression heats the air so much that the oil discharged into it will ignite and burn.

Stroke 3. Combustion. The piston travels down or out. At the beginning of this stroke, when the crank is on dead center, the fuel valve opens and the fuel charge of oil is sprayed into the heated air of the cylinder by a jet of air separately compressed by a small compressor. The spraying extends over 12 per cent of the working stroke of the piston and the combustion is gradual, the resulting pressures being even and sustained and not explosive.

Stroke 4. Exhausting. When the piston reaches the lower or outer end of the cylinder on stroke 3, the exhaust valve is opened, the pressure relieved and the piston travels up or in, driving out the exhaust gases of combustion.

Large Diesel Engines

Owing to the steady application of its power, the lack of vibration, comparative noiselessness, reliability, and to the small space which it occupies, the Diesel engine has become an almost ideal engine for marine work where oil may be had at nominal prices. An idea of the ease with which a Diesel engine may be controlled may be had from experiments run with the British motor ship *Eavestone*. This vessel is a ship of 4310 tons displacement recently built by Sir Raylton Dixon Co., Ltd. The 800 horsepower Diesel engine was largely built and installed by Richardsons, Westgarth & Co., Ltd., of Harthpool. She was capable of doing somewhat over nine knots. The action of the engines was very remarkable; they were reversed from full ahead to actually running astern in from nine to ten seconds, and this without any haste; in fact, with intentional deliberation. It was stated that the reversal had actually been completed in the remarkable time of six seconds. Observations showed that it only took about three seconds from the ringing of the telegraph till the engine was actually running ahead, the gear being already in the "ahead" position. Units of this character have been built for marine service up to about 2000 horsepower, single-acting type. The double-acting types are as yet but in the experimental stage.

Established Popularity of the Small Diesel Engine

The small and medium Diesel engine in sizes of from 40 or 50 horsepower in single-cylinder units, up to about 600 horsepower in four-cylinder units plays a vastly more important part in the commercial world than do the larger units; it has unquestionably come to stay, and has reached a high

* Abstract of an article in the January number of the Sibley "Journal of Engineering."

degree of perfection which places it right in line with the corresponding steam or gas engine plant as far as reliability and cost of operation are concerned, and far ahead of its competitors when considered from the standpoint of fuel economy. It is amazing to note how many manufacturers of gas and steam engines have taken up the manufacture of Diesel engines, because they found that the sale of suction-gas producer plants and smaller steam engines has fallen off alarmingly within the last few years.

The reason is plain. The single-acting four-cycle, single or multi-cylinder Diesel engine, but particularly the former, is comparatively simple in construction and operation. It does not require upkeep and attendance of boilers or gas

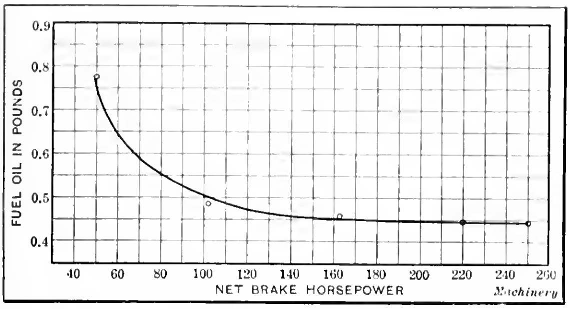


Fig. 2. Diagram showing Fuel Consumption of Diesel Engine

producers, and its cost, compared with that of a steam or gas plant, is reasonable. It can be installed in the basements of buildings below occupied dwellings. One of the greatest advantages, however, is the fact that the actual fuel consumption of Diesel engines taken over long periods of operation does not materially exceed the guaranteed figures; whereas, in gas producer and steam plants this excess is quite considerable. In a Diesel plant the human element—the skill of the operator—has much less influence upon the fuel economy than in a steam or producer gas plant, where everything depends upon the efficiency and intelligence of fireman and producer attendant.

On account of its low cost and great simplicity and variety of fuels which can be utilized the engines are being used and installed for various purposes, as for power transmissions, for operating flour mills, for lighting factories, office buildings, department stores, and for electrical works, etc. Lately they have been applied to the production of power where new and additional equipment is found necessary. It has been found that this engine can be very economically maintained as a reserve for relieving the original units of the peaks of the load and for like purposes.

Efficiency of the Diesel Engine

The efficiency of this type of engine and its characteristics may be readily obtained from the results of a test on a typical Diesel engine doing actual work. This test was conducted by A. C. Scott at the Scott Engineering Co., Dallas, Texas, on a 225 horsepower Diesel engine; the following data have been obtained which will give an excellent idea of the applicability of this engine to the generation of power.

The engine tested operates on the four-stroke cycle Diesel principle. It is a vertical three-cylinder unit, rated at 225 net brake horsepower, with allowance for power necessary to drive auxiliaries. It is directly connected to a Fort Wayne 200 K. V. A., three-phase, sixty-cycle, 2300-volt generator of 164 R. P. M. The auxiliaries consist of one belt-driven three-stage air compressor; one motor for driving compressor, 25 horsepower; and one exciter, 10 K. W., speed 850 R. P. M., belt-driven from the engine.

In many cases the air compressors for the starting and injection of air for Diesel engines are belted from the crankshaft of the engine; or when the compressor is motor driven, the power is supplied from the generator. During the series of tests, the power for the compressor was furnished from an outside source. Therefore, in order to obtain the net available power developed by the engine, readings were taken of the power consumption of the motor driving the compressor and a deduction made from the kilowatt output of the generator. No allowance was made for the efficiency of the motor; so that with the compressor belted to the engine shaft, the fuel consumption per brake horsepower hour would have been less than shown in the results given.

Fuel Oil Used

To obtain the amount of fuel oil consumed by the engine, it was only necessary to weigh the oil fed to the fuel pump, where the amount of oil actually fed to the engine cylinders is automatically controlled by the governor, and varied according to load requirements. For weighing the oil a 15-gallon tank and platform scale were used, and readings were taken at ten-minute intervals. A funnel of sufficient capacity was installed in order that a small amount of oil might be stored ahead of the governor, and the weighing tank properly re-filled with oil.

The oil used for these tests was taken from regular stock in ordinary use in this engine. Samples of oil were taken periodically, and the analysis made upon the total combined samples. The analysis of the fuel oil is given below:

British Thermal Units	18,986 per pound of oil
Specific Gravity, 25.5 degrees C. to 27 degrees C. (78 degrees F. to 81 degrees F.)	0.8531
Viscosity, 33.3 degrees C. (92 degrees F.)	1.63
Flash Point	143.6 degrees F.
Burning (Fire) Point	181.4 degrees F.
Sulphur	0.2 per cent
Water	Trace
Free Acid	None

The cost of this oil was $1.22 per barrel of 42 gallons, delivered; or practically 2.9 cents per gallon.

The instruments used in making the tests were all calibrated before using and due corrections made in the figures obtained. A water rheostat was found entirely satisfactory for the adjustment of all loads.

Tests

Six tests, each of three hours duration, were made with load changed for each hour period as follows:

Test Nos.	1	2	3	4	5	6
Net B. H. P.	2.25	49.7	111.39	162.97	219.63	245.62

Fuel Consumption

The fuel consumption for these various loads was in each instance obtained from an average of the readings taken at ten-minute intervals on the generator and the motor, and the records of oil used also taken every ten minutes. Fig. 2 is a curve showing in pounds the fuel oil consumed per net B. H. P. hour at the various loads. Test No. 1 is not included in this curve, as it was practically a no-load test. This curve was plotted by taking the average readings of output of the generator at the switchboard, corrected for the previously ascertained generator efficiency at the given load. From this was subtracted the actual kilowatt in-put to the motor and the resulting figure reduced to brake horsepower. It will be noted from the above curve, that the consumption of oil per brake horsepower hour increases but very little when the output is decreased from full load to about half load. At full load the fuel consumed was 0.441 pound per brake horsepower hour, or about 6.2 gallons per hundred net brake horsepower hours. When running at practically half load, the fuel consumed was 0.482 pound per brake horsepower hour, or about 6.8 gallons per hundred net brake horsepower hours. At quarter load the engine consumed 10.8 gallons of oil per hundred net brake horsepower hours.

* * *

The largest double-acting pile driver ever built was used for driving concrete piles for the Intercolonial Railway's new pier and shed at Halifax, Nova Scotia. The combined weight of the hammer with follower and follower guide is 24,000 pounds; weight of the ram only, 4000 pounds. The diameter of the cylinder is 14 inches and stroke 36 inches. The hammer drove 1800 reinforced concrete piles 24 by 24 inches square and 37 to 77 feet long.

RATIONAL METHODS IN ENGINEERING EDUCATION*

The work in machine design and construction at the Michigan Agricultural College is under one head. This permits of a superior selection and correlation of subjects. In this way the student, during the last three years of his course in mechanical engineering, has presented to him the fullest possible variety of subjects for design, and the work in the shops and the methods in design are more successfully correlated.

Many men, among others Mr. F. W. Taylor, have objected to the ordinary engineering graduate because of his lack of responsibility, perception and individuality. The endeavor at the college, the work of which is to be described, is to link good commercial practice with theory. The object is to put more seriousness into the teaching of engineering. School terms, such as "plate," are not used in the designation of drawings. The drafting-rooms are real drafting-rooms carried on along lines obtaining in good commercial practice. The main effort is concentrated on making the students more responsible men, and developing individuality and judgment. An endeavor is made to create a more businesslike atmosphere in the college, but the object is not to make engineering less rigid, but more interesting, fascinating and hence more understandable and better assimilated.

These things are done by applying principles as soon as possible after they have been enunciated. The examples are made real, doing away almost entirely with exercise pieces as such, both in the shops and in the drafting-rooms, and designing and building real machines in real ways for real uses. The great variety of machines and tools now being made in the shops permits of selecting in pedagogical order the proper sequence of exercises.

A need on the part of the students is created in exciting their desires by presenting subjects to them, first functionally and then following this by the pure theory underlying the subject at hand. They are led by means of that which is familiar to them, to that which to them has been unknown. The methods of making machines and tools follow the best practice; both processes, that of "building," and that of "manufacturing" in lots and by the use of special tools, jigs, etc., are used. The work differs from the condition in commercial shops only in the time required to produce a machine. The pedagogical order of selection of exercises does not permit of finishing a machine within a definite period. Of course, all of the equipment is not made at the college. The policy is to buy the very best machinery required for very accurate work, as for example, universal milling machines, and to make the general equipment.

In general, seniors and sometimes juniors design the machinery made. The details for the most part are worked out by sophomores. This follows the order in which work is done in the commercial drafting-rooms and it correlates well with the sophomore work in empirical machine design. The problems are attacked just as they would be in the commercial drafting-office. The need is first considered; a general specification sheet is then prepared by the instructor; the specifications are then elaborated by the student in accordance with his individual ideas, after which the final specification is checked and approved. As far as possible the students, in the senior year especially, work on different problems or on the same problem with different specifications. Drafting-room standards have been adopted which are rigidly followed during the three years that the students are engaged in the machine design. This follows good commercial practice.

In connection with the courses in machine design, the shop courses and the course in works management, a series of what may be termed "specialized inspection trips," has been adopted. These are not entertainment trips; nor are the students bewildered by examining all the processes occurring in any one factory. A need is first established such as, for instance, in machine tool design; after the students have endeavored to complete their specifications for, say, a radial drill by reference to a rather complete catalogue file, they find themselves somewhat shaky regarding some of the details. A trip to Lansing is then taken and radial drills, nothing else, are inspected, several different shops being visited.

A course is given in jig and fixture design, not with the idea of making tool designers of the graduates, but to acquaint them with the principles of this most important feature of manufacture. In this course especial emphasis is laid upon working hand in hand with the shop, conferences being held by the student with the machine shop foreman after the student has carefully studied his problem and has formed an opinion as to the best design, but before the work is done on paper. The jigs and fixtures designed are constructed in the shops and used in making the machinery. The courses in design and that in the construction of jigs are carried on simultaneously. The course in works management is also given during the same term, thus correlating three courses that go well together.

The course in works management includes such subjects as location and design of works, organization, costs, wages, labor, etc. The principles are given first and this is followed by a series of lectures on their application in the different departments of a factory. One advantage in giving these applications is to show to the student the relations, duties and limits of these several departments toward one another and to better enable him to fit himself into a commercial plant after graduation. In this course modern methods of production are carefully considered, and the course has enabled a number of the graduates to accept and hold positions along this line.

Efficiency is not only preached but also practiced. Indeed, the great variety and considerable number of machines and fixtures now going through the shops requires some system of checking and following up work, and this is done along approved commercial lines, using order blanks, etc., as in a first-class machine manufacturing plant.

Let us consider a hypothetical case: All orders for machines or tools that are to be made in the shops are issued, in triplicate, from the office of machine design and construction. The drawing numbers are also given here, following a standard system. The order is first issued to the pattern shops, two copies of the orders being sent with the blueprint, and the original being filed in the office under the head of "Orders issued." If the order is urgent, the pattern, when finished, is delivered to the foundry, otherwise to the pattern storage. The pattern number is given by the foreman of the pattern shop, who also has charge of the pattern storage department. The numbering system adopted at once locates the piece on its shelf. The pattern number is marked in red pencil in its proper place on the bill of material by the foreman of the pattern shop and the blueprint returned to the office with the one copy of the production order which has received the signature of the one to whom the pattern was delivered and filed under the head of "Orders filled." The second copy of the order is retained by the pattern shop. The pattern number is then put on the tracing and the casting production order is issued.

A "work order" card is also used, by means of which the shop can keep a record of the students' work, waste and efficiency, and the student is able to compare his time with that of a mechanic under similar conditions in a commercial shop. He can also obtain the shop cost of the work done, and thus have an idea of production values. The cost value of an automatic machine or special tool, such as a jig, and the rate at which the pieces to be machined could be turned out with the refined equipment, the time cost of the operation, etc., are studied. The student is thus enabled to study production while producing, and without expenditure of time.

Some of the machines now under construction are: six 14-inch engine lathes; a number of pattern lathes; a planer; a keyway slotter; two one-ton pneumatic hoists; a triplex power pump; a disk grinder; a steam hammer; a punch and shear; a star feed for a boring mill; and a vertical slotting attachment for the universal milling machine, and a great number of jigs, tools, and fixtures.

* Abstract of a paper read by Prof. Edward J. Kunze, assistant professor of mechanical engineering, Michigan Agricultural College, East Lansing, Mich., before the Michigan Engineering Society.

INVENTING MACHINES TO MAKE INVENTIONS MARKETABLE

SOME INTERESTING FACTS ABOUT INVENTIONS AND A FEW POINTS THAT THE INVENTOR USUALLY OVERLOOKS

BY E. R. MINER*

Probably ninety-eight out of every hundred men have, at times, dreams of becoming great inventors. Such dreams are usually colored by visions of some epoch-making discovery which will bring both fame and fortune. As a matter of fact, and according to history, the epoch-making discoveries have made comparatively few fortunes for the inventors. The fortunes have come to others after a long period of improvement, elimination and practical trial. Where there is one Alexander Graham Bell or Thomas Alva Edison, there are a thousand unknown and unremembered inventors. Inventors, as the old saying has it, may be born, but successful inventions are matters of pure business, the gradual evolution of new dresses for old ideas, the working out of new methods, new goods, and new applications to meet recognized trade requirements.

Whereas the large fortunes which have been made by some great and timely discovery or invention can be counted on the fingers, the moderate fortunes which have been made by inventing some small article of practical and everyday use are not only numerous, but are well represented in all sections of the country. To merely invent something is not nearly as hard as knowing what to invent. Nearly any mechanic, if turned loose in a shop, could manage to invent things, but it would only be the occasional and exceptional man who would invent things which had a money value. The really new things or the radical changes are often the ideas of persons who have but a surface knowledge of the business to which their invention applies. Not being bound by custom or by recognized methods or previous experience, they draw upon their imagination or inventive faculty. Lack of practical knowledge often does give that twist to the imagination which results in the new idea, but usually there must be a long period of experiment and the bringing into play of practical knowledge to make the idea successful.

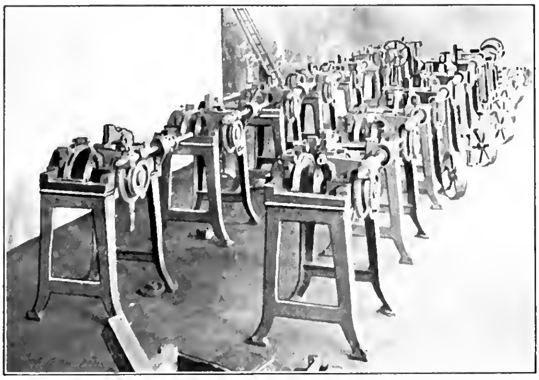


Fig. 1. A Battery of Sixteen Hair-pin Machines on the Assembling Floor in the Factory where built

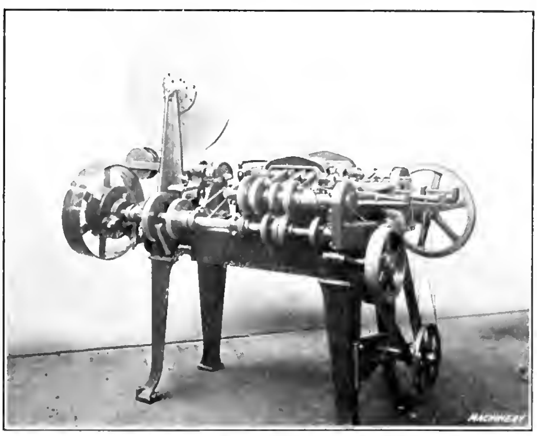


Fig. 2. A Pin Ticket Machine which prints the Ticket and makes and attaches the Pin for Tickets used on Clothing, etc., in Stores

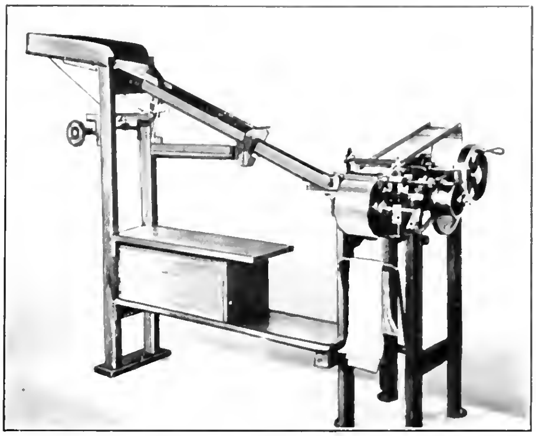


Fig. 3. Pin-sticking Machine which counts the Pins and sticks them into Papers

An electric lineman might be employed for twenty years in stringing heavy electric cable, yet his duties seem so commonplace that he never suspects or thinks that a large business could be created in making the clips or hooks which fasten the heavy cable to the supporting wire. The stranger, or possibly the young engineer who has charge of the line gang, being more or less unfamiliar with the work, notices the great number of clips or supports used. He also notices that the lineman cuts off a section of wire for making these clips, and immediately the idea is born as to why these pieces could not be manufactured more cheaply, more uniformly, or better, by machinery.

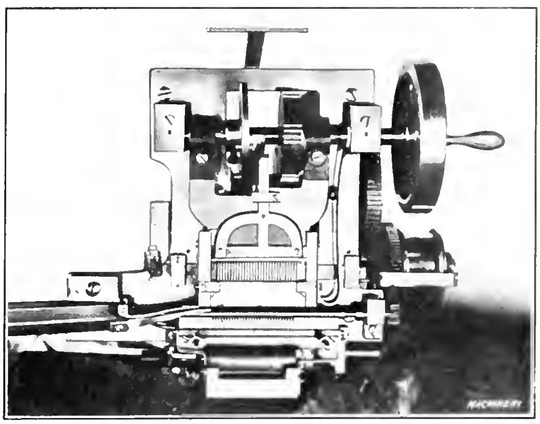


Fig. 4. Top View of the Principal Part of the Pin-sticking Machine shown in Fig. 3

To successfully follow out such an idea, it is important to understand trade conditions, to know what the possible market would be, what price they would have to be sold at, what saving in labor or cost such article would represent, and after designing a clip which would meet all requirements, to know that a machine could be made for manufacturing such a clip both rapidly and cheaply. The failures in the invention business have been mostly by reason of the inventor going ahead on some idea which appealed to him personally, but on which his actual information was very small.

So apparently insignificant a product as the hairpin illus-

* Address: Box 315, Bridgeport, Conn.

trates in a simple manner the development of an idea into an industry. Wild thorns, sharpened sticks and shaped pieces of bone or shell were the original hairpins. Later on, the goldsmiths turned out by hand various devices in the way of bands and pins for holding the hair. The inventor of the wire hairpin is unknown, but the original hairpin was probably a piece of wire bent over in the center to form two straight legs of equal length.

The practical man stepped in, and understanding the various deficiencies of the hairpin as it existed, began to make improvements until today there are dozens of patents covering the point on the pin, the crimping or waving of the wires, the general shape, and other features which presumably make the hairpin better for the purpose intended. From this development, there proceeded the development of machines for manufacturing them. A hairpin made by hand or one requiring considerable manual labor would be a hairpin of rather high cost. As a consequence, the sales would be restricted. With automatic machinery, the hairpin becomes an article where cost is reduced to a mere trifle over the cost of the raw material, and as a consequence, it becomes an article of everyday necessity. A modern hairpin machine, depending upon the size and kind of the pin, will turn out from 75 to 200 per minute. At least one modern hairpin manufacturing company making nothing but hairpins keeps 75 machines running continuously with a general average of 100 per minute or 6000 per hour for each machine.

The improvements, the attachments, and the small changes that make a thing practical, make it conform to the requirements of the trade, and generally whip it into shape, are made by those who are thoroughly familiar with the business in hand and know what will be required by trade usage. There are very few inventions that ever have or ever can immediately revolutionize conditions, trade, methods, or things in general. A design or invention that is different beyond a certain point is held up to ridicule as a freak, and regardless of actual merit, it may be years before the public will accept such a design or invention at its true worth.

Wise manufacturers seldom put out freaks, but rather keep to their general design, making small changes here, and others there, until the trade is led to accept a freak as an outgrowth of gradual improvement. Few inventors see the reasonableness or business policy in this. The true inventor would immediately revolutionize business. He forgets the interests of those who have money tied up in a competing article, and would stuff his invention into the hands of every member of the trade. Admitting that an invention had real and superior merit, this, without previous education, is not a selling point. One shotgun might be so superior to another shotgun that there would be no comparison, and yet there would be no argument that would influence the man whose knowledge of shotgun requirements could not grasp the technical difference. To him they would both be shotguns.

To the general public, inventions that are radically new are things to let the other fellow fool with. This characteristic of the public will account for about one-half of the failures of inventors to put a really meritorious article on the market. The inventor, therefore, to be successful in a financial way, should be a business man. He should be broad in mind, and willing to see things as they exist, and not as he would have them. He must recognize that all things must be manufactured, and to be of any pecuniary benefit, they must be sold. To be sold, a product must adhere more or less to certain well defined standards. Such standards can be gradually altered, but they cannot be rushed at and immediately overthrown. In addition, to be manufactured at a cost which will admit of selling at a price which will be acceptable to the public and yet admit of a profit, special machinery or special applications of standard machinery may be necessary.

Successful invention (and by successful invention we mean invention which brings financial return to the inventor) is a business which requires close study of trade conditions and the possible demand brought about by modern improvement. The man who invents a garter clasp or a new type of hairpin, and can get them on the market in a proper manner, stands a better chance of being adequately rewarded than he who struggles for many years in an effort to build some type of a great power turbine.

There have been fortunes made on pins and other fortunes on hooks and eyes, but such fortunes have been built through a universal demand that called for quantity, and the popularity of these goods and immense sales for them have been created by reason of their very small retail cost. This low cost is made possible by automatic machinery that takes the wire or metal from a reel, feeds it through the machine, and drops out the completed article. Without such machinery, neither the pin business nor the hook and eye business would be possible, and the general public would still be using the makeshifts of our ancestors.

The inventor of the hook and eye or the inventor of the pin probably could not design a machine for making them, and they must perforce go to other inventors who could build one for them. Like thousands of other things, the hook and eye was an idea. Properly made and properly put on the

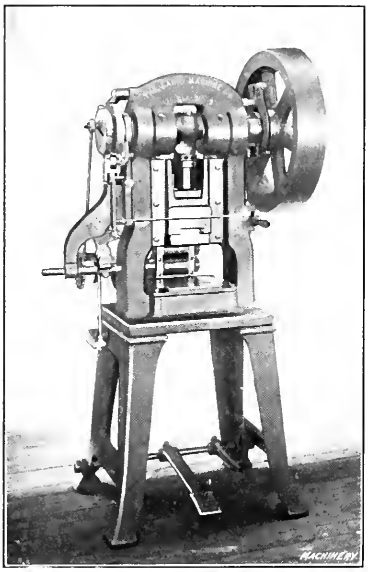


Fig. 5. A Roller Feed Automatic Press performing Half a Dozen Operations and provided with Automatic Stop

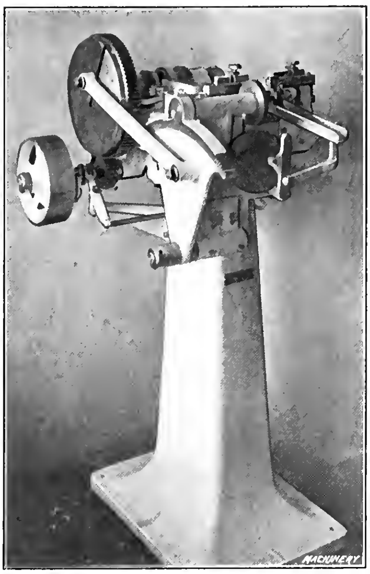


Fig. 6. A Spring Winding Machine which receives Wire from the Coil and completes Springs at the Rate of 150 per Minute

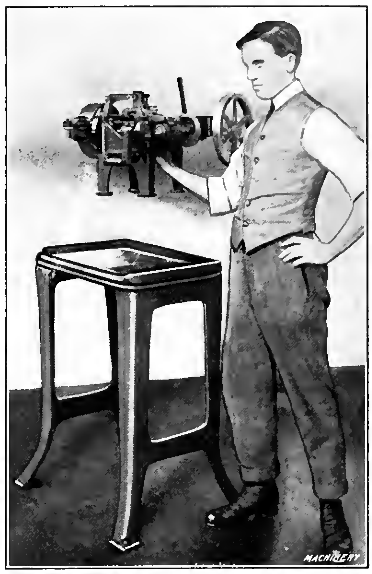


Fig. 7. Paper Clip Machine which turns out Finished Clips at the Rate of 450 per Minute

market, it was a builder of fortune, but it required the machinery back of the hook and eye to make such an idea successful.

The machine part of the proposition is really the fundamental basis for success. Fish-hooks would still be made by hand and at home by those who use them were it not for the automatic machines which turn them out so rapidly and at so low a cost that it would be a foolish waste of time and energy for anyone to attempt competition by older methods, even for their own use. The dollar watch is made possible through the design of special machinery. Even the automobile might still be an idea were it not for the machine builders who have made the rapid and uniform manufacture of the various parts possible.

Whether the article be a suspender buckle or a gas engine, the very first essential of operation will be "How can it be manufactured?" Financial success may entirely depend upon the answer to this one question. Throughout the New England states, that "Yankee district of the country so well known for its ingenious contrivances," there are shops which could be well called "inventors' factories." Probably the oldest of these, and perhaps the largest, is located in Bridgeport. To go through this factory is a liberal education on the

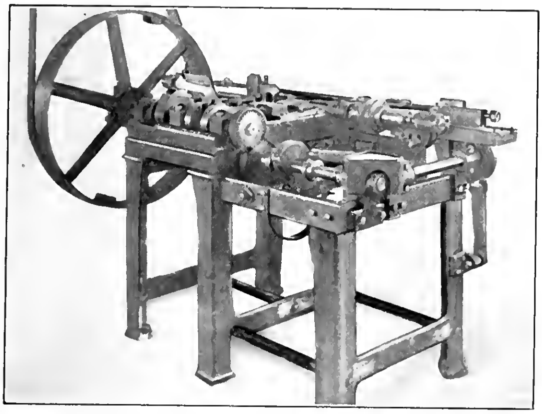


Fig. 8. Machine for making Hinges for Pianos

reduction of cost in manufacturing methods. The founder was the inventor of the original pin sticking machine, which counts the pins and sticks them in papers, so many pins to the row, and so many rows to the paper. A comparatively simple contrivance, it revolutionized the pin business, and is used in every country where pins are manufactured. It was the machine in this case that put into the hands of the manufacturers a popular, easily handled package for the retail sale, while at the same time making a reduction of cost in handling.

There is practically no industry today where the machines for making some part of the product are not the real factors of success. We hear of the inventor of a typewriter or of some other product, but we never hear of or give a thought to the inventor of special machines and special attachments which make the manufacture of the typewriter or product possible. And in the same way, there are manufacturers of special machinery whose factories are probably unknown to the general business man, yet special machines of their design are in every corner of the world, and turning out completed products or parts for pretty nearly every line of business.

A recent visit to one of these factories showed on the testing floor, having a final try-out before shipment, the following machinery: An upholstery tack machine, a form of press which pulled wire off a reel on one side, flat metal from a coil on the other side, and delivered large round headed upholstery tacks at the rate of 125 per minute; a patent thumbtack machine biting pieces out of a coil of flat brass and dropping those aids to the drawing board at 135 per minute; a butt hinge machine rolling off hinges faster than one would want to stand and count them; an electric lamp socket machine assembling the brass and porcelain sections at the rate of 60 per minute; a hook and eye machine spinning wire off a coil and dropping the familiar hump hook at 225 per minute; a paper clip machine making 300 clips per minute; a hairpin machine; a machine for making screw-on jar tops; a machine for making the wire guards for lanterns; a machine for making wire clothespins; a machine for making bed springs; a machine for making small springs; an eyelet machine for glove fasteners; a safety pin machine; a pin ticket machine for clothing; a machine for making, printing, and coating with paraffine the paper caps for milk bottles; a capping machine for beer bottles; a bucket machine; a garter clasp machine; and a great variety of wire and metal bending and forming machines.

Often a single machine will be found adequate to supply a whole industry. At the speed of 100 per minute, there is a total of 50,000 to 60,000 pieces to represent a ten-hour day. Now, 60,000 pieces per day for 300 days in the year often represents a greater quantity than can be disposed of, and there are cases where one machine pays good dividends, and is run perhaps only half or quarter of the time.

Work which is done by hand represents labor charges. It, also, if fairly large quantities are wanted, represents lack of uniformity and interchangeability. High labor charges require a high selling price, and the higher the price, the more restricted the field. Bring machinery into the question, and the labor charges for a single piece drop, the selling price drops with it, the selling field is enlarged, and the greater quantity demanded increases the business and produces a larger net profit. The machine or manufacturing part of a proposition is often lost sight of by reason of the ingenuity shown in a device, or its evident salability. Wrecked hopes are the reward of such short sightedness. The world may be waiting for a device to accomplish a certain purpose, but it will continue to wait if the price is beyond certain set limits.

There are hundreds of men earning a most excellent income by devising practical improvements for everyday products. These men do not always know all the angles regarding the particular product they may be working on, but they waste but little time on developing an idea until they know the probable market price, the quantity likely to be sold, and that it can be manufactured for the price by machinery.

* * *

REWARD FOR A RUBBER TIRE SUBSTITUTE

The Austrian War Department has offered a prize of $10,000 to be awarded to the person who with adherence to certain prescribed conditions will construct an elastic tire for motor trucks which possesses essentially greater durability, or, with equal durability, the attribute of essentially smaller cost of construction than the rubber tire, having, in addition, the properties of elasticity and adhesiveness of pure rubber. The weight must not exceed that of a pure rubber tire. Competitors must hand in a model of the fabric in natural or reduced size, together with drawing and description, before June 30, 1914, to the Automobil-Versuchsabteilung (Automobile Trial Division), VI., Gumpendorferstrasse 1, Vienna, Austria. Further details may be found in the *Militarische Rundschau*, published at I. Graben 23, Vienna, and to be had also on application, in German, to the K. K. Kriegsministerium, Vienna, Austria.

* * *

A tap is a tool for cutting internal threads. Its efficiency does not depend on a highly polished shank, nor should its sale be affected by the characteristics of superficial finish. The fact is, though, that tap makers generally bestow a great deal of care and labor on superficial finish because of the prejudices of the average run of customers. A maker of forged pipe taps—having forged flutes and squares—leaves the flutes and square black after hardening but imitates the shape of milled flutes in order that purchasers shall not be adversely influenced by the too obvious fact that they are forged. As a matter of fact a forged flute tap should be better than when cut from the solid.

NOTES AND COMMENT

It is reported that Prof. Lummer, of Breslau, Germany, has discovered a method of obtaining carbon in a liquid condition. Leading scientists believe that the possibility of producing liquid carbon will also make it possible to produce artificial diamonds by its crystallization.

The Brown-Boveri Works, in Switzerland, are constructing what is claimed to be the largest electro-steam turbine set built. The group is of about 30,000 kilowatt and is intended for the Mark electric station at Westphalia. It is expected that steam turbines in single units of as high as 50,000 or 60,000 horsepower will be constructed within the near future.

It is stated in *Engineering* that sample pieces of cast-iron pipe that have been taken up after having been in use from sixty to seventy years have been found to be practically as good as new. Many cast-iron piping systems are in use in England that were laid eighty years ago. There are some cases known where cast-iron pipes have been in service for 250 years.

The postoffice and post roads committee of the House of Representatives, on December 8, approved a bill appropriating $100,000 of the annual postoffice budget. This will be used for purchasing a number of postal cars to be operated as an experiment from which to determine the advisability of owning and operating all such cars, instead of renting them from the railroads.

The world's greatest railway tunnels are in Europe, and a brief summary of these in the *Engineer* shows that the greatest is Simplon, which is 12¼ miles long. The St. Gothard and Lotschberg tunnels are over 9 1/3 miles long, whereas the Mont Cenis is a little over seven miles long. The Arlberg, in Austria, is 6¼ miles long. The longest tunnel in this country is the Hoosac, which is 4 1/3 miles long.

The gas-engine manufacturing business is reported to be in a flourishing state in Germany. The largest of the companies has a capital of 20,000,000 marks ($5,225,000) and paid a dividend of nine per cent on this capital during the past year. The total value of the manufacturing during the year was $6,190,000. Wages continue to increase, the total increase per man per day since 1906 amounting to over forty-five per cent.

The Russian aviator and aeroplane designer, Sikorski, has built a giant biplane weighing about 7000 pounds. The new machine, it is said, is propelled by four motors of 100 horsepower each, and the biplane is claimed to have a carrying capacity of twenty people, cabins with sleeping accommodations being provided. On the trial trip, the machine rose into the air after a run along the ground of 100 yards and circled the grounds without difficulty.

Electric furnaces for the ordinary steel foundry are now being regularly built and are claimed to give good results, electric melting having many advantages from a metallurgical standpoint. The new electric furnaces are made as nearly automatic in action as possible and many improvements in their design have been introduced during the last few years, so that it is claimed to be easier at present to get good results from an electric furnace than from the ordinary type.

Lomax is a planned city in Henderson Co., Ill., which will have some novel and interesting features for manufacturers. The founders have planned for shipping facilities, power, labor and living conditions. They propose to give each manufacturing plant free power for at least ninety years on the basis of one horsepower for each male employe, charging for additional power at the rate of twenty dollars per horsepower for a year. Workmen's houses will be rented on the basis of two per cent of the actual cost and the workman will be given a chance to buy and build on small reservations without cash.

An English method of treating metal case bullets and projectiles so that the bore of the rifle will become, after continued firing, even more highly polished than a new barrel, is described as follows: Bullets or the driving bands of projectiles are first roughed by means of sand-blast. They are then treated with sodium silicate (water glass) dissolved in water. In this solution kaolin is also suspended. After the water glass has dried on the bullets, they are given a protective coating of paraffine or shellac varnish and, in addition, the bullets are given a thin coating of a lubricant such as beeswax.

The Institution of Mechanical Engineers of Great Britain has instituted a fund for the purpose of giving financial aid to prominent members who, through no fault of their own, are in poor circumstances. About $20,000 has already been contributed to this fund. The idea is to keep the fund invested and to use only the income for relief. Engineers who have held high rank in the profession and to whom the engineering field as a whole may be largely indebted may be so placed in their declining years that aid from a fund created by fellow members in the profession may be necessary and acceptable.

A new method of obtaining a black rust-proof finish on iron or steel has recently been patented by F. Richards of Coventry, England, (United States patent 1,069,903). The process can be applied to hardened steel because the work need not be heated above the boiling point of water as is necessary with some of the other black-finish processes. A solution is made of 120 gallons of water, 3 pounds of manganese-dioxide, and one-half pound of concentrated phosphoric acid. This solution is placed in a suitable receptacle and heated to the boiling point. The iron and steel articles which have previously been cleaned are placed in the solution for from thirty to ninety minutes, after which they are removed, wiped and oiled with linseed oil.

In a recent lecture given at London, England, by Mr. Richard Kerr, the title of "Father of Wireless Telegraphy" was given to James B. Lindsay, who was born in 1799 and died in 1862. This man, a not too-prosperous schoolmaster at Dundee Gaol, with a salary of £50 ($250) per year, made his own batteries and coils and sent wireless messages across the Tay and other Scottish rivers and lakes as well as across the Solent. He is said to have declared that if he only had the means to extend his experiments there was no reason why he could not send messages across the Atlantic. It was essential to the Lindsay system that there be a stretch of water between the transmitter and the receiver. Lindsay was a man of remarkable genius, but sometimes turned his energy to rather peculiar accomplishments. He died while engaged in the compilation of a dictionary on fifty languages, and was at that time regarded by his neighbors as "nutty."

Hydrogen compared to air in weight is near the irreducible minimum of the highest vacuum. There is little to hope for in reducing the bulk of dirigible balloons from the use of a much lighter gas. But an astronomer who makes the claim that the upper atmosphere of the earth is composed of coronium, a gas considerably lighter than hydrogen, suggests its use as a substitute for the latter in balloons. Inasmuch as the coronium gas is estimated to be mostly at a height of 135 miles, there is little prospect now of ever gathering it from its native "heath" in appreciable quantities. But if it could be obtained the gain would be small. At sea level and sixty degrees F. temperature, hydrogen gas weighs about 38 grains per cubic foot while air at the same pressure and temperature weighs 540 grains. The buoyancy of hydrogen is due to the difference between its weight and that of the same volume of air. The buoyancy of one cubic foot of hydrogen, then, under the given conditions is $540 - 38 = 502$ grains. If hydrogen could be replaced by a gas weighing one-fifth as much, the gain in buoyancy would be 30 grains per cubic foot, or only six per cent.

HOBBING VS. MILLING OF GEARS*

A COMPARATIVE STUDY OF THE TWO METHODS FROM THE POINT OF VIEW OF BOTH QUALITY AND QUANTITY

BY JOHN EDGAR†

The adverse criticism of the gear hobbing process has been the cause of many interesting investigations, and one of the most important of these has been the comparative study of the condition of the surfaces produced by the hob and by the rotary cutter. In making such a comparative study, it is necessary that the investigator possess the required practical knowledge, and also that he be willing to admit a point, even though his favorite processes may suffer by the comparison.

Feed Marks produced by Rotating Milling Cutters

While both the gear hobbing machine and the automatic gear cutter use rotating cutting tools, the operations cannot be placed on a common basis and considered as similar milling operations, although they may, to a certain extent, be compared as such. In comparing the quality of the surfaces produced by the two processes, consider first the milled surface produced by an ordinary rotary cutter. This surface has a series of hills and hollows at regular intervals, the spacing between these depending upon the feed per revolution of the cutter, and the depth on both the feed and the diameter of the cutter. The ridges are more prominent when coarse feeds and small diameter cutters are used. These feed marks are the result of the convex path of the cutting edge and the slight running out of the cutter, which is inevitable in all rotary cutters with a number of teeth. As is well known to those familiar with milling operations, the spacing of the marks does not depend on the number of teeth in the cutter. Theoretically, it should depend on this number, but as it is practically impossible to get a cutter which will run absolutely true with the axis of rotation, only one mark is produced for each revolution, and, hence, the spacing becomes equal to the feed per revolution. The eccentricity of the cutter with the axis of rotation is, therefore, the factor which, together with the diameter of the cutter and the feed per revolution, determines the quality of the surface, other conditions being equal.

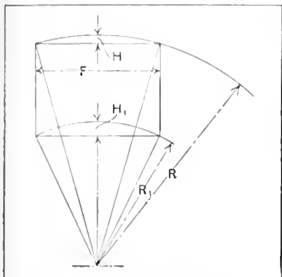


Fig. 1. Diagram illustrating the Relation between Feed, Diameter of Cutter and Depth of Feed Marks

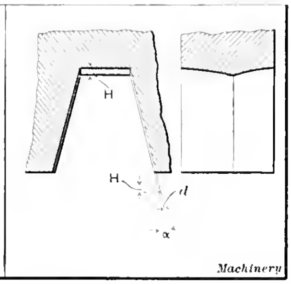


Fig. 2. Diagram for finding Depth of Feed Marks on Side of Tooth cut by Milling Cutter

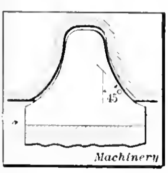


Fig. 3. Angle which limits the Feed

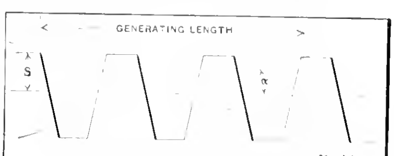


Fig. 4. Diagram for deducing Formulas for analyzing Action in Gear Hobbing Machine

The depth of the hollow produced by the high side of the revolving cutter is equal to the height or rise of a circular arc, the radius of which equals the radius of the cutter, and the chord of which equals the feed per revolution. (See Fig. 1). The length of the chord or the feed per revolution may be expressed:

$$F = 2 \times \sqrt{2\ HR - H^2}$$

in which F = feed per revolution;
H = height of arc;
R = radius of cutter.

Since H^2 is a very small quantity, it may be discarded in the expression, which is then simplified to read:

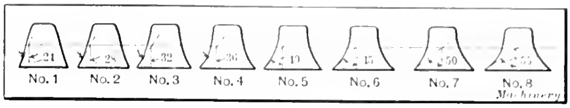


Fig. 5. Angles limiting the Feed for 14½-degree Standard Gear Cutters

$$F = 2 \times \sqrt{HD}$$

in which D = diameter of cutter.

Transposing this expression, we obtain $H = \frac{F^2}{4D}$, which is an approximately correct expression of the depth of the hollows produced by milling. As an example, take an 8-pitch rack cutter, with straight rack-shaped sides, 3 inches in diameter, milling with a feed per revolution of 0.1 inch. The depth of the feed marks at the bottom of the cut will be equal to:

$$\frac{(0.1)^2}{4 \times 3} = 0.00083 \text{ inch.}$$

The working surface of the tooth, however, is produced by the side of the cutter, as illustrated in Fig. 2, and the depth of the feed marks is normal to the surface, and is expressed as:

$$d = H \times \sin \alpha$$

in which d = depth of the feed marks on the side of the tooth, and α the angle of obliquity. In the example given, the depth d would equal 0.00021 inch, for a 14½-degree involute tooth.

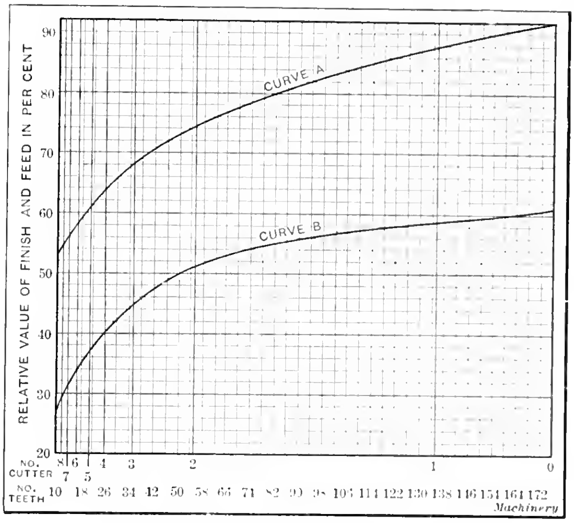


Fig. 6. Diagrams showing the Relation between Feed, Finish, and Number of Teeth when cutting Gears with Formed Gear Cutters

The depth of the feed marks is inversely proportional to the diameter of the cutter, and is, therefore, greater at the point of the tooth than at the root. In the example given, the depth would be 0.00025 inch at the extreme point of the rack tooth. It is thus apparent that the quality of the surface at any position along the tooth from the root to the point depends upon the diameter and form of the cutter and the feed per revolution.

In Fig. 3 is shown the outline of a No. 6 standard 14½-degree involute gear cutter. This outline, at the point close

* See also MACHINERY, July, 1912, engineering edition, "Hobs for Spur and Spiral Gears," and the articles there referred to.
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to the end of the tooth of the gear, is a tangent inclined at an angle of 45 degrees, as indicated. Hence, the depth of the revolution marks is:

$$\frac{(0.1)^2}{4 \times 2.5} \times \sin 45° = 0.000707 \text{ inch, instead of } 0.00024 \text{ inch, as}$$

in the case of the straight rack tooth. It is evident that to produce an equal degree of finish with that left by the rack cutter, the feed must be considerably less for a No. 6 involute gear cutter than for the rack cutter. In Fig. 5 is shown the full range of cutter profiles from Nos. 1 to 8, with the angle of the tangent in each case which determines the quality of the surface under equal conditions of feed and diameter of cutter.

If the depth of the feed marks is used as the determining factor in comparing the condition of the surfaces produced by a series of cutters, it is evident that if the surface produced by the rack cutter is taken as a standard, the feed for cutting a pinion must be considerably less than the feed used for cutting gears with a large number of teeth. In fact, if a rack cutter is fed 0.100 inch per revolution, a No. 8 standard involute gear cutter should not be fed more than 0.055 inch per revolution to produce an equally good surface. The feed is proportional to the square root of the reciprocal of the sine of the angle of the limiting tangent.

If we assume the accuracy of the surface left by the straight-sided rack cutter as equal to 100 per cent, then the relative feeds required for cutting gears with any formed cutter can be calculated. This has been done, and the results are shown plotted in curve A, in Fig. 6. This curve is based on an equal depth of the feed marks for the full range of numbers of teeth in the gears. If, on the other hand, the surfaces left by the cutter for a given feed per revolution are compared, the depth of the feed marks will vary with the sine of the angle of the limiting tangent, and taking the straight-sided rack cutter as a basis, the relative accuracy of the surfaces is inversely proportional to the sine of the angle, and is plotted in curve B, in Fig. 6.

Comparison between Surfaces produced by Milling and Hobbing

A relation has now been established between the quality of the surface and the permissible feeds for cutters for cutting gears with any number of teeth. We will now consider the condition of the surface produced by a hob in a gear hobbing machine. The hob is made with straight-sided rack-shaped teeth and with sides of a constant angle, and is used

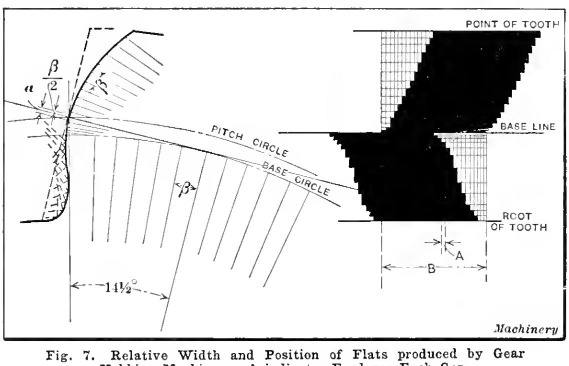

Fig. 7. Relative Width and Position of Flats produced by Gear Hobbing Machines. A indicates Feed per Each Generating Tooth; B, Feed per Revolution of Blank

to produce gears with any number of teeth. We may therefore assume that it is cutting under the conditions governing the rack cutter, as just explained, the surface produced being considered merely as a milled surface. If this assumption be correct, then the quality of the surface produced by a hob, whether cutting a gear of twelve teeth or of two hundred teeth, will be the same for a given feed, and the same relation exists between the hob and any formed cutter that exists between the rack cutter and any formed cutter; hence, curves A and B, in Fig. 6, may be assumed to show the permissible feeds and the quality of the surfaces produced by formed cutters when compared with the surfaces produced by a hob, provided the surfaces are considered merely as milled surfaces. However, a condition enters in the case of the hob which has no equivalent in the case of the formed milling cutter, and this influences the condition of the surface. This condition is the distortion of the hob teeth in hardening which causes them to mar the surface of the tooth by "side swiping," producing a rough surface. The eccentricity of the hob with the axis of rotation also has a different effect on the surface than in the case of a formed gear cutter. The effect is shown in a series of flats running parallel with the bottom of the tooth, if excessive; if the eccentricity is small, the effect will merely be to round the top of the tooth. These inaccuracies, however, can be taken care of in a number of ways.

Comparison of Output

For reasons not connected with the quality of the surface, the hob may be worked at a greater cutting speed and feed

COMPARISON OF TIME REQUIRED FOR CUTTING GEARS ON AUTOMOBILE GEAR CUTTING MACHINES AND HOBBING MACHINES

Number of Teeth	Automatic Gear Cutters		Gear Hobbing Machines	
	Feed, Inches	Time, Minutes	Feed, Inches	Time, Minutes
32	0.022	15	0.050	6.5
31	0 020	19	0.050	9
24	0.024	22	0.050	6
17	0.020	8	0.050	4
17	0.020	17.5	0.050	5
16	0.018	10.5	0.050	7
13	0.013	6.25	0.050	6

Machinery

than a rotary cutter, when cutting from the solid, the reason being due to the generating action of the hob which results in the breaking of the chips. This preserves the cutting edges and reduces the heating effect of the cut, and explains why the hob may give such good results as compared with a rotary cutter in the matter of output. It is possible to get good results in the general run of work in the hobbing machine in one-third to one-half of the time required in an automatic gear cutter. The accompanying table gives the results obtained on automobile transmission gears with automatic gear cutting machines and hobbing machines. If anything, the conditions under which the comparisons were made favored the automatic machines. The speed of the cutter in all cases was 120 revolutions per minute, except in the case of the 13-tooth pinion, when the speed was raised to 160 R. P. M. to increase the output. The hob was run at a speed of 105 R. P. M., in all cases. The hob and cutters were of practically the same diameter. The results were obtained in producing an ordinary day's work and clearly indicate the advantage of the hobbing process over the milling process, when the quality of the tooth surface alone is considered, on the basis that both processes produce a milled surface.

The Tooth Outline

Going further into the subject, we will take up the question of the tooth outline. The tooth of a gear milled with an ordinary milling cutter must be, or at least is expected to be, a reproduction of the outline of the cutter, and since each cutter must cover a wide range of teeth, the outline is not theoretically correct, except for one given number of teeth in the range. Theoretically speaking, the outline of the hobbed tooth may be considered as a series of tangents, the tooth surface being composed of a series of flats parallel with the axis of the gear. To show the significance of these flats, assume, for example, that a gear with thirty-two teeth is cut with a standard hob, 8 pitch, 3 inches in diameter, having twelve flutes. The length of the portion of the hob that generates the tooth surface is $2\ S \div \tan\ \alpha$, where α is the pressure angle, as indicated in Fig. 4. The number of teeth following in the generating path is:

$$\left(\frac{2\ S}{\tan\ \alpha} \div \text{circular pitch}\right) \times \text{number of gashes.}$$

In this case, the generating length is approximately 0.96 inch, and there are thirty teeth in the generating path. The flats of those parts of the tooth outline which each of the hob teeth form vary in width along the curves. They are of

minimum width at the base line and of maximum width at the point of the tooth. The width of the flats at the pitch circle is proportional to the number of teeth in the gear, the number of gashes in the hob, and the pressure angle. The angle β, to the left in Fig. 7, which is the angle between each flat, is proportional to the number of teeth in the gear and the number of gashes in the hob. In the example given, it is:

$$\beta = \frac{360 \times \dfrac{0.96}{3.1416 \times 4}}{30} = 0.91 \text{ degree, or 55 minutes.}$$

The Width of Flat Produced

The width a of the flat at the pitch line is equal to twice the tangent of one-half β times the length of the pressure line between the point of tangency with the base line and the pitch point, and is:

$$a = 2 \tan \tfrac{1}{2} \beta \times \tan 14\tfrac{1}{2}° \times 2 = 0.0081 \text{ inch.}$$

This is not a flat that could cause serious trouble. As in the case of the feed marks, it is not the width of the flat alone that is to be considered, but the depth must be taken into account; in fact, the quality of the surface may be spoken of as the ratio of the depth to the length of the flat. The depth of the flat is the rise or height of the arc of the involute and is approximately proportional to the versed sine of the angle $\frac{1}{2}\beta$, and with the pitch assumed in the example given, would be 0.000015 inch. It is difficult to conceive of any shock caused by this flat, as the gear teeth roll over each other. The action of the hob and gear in relation to each other further modifies the flat by giving it a crowning or convex shape. In fact, the wider the flat the more it is crowned. This explains the fact that hobs with a few gashes produce teeth of practically as good shape as hobs with a large number of gashes. It is desirable, therefore, to use hobs with as few gashes as possible, because from a practical point of view the errors of workmanship and those caused by warping in hardening increase with the number of flutes.

A peculiar feature of the hobbed tooth surface is shown to the right in Fig. 7, which illustrates the path on a tooth produced by a hob in one revolution. In fact, there are two distinct paths, the first starting at the point of the tooth and working down to the base line, the cutting edges of the hob tooth then jumping to the root of the tooth and working up to the base line, producing the zigzag path shown.

Conclusion

That the flats so commonly seen in the results obtained from the hobbing machine are not due to any faults of the process that cannot be corrected, but are due to either carelessness on the part of the operator in setting up the machine without proper support to the work or to the poor condition of the hob or machine, and that nearly all cases of flats can be overcome by the use of a proper hob, may be assumed as a statement of facts. When the hobbing machine will not give good results, the hob is in nearly all cases at fault. If a gear is produced that bears hard on the point of the teeth, has a flat at the pitch line or at any point along the face of the tooth, do not think that the process is faulty in theory, or that the machine is not properly adjusted, or that the strain of the cut is causing undue torsion in the shafts, or that there is backlash between the gears in the train connecting the work and the hob; these things are not as likely to cause the trouble as is a faulty hob.

After an experience covering all makes of hobbing machines, the writer has come to the conclusion that the real cause of the trouble in nearly every case is a faulty hob. Machine after machine has been taken apart, overhauled and readjusted, and yet no better results have been obtained until a new and better hob was produced. The faults usually met with in hobs were referred to in an article, "Hobs for Spur and Spiral Gears," in MACHINERY, July, 1912. The means for getting the hob into a good working condition were explained in the same article. It is not desired in any way to disparage the formed cutter process in favor of the hobbing process, but simply to state the facts as they appear. In every case, practice seems to substantiate the conclusions arrived at.

CALCULATIONS FOR ROLLER CHAIN DRIVES*

BY O. M. BARTLETT†

There is much that is still to be learned about the action of a roller chain upon its sprockets when running at high speed. Systematically tabulated data bearing on the durability of chains under various conditions of linear velocity, angular velocity, chain pull and numbers of teeth on the sprockets are very meager, and no conclusions have yet been reached by which it is possible to predict the behavior of a given chain under unusual conditions. With a light, steady load, short pitch, and large sprockets, chains have run with perfect satisfaction at speeds as high as 4000 feet per minute; while with heavier loads, and sprockets with but few teeth, chains have been wrecked in a short time at speeds not exceeding 1200 feet per minute.

Under ordinary conditions, however, certain rules derived from experience can be used for chain drives where the speeds range from 400 to 1200 feet per minute. Within these limits the load that can safely be carried by the chain varies inversely as the chain speed. That is, if a chain can work safely under a tension of 400 pounds at a speed of 600 feet per minute, the safe working load at 1200 feet per minute would be only 200 pounds. The load that a chain can carry should be based upon the projected wearing surface of the rivet, and not upon the ultimate strength of the chain. To find the projected rivet area of a chain, multiply the rivet diameter by the length of the bushing. To find the approximate horsepower of a chain for speeds between 400 and 1200 feet per minute, multiply the projected rivet area by 24. This is based upon an allowable pressure of 1000 pounds per square inch of projected rivet area at a speed of 800 feet per minute and of 2000 pounds at 400 feet per minute. To select a chain for a given horsepower, divide the horsepower by 24. The result is the projected rivet area (approximately) of the required chain expressed in square inches.

PITCHES OF CHAINS FOR VARIOUS HORSEPOWERS

Pitch of Chain, Inches	Type of Chain	Horsepower at 400 to 1200 Feet per Minute	Pitch of Chain, Inches	Type of Chain	Horsepower at 400 to 1200 Feet per Minute
1	Solid blocks	$\frac{1}{2}$ to $2\frac{1}{4}$	1	Roller chain	$4\frac{1}{2}$ to 8
1	Twin roller chain	$1\frac{1}{8}$ to 2	$1\frac{1}{4}$	Roller chain	7 to $12\frac{1}{2}$
			$1\frac{1}{2}$	Roller chain	$10\frac{1}{8}$ to 18
$\frac{1}{2}$	Roller chain	$1\frac{1}{8}$ to 2	$1\frac{3}{4}$	Roller chain	$13\frac{3}{4}$ to $24\frac{1}{2}$
$\frac{5}{8}$	Roller chain	$1\frac{3}{4}$ to $3\frac{1}{4}$	2	Roller chain	18 to 32
$\frac{3}{4}$	Roller chain	$2\frac{1}{2}$ to $4\frac{1}{2}$	...	...	...

Machinery

The accompanying table will be found useful in roughly determining the pitch of the chain to be used for a given horsepower. As chains of the same pitch are made of various widths and of various rivet diameters, the range in carrying capacity is rather large. The upper limit is the horsepower that can be transmitted by a chain of the greatest width and largest rivet diameter commonly supplied at the present time. Sprockets with less than 14 teeth should not be used except where the chain speed is low. The center distance, wherever possible, should be at least one and one-half times the diameter of the larger sprocket.

Having determined the pitch of the chain to be used, the pitch diameter, bottom diameter, and outside diameter of the sprockets can be found from the tables usually published by chain makers, or they may be calculated from the formulas:

$$\text{Pitch diameter} = \frac{P}{\sin \dfrac{180°}{N}} \qquad (1)$$

where N = number of teeth in sprocket and P = pitch of chain.

$$\text{Bottom diameter} = \text{pitch diameter} - \text{roller diameter} \qquad (2)$$

$$\text{Outside diameter} = \text{pitch diameter} + P\,(3N - 8) \div 5N \qquad (3)$$

* For further information on the subject of chain drives and allied subjects, see "Standard Sprockets for Detachable Link Belts," published in MACHINERY, August, 1913; "Lineometer for Determining Chain Lengths," May, 1912; "Design of Dished Sprockets," October, 1911; "Worm vs. Chain Drive for Auto Trucks," May, 1911; and "Chain Drives," February, 1909.

† Address: Diamond Chain & Mfg. Co., Indianapolis, Ind.

To estimate the outside diameter roughly, divide the number of teeth by 3 and multiply by the pitch.

To calculate the chain length, let

C = distance between centers;
D = pitch diameter of large sprocket;
d = pitch diameter of small sprocket;
N = number of teeth on large sprocket;
n = number of teeth on small sprocket;
P = pitch of chain;
θ = angle between straight part of chain and line of centers of sprockets.

$$\text{Sin } \theta = \frac{D - d}{2\,C} \qquad (4)$$

L = length of chain in inches

$$= \frac{P}{180}\,[N\,(90° + \theta) + n\,(90° - \theta)] + 2\,C\,\cos\theta. \qquad (5)$$

This gives a theoretical chain length. The actual length must, in general, be enough greater than this to make it an even multiple of the pitch. If, however, a special offset link is used, the chain length will be an odd multiple of the pitch. This sometimes means that there will be a considerable sag in the chain, unless the center distance can be adjusted to take up the slack.

To calculate the center distance for a tight chain, let:

Z = chain length in pitches $= \dfrac{L}{P}$;

C_1 = the center distance for a tight chain, in inches.

$$C_1 = \frac{P}{8}\,[2\,Z - N - n + \sqrt{(2\,Z - N - n)^2 - 0.824\,(N - n)^2}] \quad (6)$$

This is an approximate formula, but it will be found sufficiently accurate for most cases. If greater accuracy is required, continue the calculations as follows:

$$\text{Sin } \theta_1 = \frac{D - d}{2\,C_1} \qquad (7)$$

$$C_2 = \frac{P\left[2\,Z - N - n - (N - n)\,\dfrac{\theta_1}{90}\right]}{4\,\cos\theta_1} \qquad (8)$$

This formula is exact, but the value of θ is only approximate, since it was determined indirectly from Formula (6). The value of C_2 is, however, more nearly correct than that of C_1, and one may obtain any desired degree of approximation by solving (7) with the value of C found in (8), and then solving (8) with the value of θ found in (7). One or two alternations will give a result more accurate than would ever be required in practice.

To calculate the chain velocity V in feet per minute, the chain tension T in pounds, and the horsepower $H.P.$, use the following formulas, in which S will represent the number of revolutions per minute:

$$V = \frac{SNP}{12} \text{ or } V = 0.262\,DS \text{ feet per minute} \qquad (9)$$

where N = number of teeth on sprocket and D = diameter of sprocket in inches.

$$T = \frac{33{,}000 \times H.P.}{V} \text{ or } T = \frac{126{,}283 \times H.P.}{SD} \text{ pounds} \qquad (10)$$

$$H.P. = \frac{VT}{33{,}000} \qquad (11)$$

To find the minimum safe shaft diameter D_1 for a given sprocket:

$$D_1 = 3\sqrt[3]{\frac{H.P.}{S}} \qquad (12)$$

This is for a shaft of mild steel subjected to a twisting moment only. For a shaft subjected to a combined twisting and bending moment, multiply the result of Formula (12) by 1.5. As an example, let it be required to select the chain and sprockets to transmit 15 horsepower from a motor running at 600 revolutions per minute to a lineshaft running at 230 revolutions per minute, the outside diameter of the sprocket on the lineshaft not to be greater than 20 inches, and the center distance to be approximately 40 inches. The projected rivet area of the chain should be not less than H. P. ÷ 24 or 0.625 square inch. A chain is found whose rivet diameter is 7/16 inch; length of bushing, 1.440 inch; projected rivet area, 0.629 square inch; pitch, 1½ inch; diameter of roller, ⅞ inch; width of roller, 1 inch; and ultimate strength, 21,000 pounds. Since the maximum outside diameter of the larger sprocket is 20 inches, the maximum number of teeth will be 40, as found in a table of sprocket diameters. But it is necessary for the number of teeth to be so selected that the velocity ratio will be as close to $\frac{230}{600}$ as possible. Dividing 230 by 600 we have 0.3833 as the decimal equivalent of the ratio. Referring to a table of decimal equivalents of gear ratios, such as may be found in MACHINERY's Data Sheet No. 158 (published in September, 1912), the nearest fraction to 0.3833 with a denominator not greater than 40 is $\frac{5}{13}$ or $\frac{15}{39}$. We may therefore choose 15 and 39 as the numbers of teeth on the driving and driven sprockets, respectively.

Chain velocity $= V = \dfrac{SNP}{12} = \dfrac{600 \times 15 \times 1.5}{12} = 1125$ feet per minute.

Chain pull under full load $= T = \dfrac{33{,}000 \times 15}{1125} = 440$ pounds.

As a lineshaft is usually subjected to both twisting and bending stresses, the minimum allowable diameter would be

$$1.5 \times 3\sqrt[3]{\frac{H.P.}{S}} = 4.5\sqrt[3]{\frac{15}{230}} = 1.811 \text{ inch.}$$

The use of a 1⅞-inch shaft would be good practice.

The chain length is found from Formulas (4) and (5), thus:

$$\text{Sin } \theta = \frac{18.641 - 7.215}{2 \times 40} = 0.142825$$

$$\theta = 8°\ 12'\ 40'' = 8.2111° \qquad \text{Cos } \theta = 0.98975$$

$$L = \frac{1.5}{180}\,[39\,(90° + 8.2111) + 15\,(90° - 8.2111)\,] + 2 \times 40 \times 0.98975 = 121.321 \text{ inches.}$$

The next higher number than this which is an even multiple of the pitch is 123 inches. Hence $L = 123$ inches or 82 pitches. But if the center distance is 40 inches, there will be considerable sag in the slack portion of the chain. To take up this sag, the center distance must be increased to

$$C_1 = \frac{1.5}{8}\,[2 \times 82 - 39 - 15 + \sqrt{110^2 - 0.824\,(24)^2}] = 40.841 \text{ inches.}$$

If this is not thought sufficiently accurate, Formulas (7) and (8) may be used, thus:

$$\text{Sin } \theta_1 = \frac{11.426}{2 \times 40.841} = 0.13988$$

$$\theta_1 = 8°\ 2'\ 27'' = 8.0408°$$

$$\text{Cos } \theta_1 = 0.99013$$

$$C_2 = \frac{1.5}{4 \times 0.99013}\left[2 \times 82 - 39 - 15 - (39 - 15)\,\frac{8.0408}{90}\right] = 40.849 \text{ inches.}$$

This second approximation differs from the first by 0.008 inch. Substituting this value in (7) and (8), we have:

$$\text{Sin } \theta_2 = \frac{11.426}{81.698} = 0.13985$$

$$\theta_2 = 8°\ 2'\ 20'' = 8.0389 \qquad \text{Cos } \theta_2 = 0.99016$$

$$C_3 = \frac{1.5\left(110 - 24 \times \dfrac{8.0389}{90}\right)}{4 \times 0.99016} = 40.848 \text{ inches.}$$

Further approximations would affect only the decimal places beyond the third. This shows that Formula (6) is sufficiently accurate for most practical purposes.

As a final word, it may be pointed out that the life of a chain drive can be greatly lengthened by enclosing it in a case and running it in oil. Also, that both the efficiency and wear will be improved by the use of a strut rod, or its equivalent, rigidly connecting the bearings of the two sprockets, thus preventing relative motion between the sprocket centers.

PUNCHING MACHINE FRAMES*

THEORY OF SHEAR AND PUNCH FRAME DESIGN BASED ON MODERN ANALYSIS OF THE STRESSES

BY O. D. ALBERT†

While numerous articles have appeared dealing with the applicability of the theory of curved bars to such curved members as crane hooks, punch and riveter frames, and the like, the dictates of the theory as to the proper outline for such members have seldom been touched upon.

Careful mathematical and experimental investigation has shown that to approximate the maximum induced stress in a steel or wrought iron crane hook the expression used must take account of the curvature of the member. In the discussion to follow, it will be assumed that the theory of curved bars may be extended to curved members of cast iron, so long as the maximum stress induced does not exceed one-third to one-fourth the ultimate tensile strength of the material. Such limits are imposed, since up to such limiting stresses the stress-strain diagrams for cast iron in tension and in compression are almost straight and practically coincide. It can therefore be assumed without appreciable error that stress is proportional to strain and that the direct modulus of elasticity in compression is equal to that in tension. So far then as these assumptions are concerned there is no more objection to applying the theory of curved bars to curved members of cast iron than to treating straight or slightly curved members of cast iron in the ordinary way.

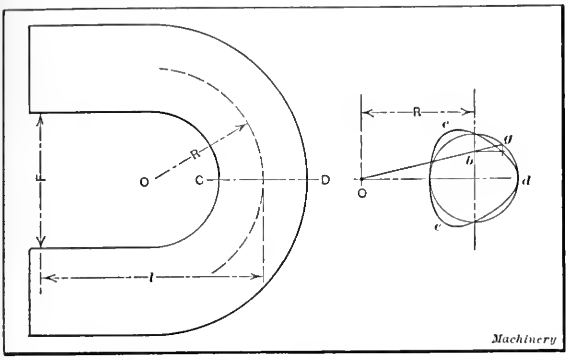

Fig. 1. Diagram indicating Notation in Formulas

The stress in pounds per square inch at any distance x from the gravity axis of the section CD, Fig. 1, is,

$$S = \frac{F}{A}\left[\frac{l}{R-x}\left(\frac{x}{R}\times\frac{a}{a-A}-1\right)+1\right] \qquad (1)‡$$

where x is positive if measured toward, and negative if measured away from, the center of curvature O.

F = the force or load in pounds acting at a distance of l inches from the gravity axis;

A = the area of the section CD in square inches;

R = the radius of curvature at section CD of the curve passing through the centers of gravity of the sections of the member;

$a = \int\left(\frac{R}{R-x}\right)\delta A$ = the area in square inches of a figure derived from the original section CD.

The expression given above takes account of the curvature of the member, but does not, as does the more complete analysis of Pearson and Andrews, take account of the lateral or transverse strains. For this reason it would, for the case illustrated in Fig. 1, indicate a somewhat lower maximum tensile stress and a somewhat higher maximum compressive stress than the more complete theory. To neglect, however, the lateral strains greatly simplifies the resulting expression, giving one that is quite easily handled and sufficiently accurate for all ordinary purposes, since in it account is taken of the curvature of the member which is the chief factor affecting the induced stress.

For irregular sections it is best to determine a graphically. Where, however, the section is made up of regular figures such as rectangles, triangles, or trapezoids, it is, as a rule, more accurate and easier to determine a algebraically. In any case a should be very carefully determined, since it is evident that any appreciable error will affect the ratio $\frac{a}{a-A}$, and therefore the results, quite seriously.

In Fig. 1, to the right, is shown how, from the original section, which in this case is circular, the derived figure *cde* is obtained graphically. From any point g on the outline of the section under consideration draw a radial line to the center of curvature O; through the point b where this radial line crosses the gravity axis draw a perpendicular; the intersection of this perpendicular through b with a line through g parallel to the gravity axis, locates a point on the outline of the derived figure *cde* the area of which is a.

Application to Punch Frame Sections

In Fig. 2 is shown a form of hollow section often used for punching machine frames, the filleting and rounding of the corners having been omitted. This section can for convenience be drawn in the form shown to the right and treated as made up of the rectangles A, B and D, and the trapezoid C.

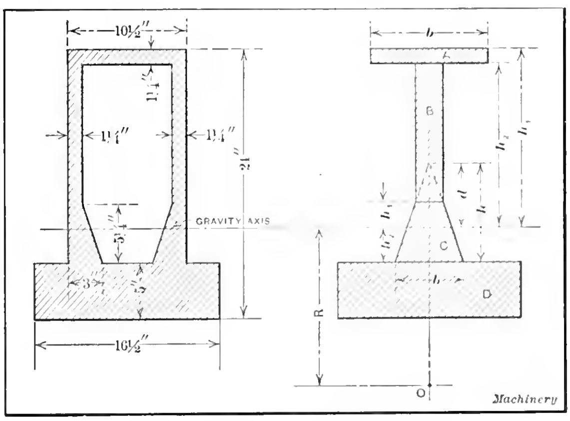

Fig. 2. Typical Section of Punch Frame

For any one of the rectangles A, B, or D:

$$a = \int\left(\frac{R}{R-x}\right)\delta A = Rb \text{ hyp. log}\left(\frac{R-h_1}{R-h_2}\right)$$

For the trapezoid C (or a triangle):

$$a = \int\left(\frac{R}{R-x}\right)\delta A =$$

$$R\frac{b}{h}\left[(d+R)\text{ hyp. log}\left(\frac{R-h_1}{R-h_2}\right) - h_2 + h_1\right]$$

To illustrate the purpose of this article as stated in the opening paragraph, a cast-iron frame for a machine to punch ⅝-inch holes in ⅝-inch plate will be taken up, the maximum resistance to punching being taken at 77,000 pounds. The frame and general dimensions shown in Fig. 3 will be found to be in fair agreement with machines of a like capacity.

In order that the radius of curvature for the horizontal or 0-degree section might in all cases be taken as the inner

* The following articles on kindred subjects have previously been published in MACHINERY: "The Design of Curved Machine Members under Eccentric Loads," December, 1909; "The Designing of Machine Frames," August, 1908; "Strength of Punch and Shear Frames," February, 1907; "Design of Punch and Riveter Frames," November, 1903.

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‡ The expression given is the same as that in Morley's "Strength of Materials," page 325, although it is given here in a slightly different form.

radius of the throat plus the distance from the gravity axis to the outermost fiber in tension, the cross-section of the frames for 20 degrees each side of the horizontal was kept the same. Furthermore, for the frame outlines illustrated in Figs. 3, 4 and 5, the 0-, 20-, 45-, 67½- and 90-degree sections have been kept the same in each of the three designs shown, the changes in outline being due to changes in the inner radius of the throat. The horizontal section for these frames is shown in Fig. 2.

For the purpose of the conclusions to be drawn the maximum tensile stress at the horizontal section and at the 45-degree section for each of the three frames illustrated in Figs. 3, 4, and 5 will next be computed. First the curvature of the frames will be neglected and the stresses found in the ordinary way; then the curvature of the frames will be considered and the corresponding stresses found.

For the frame shown in Fig. 3 the following values obtain:

Section	0	20°	45°	67.5°	90°
e	8	8	7.65	6.95	6.05
A	149.20	149.2	145.75	....	126.60
I	8487.00	....	7582.70	....	....
a	190.08	....	239.64	....	....
R	14.00	....	9.75	....	....

Machinery

In the table above,

e = distance in inches from gravity axis to the outermost fiber in tension;
A = area of section in square inches;
I = moment of inertia of section;
a = area in square inches of derived figure;
R = radius of curvature in inches.

Calculations Taking no Account of Curvature

Neglecting the curvature of the frames, the maximum tensile stress at the horizontal section for each of the three frames illustrated in Figs. 3, 4, and 5 is:

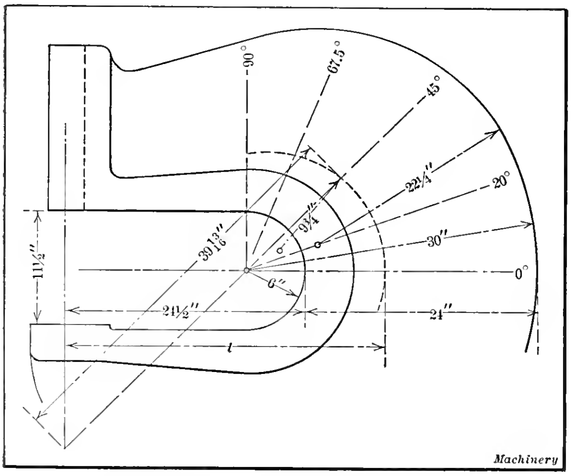

Fig. 3. Design of Punch Frame as commonly made

$$S_t = \frac{F}{A} + \frac{Fle}{I} = \frac{77{,}000}{149.2} + \frac{77{,}000 \times 32.5 \times 8}{8487} = 2876 \text{ pounds per}$$

square inch.

The maximum tensile stress at the 45-degree section due to flexure and direct stress is, for the frame shown in Fig. 3:

$$S_t = \frac{F \cos 45}{A} + \frac{(F \cos 45)\, le}{I} = \frac{54{,}450}{145.75} + \frac{54{,}450 \times 39.8125 \times 7.65}{7582.7} = 2560 \text{ pounds per square inch.}$$

The shearing stress over this section is $S_s = (F \sin 45) \div A = 374$, and the maximum resultant tensile stress is:

$$S = \tfrac{1}{2}\,[S_t + \sqrt{S_t^2 + 4\,S_s^2}\,] = \tfrac{1}{2}\,[2560 + \sqrt{2560^2 + 4 \times (374)^2}\,]$$
$$= 2615 \text{ pounds per square inch.}$$

For the frame shown in Fig. 4, the distance from the center of gravity of the 45-degree section to the intersection of the 45-degree plane with the line of action of the load is 39 inches; for the frame shown in Fig. 5 this distance is 38⅛ inches. The 45-degree sections for these frames being the same as for the frame in Fig. 3, the maximum resultant

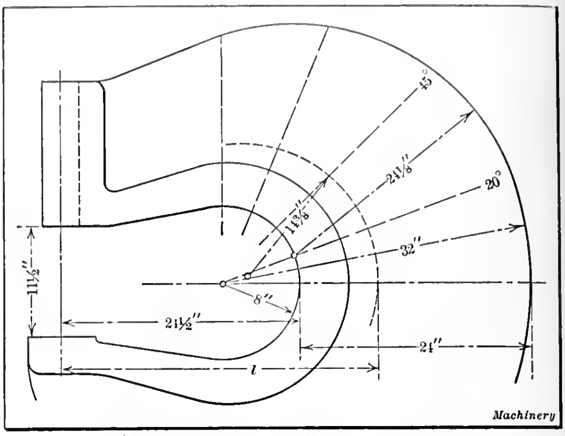

Fig. 4. An Improved Design of Punch Frame

tensile stress at the 45-degree section is for Fig. 4, 2566, and for Fig. 5, 2525 pounds per square inch.

Thus it is seen that, disregarding curvature, the frames are practically of uniform strength, but slightly weaker at the horizontal than at the 45-degree section.

Calculations Taking Account of Curvature

Considering the curvature of the frames the maximum tensile stress at the horizontal section for the frame in Fig. 3, is:

$$S_t = \frac{F}{A}\left[\frac{l}{R-e}\left(\frac{e}{R} \times \frac{a}{a-A} - 1\right) + 1\right]$$

$$= \frac{77{,}000}{149.2}\left[\frac{32.5}{14-8}\left(\frac{8}{14} \times \frac{190.08}{190.08 - 149.2} - 1\right) + 1\right] = 5150$$

pounds per square inch, or a value 1.79 times as great as that indicated by the ordinary method of computation.

For the 45-degree section frame, Fig. 3, the values obtained when considering curvature are more or less approximate, since the center of curvature does not fall in the plane of the section. So far, however, as the probable maximum stress in the section is concerned the calculation, considering curvature, is far more indicative of the true state of stress than the ordinary method not considering curvature.

The maximum tensile stress in the 45-degree section due to flexure and direct stress is for the frame in Fig. 3:

$$S_t = \frac{F \cos 45}{A}\left[\frac{l}{R-e}\left(\frac{e}{R} \times \frac{a}{a-A} - 1\right) + 1\right]$$

$$= \frac{54450}{145.75}\left[\frac{39.8125}{9.75 - 7.65}\left(\frac{7.65}{9.75} \times \frac{239.64}{239.64 - 145.75} - 1\right) + 1\right]$$

= 7450 pounds per square inch.

The augmentation due to the direct shear would raise this value, computed by the method illustrated above, to approximately 7475, or a value 2.86 times as great as that indicated by the ordinary method neglecting curvature.

The radius of curvature for the 45-degree section was determined graphically. While by this method it is perhaps impossible to say just what the exact value of the radius is, it is entirely possible to obtain a value slightly less rather than over the exact value, and thus be on the safe side.

For the frames in Figs. 4 and 5, the inner radius of the throat has been changed from 6 inches to 8 and 10 inches, respectively. The radius of curvature at each of the various sections is therefore increased with a consequent change in the value of a. For these frames the following values obtain:

	Horizontal Section		Forty-five Degree Section	
	Fig. 4	Fig. 5	Fig. 4	Fig. 5
e	8	8	7.65	7.65
A	149.2	149.2	145.75	145.75
a	179.14	172.64	178.135	173.45
R	16	18	14.375	15.625
I	32.5	32.5	39	38.125

Machinery

Results Obtained from Calculations

Having the above values, the maximum tensile stresses at the horizontal and 45-degree sections can be found. Tabulating these and the values already found we have:

Conditions		Fig. 3	Fig. 4	Fig. 5
Horizontal section	Curvature neglected	2875	2875	2875
	Curvature considered	5150	4685	4320
45-degree section	Curvature neglected	2615	2566	2525
	Curvature considered	7475	4570	4110

Machinery

So far as the horizontal section is concerned, the frame in Fig. 4 has an advantage of about 9 per cent, and the frame in Fig. 5 of about 16 per cent over the frame in Fig. 3. Now, since the breaking load for a frame cannot be computed by either method, it would seem, for the particular frame taken up, that, in so far as the horizontal section is concerned, the curvature of the frame might be neglected in our computations, if a proper limiting stress be chosen. To make such a deduction on the basis of the above problem and to extend it to any punch frame would, however, be a mistake since it is evident from Formula (1) that the maximum induced stress in such a member depends very largely on the relation of the radius of curvature to the size and general proportions of the section. The results of the computations on the 45-degree sections very well illustrate this.

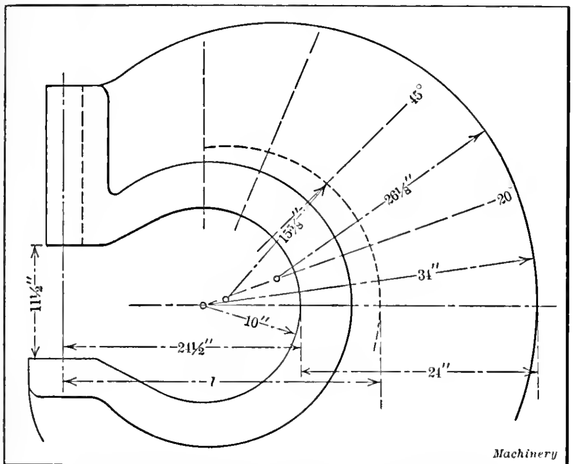

Fig. 5. A Further Improvement in Punch Frame Design

The computations, curvature considered, show the frame in Fig. 3 to be considerably weaker at the 45-degree section than at the horizontal section; the computations neglecting curvature show the reverse of this. The tabulation, curvature considered, shows the stress in the 45-degree section for the frame in Fig. 3 to be much higher than that in the horizontal section, and the stresses in the horizontal sections of the frames in Figs. 4 and 5 to be higher than in the 45-degree sections. On this basis the frame in Fig. 4 has an advantage of approximately 37.5 per cent and the frame in Fig. 5 an advantage of approximately 42 per cent over that in Fig. 3.

Conclusion

Apparently, then, that there may not be any abrupt changes of stress in the frame, there should not be any abrupt changes of curvature in the curve passing through the centers of gravity of the sections. Furthermore, the radius of curvature at the horizontal section should be as great as possible and the value of the radius of curvature at any other section as we pass forward should be as little below that at the horizontal as possible. The inner outline of the throat should, therefore, be a smooth curve with no abrupt changes of curvature. The frames in Figs. 4 and 5 suggest a way in which the above requirements may be met, due account being taken of appearance and the general limitations of the problem, and are much to be preferred to the frame in Fig. 3.

* * *

THE SAFEGUARDING OF BELTS, SHAFTS AND PULLEYS

The following concise rules have been issued by a large British steel company with a view to preventing accidents in the company's mills, arising from moving belts, shafts or pulleys. The rules are practical and concisely stated, and may be of considerable value in formulating similar rules to meet the conditions in other plants:

Belt, rope, and cable transmission should be arranged, so far as possible, to be easily guarded.

Pipe or angle railing placed 18 inches from the pulley or belt should be provided where there is but little danger of persons getting caught by the belt.

Wire-mesh or perforated-plate casing should be provided where the location of the belt is such that persons are likely to get caught between the belt and the pulley.

Where the belt is located in such a position that, should it break, flying ends would strike passers-by, it should be enclosed by a suitable guard.

The width of a belt should be allowed between two pulleys or a pulley and a hanger on shafting so as to prevent the belt from becoming wedged and possibly pulling the line-shafting down.

Belt splicing should be made so as to eliminate ragged edges or projections which might catch employes' clothing. Endless belts are recommended, especially for high-speed machines.

Belts should be inspected frequently and kept in a condition to avoid accidents. Tight belts should be avoided.

Wherever it is necessary to shift belts a mechanical device should be provided.

Where it is necessary to unship a belt, a hook or belt-perch should be provided to prevent the belt from resting on the shaft.

Shafting not over 12 inches above floor should be covered.

Shafting over 12 inches and not over 7 feet above floor should be encased or railed off.

Exposed ends of shafting should be encased or otherwise guarded.

Overhead shafting which must be oiled should be equipped with a walk for the oiler, if practicable.

Electrically-driven shafting should be provided with a safety switch, to be used when men are working on it. This switch should be placed at the top of the ladder or in some place where no one will tamper with it.

Shaft couplings should be guarded where a safety coupling is not used.

To prevent gears or pulleys from working off the ends of shafting, shaft ends should project at least the diameter of the shaft beyond the hub of the gear or pulley, so that the key can be locked in place.

Hangers for shafting should be particularly strong and well secured.

All projecting keys in shafting, when exposed so that a person might get caught thereon, should be guarded or cut off.

Wherever possible, cotter pins or spring washers should be provided to prevent nuts from working off the ends of bolts.

Set-screws should be guarded, countersunk, or placed in safety collars with flanges high enough so that the set-screw head will not project above the flange.

* * *

The man who works with one eye on the clock and the other on the boss, and who is the first one out of the door at night, is provided with an automatic resignation.

POWER REQUIRED FOR ROLLING METAL*

Twenty-eight years ago the writer was asked to compute the power required to roll billets to rods, and also the power required to draw the same rods to wire. It was first necessary to assume a common unit for comparison. One base only appeared rational, the power required to cause a unit reduction of a unit mass in a unit time. The units the writer first adopted were a unit reduction of 50 per cent or doubling of the length; a unit mass of one ton; and a time unit of one minute. This gave a formula

$$H. P. = CTD$$

where C = constant;

T = tons worked per minute;

D = doublings or number of times the length has been doubled.

A table of lengths and doublings was prepared corresponding with each successive per cent reduction from 1 to 99 per cent. The last column of this table was a table of logarithms having 2 for a base. For example:

50 per cent reduction = length 2.00 log 2.00 = 1;

75 per cent reduction = length 4.00 log 4.00 = 2; etc.

As is well known, the logarithms of any base are made by multiplying common logarithms by the reciprocal of the common logarithm of the desired base, or, in other words, by a constant. Hence, the formula is more available when common logarithms are used, and it becomes

$$H. P. = CT \log E$$

where

$$E = \text{elongation} = \frac{\text{length after rolling}}{\text{length before rolling}}.$$

This simply changes our unit reduction from 50 to 90 per cent; 90 per cent reduction gives an elongation of 10 to 1, and 10 is the base of our common logarithms which are universally available. In the above formula, C is a constant when other conditions are constant, but other conditions are seldom constant. Careful and extended dynamometer tests of cold-rolling relatively wide strips of commercially pure aluminum showed clearly that the power required increased somewhat faster than $\sqrt{\frac{D}{t}}$ where

D = roll diameter,

t = finished thickness.

This changes the formula to

$$H. P. = CT \log E \sqrt{\frac{D}{t}}.$$

Commercially pure aluminum was chosen because its malleability is perhaps exceeded only by gold and silver, and it does not harden appreciably with continued rolling. Averages of repeated tests plotted on logarithmic cross-section paper from the above formula appear to indicate that the power does increase almost directly as $\sqrt{\frac{D}{t}}$, between the values $\sqrt{\frac{D}{t}} = 5$ and $\sqrt{\frac{D}{t}} = 10$. After passing the latter point, the power required increases more rapidly, until for values $\sqrt{\frac{D}{t}} = 15$ the unit power required was 30 to 50 per cent more than that called for by the formula. Perhaps this was partly due to the hardening of the aluminum by the continued rolling, but is not much of it due to the increased ratio between the arc of contact and the thickness of the metal? In other words, is it not true that more pressure per unit area is required to compress a very thin sheet of metal between two flat plates than would be required to compress a much thicker sheet? The diagram previously referred to, for showing the relative work required to roll plates of varying final thickness and percentage reductions, also seemed to indicate that from 40 to 60 per cent reductions are the most economical in the use of power; that reductions less than 30 per cent are extravagant in power consumption, due perhaps to an excessive proportion of journal friction; and that rough rolls require much more power than smooth rolls.

Temperature is another factor nearly as important as roll diameter. Someone has covered this in what appears to be a perfectly logical way, by assuming that the power varies directly with the tensile strength of the bar being rolled. Adding this makes the formula quite complete:

$$H. P. = CT \log E \sqrt{\frac{D}{t}}\, S$$

in which S = tensile strength at the rolling temperature.

This formula clearly shows why a continuous sheet bar mill may require more power to deliver a bar 1/4 inch thick than it does to deliver twice the tonnage at the same speed of a bar 1/2 inch thick, and only slightly warmer. It is interesting and easy to remember that through nearly the entire range of rolling temperatures, a reduction of 400 degrees F. practically doubles the tensile strength and hence the power required to roll. The formula also shows why small rolls and high speeds will conserve temperature and power.

At least one more factor is necessary to make the formula complete, *viz.*, the efficiency of the pass. Obviously, the metal can take the speed of the roll at one point only in the arc of contact. At all other points the metal must slip either against the face of the roll or internally. As an example, it is well known that a barrel hoop may deliver fully 10 per cent faster than the surface speed of the roll. This slipping, either external or internal, requires and wastes power. The smoother the roll, the less power wasted.

Cold-rolling is done in oil and all rolls for cold work are ground as true and smooth as possible. Should not the same reason lead us to grind with much care all rolls for hot work that can be so finished? Less power is required, the rolls last longer and better work is produced. The foregoing applies to plain, flat passes.

The efficiency of all shaped passes decreases as the slipping increases. This loss of efficiency is especially noted in some of the passes used for rolling rails, but the benefits from using such passes may fully warrant the resulting excess roll wear and power. Light reductions have a low efficiency. It may not be easy to get a formula that will cover the efficiency of a pass, but it should not be overlooked in computing power requirements.

* Abstract of a paper presented before the Engineers' Society of Western Pennsylvania, Pittsburg, Pa., by Victor E. Edwards.

* * *

UNIQUE POWER PLANT FOR FORD MOTOR CO.

The Ford Motor Co. has placed contracts for a gas engine-electric power plant that will be not only one of the largest in the country, but in many respects absolutely unique. The company has appropriated about a million dollars for the project, which will put into effect plans that Henry Ford has long had in mind for utilizing the waste heat of the ordinary producer gas engine. Four 6000 H. P. Hamilton-Gray gas engines of novel design will drive four Crocker-Wheeler 3750 K.W., 250 volt, 80 R. P. M. engine type direct-current generators. A plan view of each engine will be similar to a cross-compound steam engine, with two cylinders in tandem on each side. One pair of cylinders will be operated by producer gas and the other by steam. The steam will be generated from the water used in the water jacket of the gas engine, further heated by the exhaust gases and by waste heat from the producer gas plant. This water or steam will be used as the feed water for the boiler which supplies the steam engine cylinders. A heavy flywheel will equalize the characteristics of the gas and steam driven elements of the engine. These generators are designed for much higher efficiency than is ordinarily found in commercial practice. Full load efficiencies will be not less than 94½ per cent. By these means and by the utilization of energy usually lost in waste heat, it is proposed to make the new Ford power plant the most economical in the country in respect to cost of production per kilowatt hour. The armatures will be of split construction which is necessitated by clearance requirements through tunnels and bridges in shipment from Ampere to Detroit, and the generators will be finally assembled at the Ford plant.

MAKING SECTIONAL DIE PARTS*

SOME TOOL-MAKING METHODS AND TOOLS EMPLOYED BY THE COLUMBUS DIE, TOOL & MACHINE CO.

BY DOUGLAS T. HAMILTON†

The making of sectional dies for armature disks and work of a similar kind calls for considerable ingenuity on the part of the toolmaker in devising means for producing these parts accurately and economically. It is necessary, if the best results are to be obtained, to secure a steel which will not warp or distort during the hardening process so that grinding of the parts after hardening need not be resorted to. Should the die and punch sections warp or shrink, it adds greatly to the difficulty of manufacturing the parts and greatly increases the cost of the tool. In many cases grinding of the die and punch sections is necessary, so that special devices and tools have been devised for handling this work as expeditiously as possible. In the following article, a number of the most interesting methods employed by the Columbus Die, Tool & Machine Co. of Columbus, Ohio, will be given. This company makes a specialty of producing for various firms punches, dies, tools and special equipment, and therefore is in a position to devise means for getting this work out in the shortest possible time.

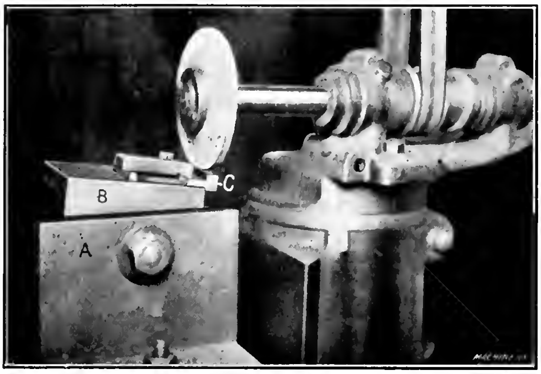

Fig. 1. Grinding the Die Sections

Grinding the Die Sections

In order that the die sections will fit properly in place after hardening and give the required outside and inside diameters, it is necessary to leave a slight amount of excess stock on the sides of the sections that fit against each other in the die holder. These sides are then ground to the required angle and thickness in a special fixture. The toolmaker figures out the required angle of the side sections and also the least or greatest thickness. The type of fixture used for grinding these die sections is shown in Fig. 1. It consists of an ordinary angle-plate *A* which is fastened to the table of a grinder of the surface type, and against which is held another angle-plate *B* that can be set around to the desired angle and carries the work to be ground. The work or die section *C* in this case is held in place by a special toe clamp, and when one side of the section is ground it is reversed and the other side is ground.

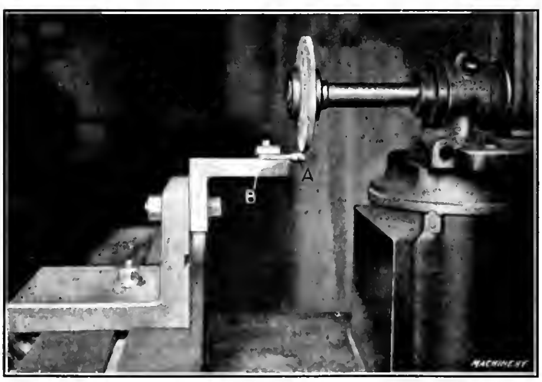

Fig. 2. Grinding the Punch Sections

The sides of the punch sections are ground in a similar manner on the same fixture which, however, is swung around into the position shown in Fig. 2. The punch section *A* is held to the small angle-plate *B* as illustrated, and when one side is ground the section is reversed on the angle-plate and the other side finished. When the fixture has once been set up, however, all the punch or die sections are ground on one side first. Then the setting of the machine is changed and the other side of all the sections ground. This enables the toolmaker to turn out the work much more quickly than if he were to reset the machine for both sides of the piece, thus finishing it complete without removing it from the fixture to put another in its place.

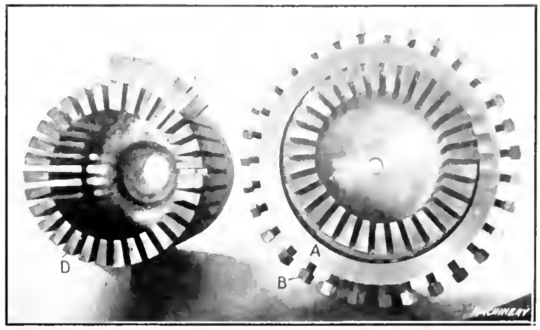

Fig. 3. Special Chucks for holding Die and Punch Sections while Grinding

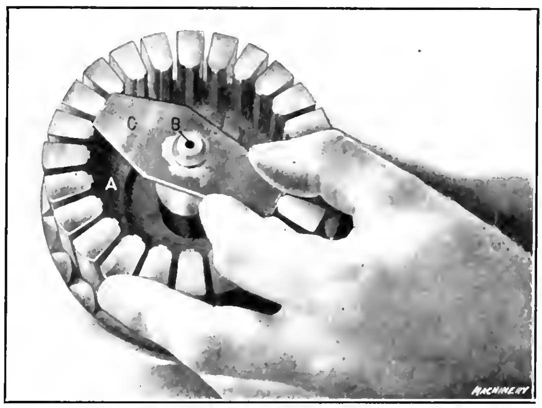

Fig. 4. Assembling a Sectional Armature Disk Punch

Special Chucks for Holding Die and Punch Sections while Grinding

In Fig. 3 are shown two special chucks which are used for holding punch and die sections while grinding the inside and outside diameters and the top and bottom faces, so that all the important machined surfaces can be finished at the same setting. The special chuck for holding the die section is shown to the right of the illustration. This, as can be clearly seen, consists of a cup-shaped body *A* around the periphery of which are located set-screws *B*. These set-screws bear against the backs of the section and bind them together, the beveled surfaces of the punch section being wedged together by the action of the set-screws, and consequently held rigidly in place for the grinding operation. The grinding is accomplished in a cylindrical grinding machine, the chuck being screwed to the nose of the spindle in the ordinary manner. The outside surfaces are ground tapered to an angle of 5 degrees to enable them to be held in place in the punch holder by a retaining ring.

* For further information on sectional punch and die work, see "Punch and Die made in Sections," March, 1913, and "Sectional Punch and Die Construction," July, 1913.

†Associate Editor of MACHINERY.

The special chuck for holding the die sections for grinding is shown to the left of the illustration. Here only four die sections C are shown in place, simply to indicate the manner in which they are held. The narrow portion of the die section is a drive fit in the slots of the die holder and these sections are tapped lightly into place until the beveled surfaces contact. The chuck D is also held in a cylindrical grinder, being screwed to the nose of the spindle as previously mentioned in connection with the chuck for the punches. This chuck enables the inside and outside diameters of the die sections to be ground and also the top face. The lower face is ground by reversing the position of these sections in the chuck, and then holding them in the manner in which they are held in the illustration.

Assembling an Armature Disk Punch

After the beveled sides of the punch sections have been ground, it is then necessary to test these sections to see whether the correct inside and outside diameters have been secured, and also if the small projections on the inner surfaces of the punch sections are properly located axially. This, of course, proves whether the correct amount of stock has been ground from the sides of the punch sections. The fixture used for this purpose is shown in Fig. 4 and consists of a block A, circular in shape, in which a stud B is located. This stud acts as a means for holding the gage C, which as can be seen, is cut out to fit over the projections on the punch sections and is also fitted over the stud, being centrally located in this manner. In this particular case, a limit of only 0.0005 inch is allowed from the center of the plug to the inside face of the punch section. Also the blank must be re-

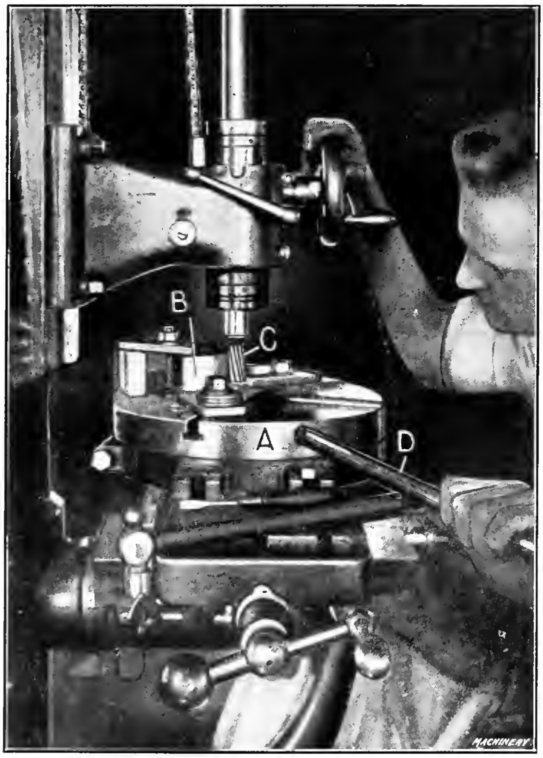

Fig. 5. Milling Segments for Pole-piece Punches

versible on the punch. When it is realized that these dimensions are governed entirely by the amount of metal removed from the sides of the sections, it will be seen that the grinding operation is one that must be very carefully handled and that requires considerable ingenuity on the part of the toolmaker if the parts are to assemble accurately.

Milling Segments for Pole-piece Sectional Punches

Fig. 5 shows how segments for pole-piece sectional punches are milled both on their circular and angular faces. A Knight milling and drilling machine is used for this purpose, being equipped with a circular milling attachment A. The section B of the pole-piece punch to be machined is clamped to the top face of the circular milling attachment by clamps as illustrated, and the machining is accomplished by an end-mill C held in the spindle of the machine. The circular attachment is operated by a bar D which can be located in holes provided around the periphery of the faceplate. For milling the beveled faces, the circular attachment is clamped to prevent it from rotating and the feed-screw for the table is operated.

Boring Sub-press Die Guide Pin Holes

After all the various members of the sectional punch and die have been completed, they are assembled in the punch and

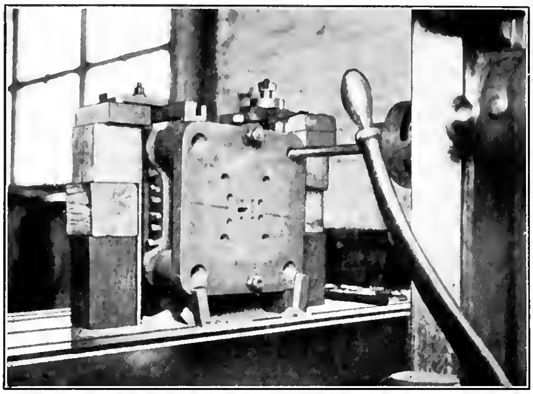
Fig. 6. Boring Sub-press Die Guide Pin Holes

die holders and then the next operation is to bore the holes for the aligning pins, when the dies are of the sub-press construction, which is the usual type of construction adopted for complicated sectional punches and dies. The manner in which these guide pin holes are machined is shown in Fig. 6. The punch and die holder are located in the proper relation to each other and are fastened together by through bolts as illustrated. Then these holders for the sectional members are located on the table of a milling machine and the holes are first drilled and then bored by a boring tool held in the spindle of the machine. The two lower holes are bored and counterbored first, the center distances, of course, being located by the micrometer dial on the feed-screw. Then the table is lowered and the top or two remaining holes are bored and counterbored in a similar manner. This method of boring the guide pin holes enables them to be produced quickly and accurately with very little difficulty.

* * *

One of the most important iron mines in the world is the Loussavaara-Kürunavaara, situated at Kiruna, Lapland, in latitude 68½ degrees north, which is about the same as the northernmost boundary of Alaska. The climate is somewhat milder than in Alaska, and these mines are worked the year round. About 1600 men are employed. The plant is operated by steam power, the coal coming from England and Spitzbergen. The electrification of the mine is in progress, and this power will be used exclusively as soon as the new power plant of the Swedish government, now under construction at Porjus Falls, is completed. The capacity of this station will be 150,000 H. P. to be transmitted at 78,000 volts over a distance of 150 miles. The ore is shipped from Kiruna to Narvik on the Norwegian coast by rail, and from there by water to Germany, a small percentage finding its way to other countries. The ore is magnetite and contains from 53 to 68½ per cent iron. Owing to the comparatively large content of phosphorus it was impossible to utilize it until the Thomas furnace was developed.—*Daily Consular Report.*

* * *

At the International and Colonial Exhibition to be held in Genoa, Italy, beginning in March, there will be an interesting section devoted to showing methods of packing for export. There will be nine different lines of goods exhibited with the proper packing for each, one of these lines being packing required for machinery.

DRILLING AND TAPPING FIXTURE

BY CHRISTIAN F. MEYER*

The drilling and tapping fixture to be described in this article was designed for machining holes in the bed of a textile machine. Fig. 1 shows a section of the bed *A*; this bed is about 30 feet long and is supported by legs *B*. After the bed has been machined, a number of other parts are assembled on it, the finished surface of the bed being used as a base in lining up the other members. When the assembling has been completed, a number of holes *a* are drilled and tapped in the bed to receive guide pins *C*. These guide pins are screwed into different holes in the bed according to the kind of fabric that is to be woven, and it is very important to have them exactly perpendicular to the top surface of the bed *A*. They must also be accurately located in relation to other members of the machine. These conditions make it impossible to remove the bed from the machine, after it has been assembled, in order to drill the holes, and as a result it was necessary to devise a fixture which would make it feasible for the holes to be drilled and tapped with the bed in position. The drilling was formerly done with an electric drill, after which the holes were tapped by hand. This method required a considerable amount of time and the results obtained were unsatisfactory. Great care and a good deal of skill had to be exercised in order to get the holes perpendicular to the upper surface of the bed.

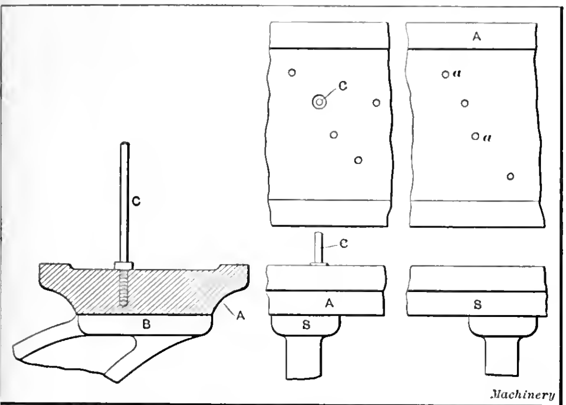

Fig. 1. Machine Bed for which the Drilling and Tapping Fixture was designed

In order to eliminate the difficulties experienced in machining these holes by hand, the drilling and tapping fixture illustrated in Figs. 2, 3 and 4 was designed. It consists of a cast-iron base *D* which is made to slide along the surface of the bed *A*. After the longitudinal position of the fixture has been adjusted the fixture is held securely by means of hexagonal headed set-screws and a clamping gib. It will be seen that this gib is held in place in the fixture by means of the cover *E*. The base *D* supports an upper slide *F* which is held in any desired position by means of a clamping gib and set-screws. Referring to the plan and sectional views shown in Figs. 3 and 4, it will be seen that the slide *F* has a lug *G* at its rear end. This lug is tapped to receive an adjusting screw which is held against longitudinal movement by means of collars at each side of the end plate *H*.

It will be seen that the slide *F* carries a round boss about which the bushing *I* can be revolved. This bushing is held in any desired position by means of a set-screw. The tool-holder *K* revolves about the bushing *I* and is supported by the flange at its lower end. It will be seen from Figs. 2 and 3 that the tool-holder is provided with three arms *L*, *M* and *N*. The centering arm *L* is provided with a long "feeler" which slides in a vertical bushing and can be fastened in the desired position by a set-screw. The drill-arm *M* carries a steel bushing which is provided with rack-teeth. The bushing and rack slide on the arm, the movement being obtained by a pinion which provides for feeding the drill. The pinion shaft has a hub at its outer end which is provided with a hand-lever *T* for operating the feed mechanism. The drill spindle *W* revolves in the bushing and is driven by a direct-connected motor *R* which is mounted on a bracket at the rear of the tool-holder. It will be seen that this motor transmits through a pair of spur gears, the shaft *k* and the bevel gears *Q*. The bracket *S* is provided at the front of the tool-holder to support the shaft *k* and the lower bevel gear *Q*. The movement of the drill spindle is limited by a stop-pin *m* carried by the bushing which slides in a slot in the arm *M*. The weight of the spindle is counterbalanced by a weight located inside the boss on the slide *F*.

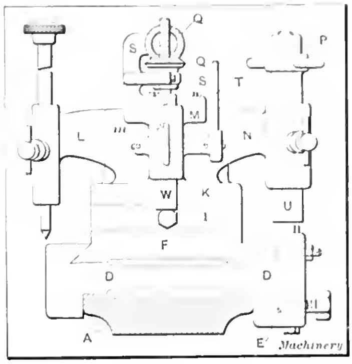

Fig. 2. Front View of the Drilling and Tapping Fixture

The tapping-arm *N* carries a steel bushing which may be held in any desired position by a set-screw. The spindle *U*, which revolves in this bushing is made with its lower end of the same diameter as the bushing. This section of the spindle is separated from the bushing by means of a leather washer, and two nuts *P* are used to draw the spindle *U* up against the base of the bushing. It will be seen that a similar leather washer is provided between the lower nut *P* and the top of the bushing. The bushing is turned by hand levers and when the nuts *P* are tightened, it will be evident that the spindle is driven by the friction of the leather washer. If the resistance of the tap becomes great enough to overcome this friction, the rotation of the spindle will be stopped, and the friction is adjusted so that slippage will occur before the resistance is great enough to break the tap.

It will be seen from the sectional view, Fig. 4, that the tool-holder *K* carries a boss on the opposite side to the arm *M*. This boss is drilled to receive the taper index pin *V* which is pressed inward by a compression spring. The taper section of the pin *V* fits into three corresponding holes in the bushing *I*, these holes being drilled radially so that their center lines and the center lines of the arms *L*, *M* and *N* all intersect at the center of the bushing. The index holes in the bushing are located 60 degrees from each other, the arms of the tool-holder being located similar distances apart. From the preceding it will be evident that the three spindles of the fixture will be located at exactly the same point over the work when held by inserting the index pin into successive holes in the bushing *I*.

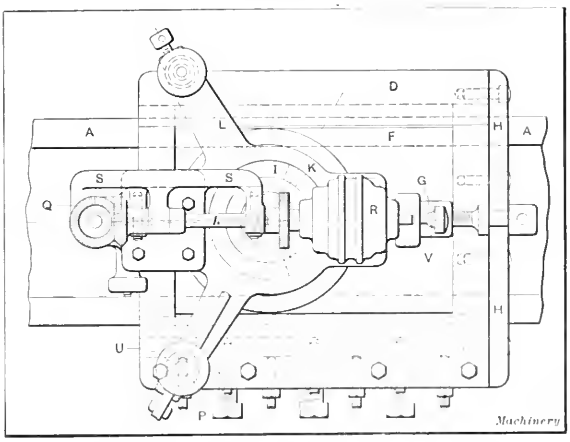

Fig. 3. Plan View of the Drilling and Tapping Fixture

The operation of this drilling and tapping fixture may be briefly described as follows: The holes to be drilled and tapped are first laid out on the top surface of the bed of the machine. The fixture is then mounted in position and slid along the bed to the first group of holes. It is fastened in this posi-

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tion by tightening the set-screws against the gib. The feeler-arm *L* is next located by first inserting the index pin *V* in the proper hole; then by revolving the bushing *I* and using the adjusting screw to regulate the position of the slide *F*, the point of the center punch is brought into coincidence with the center of one of the holes. Bushing *I* is then fastened by tightening the set-screw. The index pin is then withdrawn and the tool-holder *K* is revolved through 60 degrees, when the index pin is forced into the next hole in the bushing *I* by the action of the compression spring. This brings the drill spindle into the operating position so that the hole can be drilled. As the depth of the hole is governed by the stop-pin *m*, the operator does not have to waste any time in gaging. After the hole has been drilled, the fixture is again indexed to bring the tapping spindle into the operating position, after which the hole is tapped.

The use of this fixture insures having the drill and tap held exactly perpendicular to the surface of the work so that an inexperienced workman can machine the holes more quickly and accurately than a skilled mechanic could when the old hand-method was used. Although this drilling and tapping fixture was designed for the particular class of work referred to, the same device could be used to advantage on a variety of other classes of work.

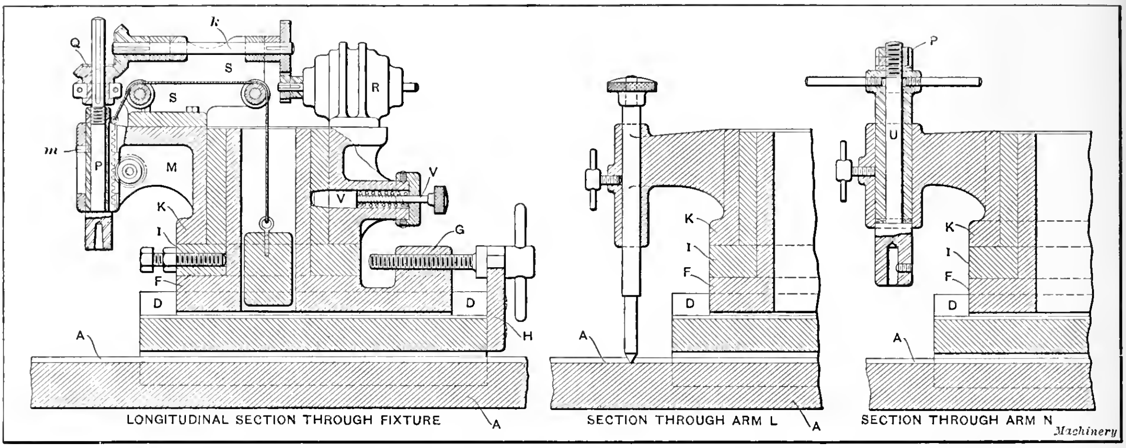


Fig. 4. Longitudinal Cross-sectional View of Drilling and Tapping Fixture and Cross-sectional Views of Arms L and N

* * *

As a rule, hard water causes little or no corrosion in metal pipes, principally because of the formation of protective coatings upon the metal by ingredients in the water. The carbonic acid and atmospheric oxygen in soft waters cause corrosion. Investigations made by the Department of Water Supply, New York City, indicate that the addition of lime or soda to soft water forms coatings on the inside of the pipes so that corrosion may be practically negligible.

BROACHING ROUND HOLES

BY RALPH R. LAPOINTE*

When finishing a hole by reaming, the cutting edge of each reamer blade travels a distance approximately equal to the circumference of the hole multiplied by the number of revolutions or turns made by the reamer in passing through the work. In the case of a round broach, the distance traversed by any point on the broach in machining a hole is equal to the length of the work; hence, it can easily be seen that broaching is a much faster operation than reaming, especially when the broach has a cutting speed of at least four feet per minute; moreover, the broach will maintain its size for a longer period than a solid reamer, because the finishing end of the broach has a number of teeth of the same diameter, and as these only take very light finishing cuts they are subjected to very little wear. Even an adjustable reamer has no longer life than a well made round broach.

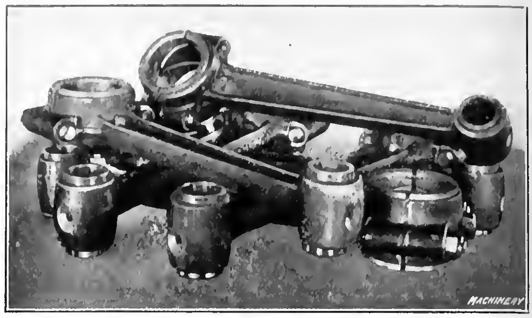


Fig. 1. Finished Connecting-rods broached as indicated in Fig. 2

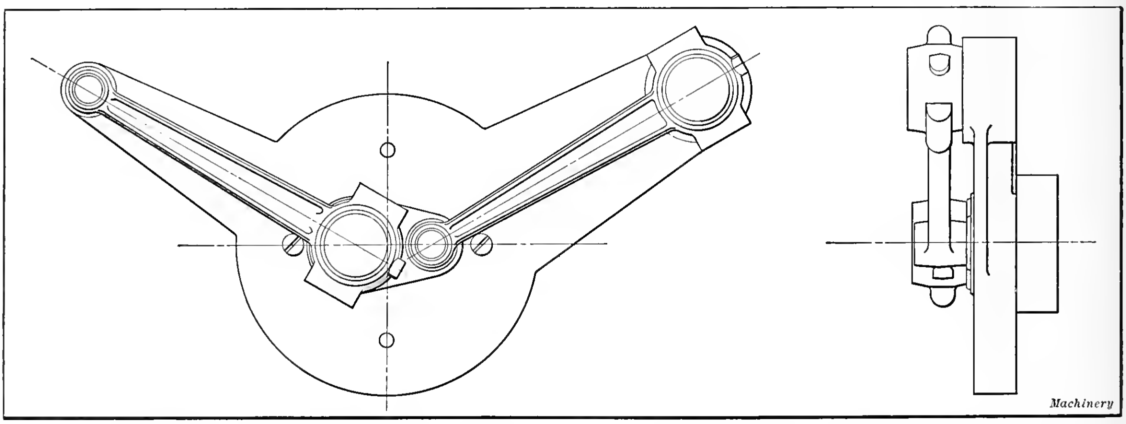


Fig. 2. Method of broaching Large and Small Connecting-rod Ends simultaneously on a Regular No. 3 Lapointe Broaching Machine

* Superintendent, Lapointe Machine Tool Co., Hudson, Mass.

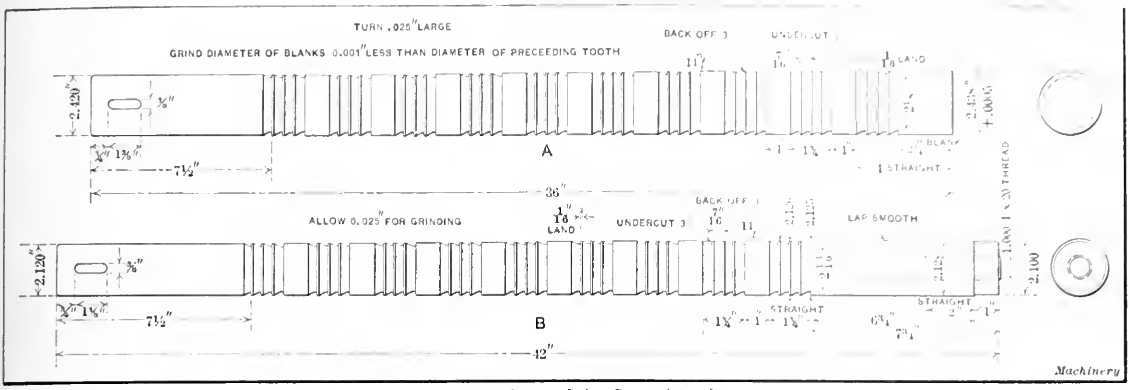


Fig. 3. Broaches used for Connecting-rods

It has been demonstrated that the broaching of hard chrome-nickel steel, such as is used in automobile work, is a much cheaper process than reaming. A typical job is shown in Fig. 2, which illustrates two connecting-rods and their broaching fixture. The small end of one rod and the large end of the other are broached simultaneously on a regular No. 3 Lapointe broaching machine. In this way, one complete rod is finished for every stroke of the machine. The fixture is not absolutely necessary but adds considerably to the production. These connecting-rods are first drilled to the size of the broach shank or to a diameter of from 0.015 to 0.018 inch under the required size. They are then finished by broaching, thus eliminating both machine and hand reaming. After the rods have been broached, the large end is split and the lining bushing for the large end is inserted. The bushing for the small end is pressed into the rod. These bearings or bushings are then broached, and the finish obtained can only be duplicated by scraping, although broaching is, of course, much cheaper, and the metal is compressed somewhat, thus giving the bearing a hard, glazed surface that resists wear. A number of finished connecting-rods are shown in Fig. 1.

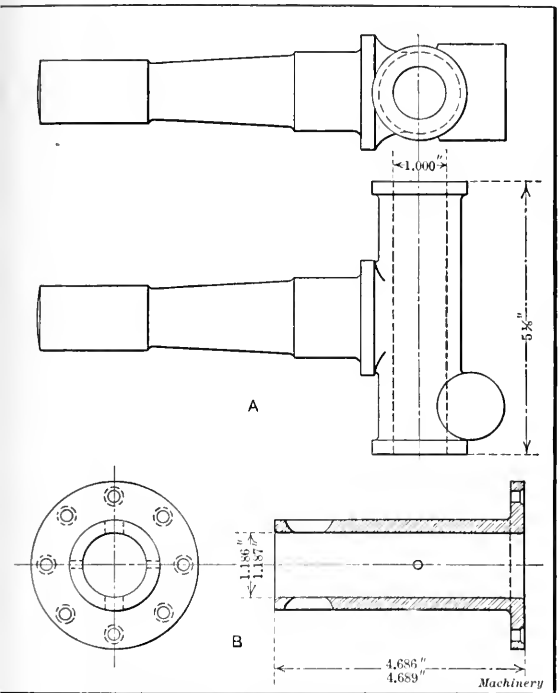


Fig. 4. Examples of Work machined by broaching

The broach illustrated at *A* in Fig. 3 is used for broaching the hole in the large end of the rod, whereas the smaller broach *B* is for finishing the bushing. The plain round sections seen on these broaches are for the purpose of keeping the broach from "running" or "crawling," as it is essential that the center-to-center distance of these rods be kept fairly accurate. By introducing plain blanks or sections between the teeth, as shown, the broach is kept properly aligned with the hole because there is always some portion of the blank section in the work while some of the teeth are cutting.

When using a broach, it is passed through the work and is fastened to the draw-head of the machine by a cotter-key which passes through the slotted end in the usual way. Only such clamping as is necessary to support the work is required, as the blank sections on the broach will hold the part in alignment. When using these broaches in cast iron, a soap cutting compound is used, as this gives the broached surface a highly polished finish. For chrome-nickel steel, a good grade of cutting oil will give satisfactory results. On some work, no drilling whatever is done prior to broaching, and very often only one broach is used, but if the work is longer than, say, two inches, a roughing broach usually precedes the finishing broach. Of course, broaching from the rough can only be done when the broaching operation comes first, as otherwise the broach would follow the rough hole and, consequently, the finished hole would be out of true with any other surfaces which might be machined afterward.

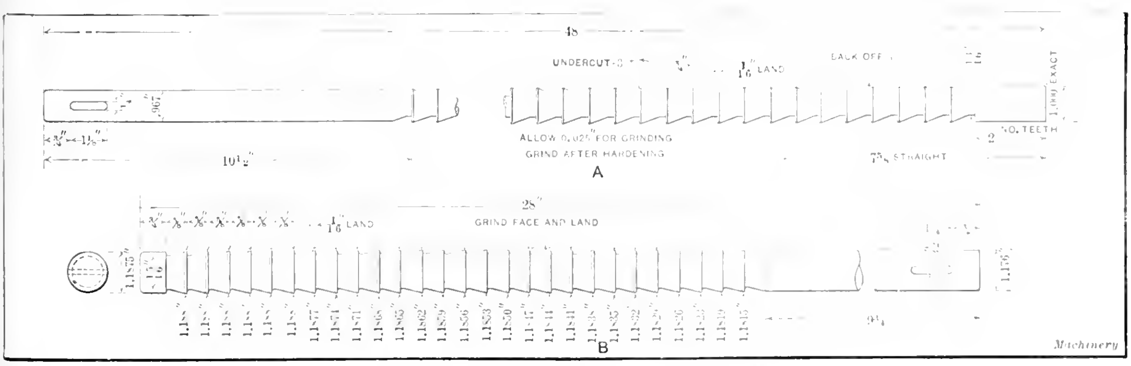


Fig. 5. Broaches used for Parts illustrated in Fig. 4

The part shown at A in Fig. 4 is another example of work on which broaching saved considerable time. This is a steering pivot for the front axle of an automobile. The hole is 5⅛ inches long and 1 inch in diameter. These pivots, at one time, were machined by first drilling the holes with two drills of different diameters which were followed by a rose reamer and a machine reamer, but even with these four operations, the hole was not finished straight and a hand reamer had to be used to secure satisfactory results.

Prior to the broaching operation, the pieces are roughly drilled 1/32 inch under size and then they are broached. The result is that the work does not need hand reaming and is produced cheaper and with a better finish than could be obtained by hand reaming. In this case, the broaching was done before any of the other machining operations. The material is chrome-nickel steel. The broach used for this work is shown at A in Fig. 5.

The example of work shown at B in Fig. 4 is another automobile part that is made of vanadium steel. The average production of these parts by broaching was sixty per hour, and one broach machined as many as 7685 pieces before it was worn too much for standard work. The dimensions of the broach used are given at B in Fig. 5.

* * *

CENTRIFUGAL FORCE ON AUTOMOBILE TIRES*

At first glance it would seem that every element going to make up the running gear of the modern automobile is balanced to such a nicety that any speed attainable under normal conditions would hardly be sufficient to necessitate serious consideration being given to any small, unbalanced weight. However, it has been demonstrated that even such a small weight as the tire valve is subjected to sufficient centrifugal force at high speeds, especially in racing cars, to warrant the placing of an equal weight on the opposite side of the wheel to overcome the energy developed by the rapid motion of the unbalanced valve.

The valves, including their caps, vary in weight for the different sized cars on which they are used from 3½ to 8½ ounces, and these weights seem insignificant when compared with the weight of a wheel and rim. But when the wheel is revolved at several hundred revolutions per minute a considerable centrifugal force is exerted, acting at any point in its travel radially away from the center of the wheel. It is intended to show here the tremendous forces that are developed at different speeds if the valves are not counterbalanced by weights on the opposite sides of the wheels.

The velocity V in feet per second of any particle of matter moving in a circular path with a constant radius, is represented by the product of the circumference and the number of revolutions per second. Now the centrifugal force of the same particle is the product of the weight and the square of the velocity, divided by the product of the radius and the force of gravity, which is 32.16 feet per second. Then substituting the value of V^2 in this second formula, we derive the equation, $C = 0.00034\ WRN^2$ pounds, where W is the weight of the body, R the radius of action, N the revolutions per minute and C the centrifugal force.

For the purpose of demonstrating by means of this formula, the necessity of balancing the wheels on high-speed cars, values will be assumed to correspond as nearly as possible to actual practice. Let the distance from the center of the wheel to the center of gravity of the valve be 15 inches; the weight of the valve and cap, 7½ ounces or 0.468 pound; and the diameter of the tire, 36 inches. Cars which will not attain a speed of 60 miles per hour are unusual, and it is an everyday occurrence for racers to maintain a speed of 75 or 80 miles per hour throughout a long contest or trial run. As a speed that is not at all unusual, let us assume 70 miles per hour for the first example. This is equivalent to 6160 feet per minute, and in traveling at this speed a wheel with a 36-inch tire will make 654 revolutions per minute. Substituting these values in the above equation we get:

$$C = 0.00034 \times 0.468 \times 1.25 \times 654 \times 654 = 85.1 \text{ pounds.}$$

In other words, a 7½-ounce valve on a 36-inch wheel traveling at 70 miles per hour will exert a lifting force of over 85 pounds when the valve reaches the top of the wheel. In case both valves of either pair of wheels are in the same relative position with regard to the axle, they will exert a combined lifting force of 170.2 pounds, and if they are opposite each other there will be a seesawing force acting on the car. Considering that there are four of these valves it is easily seen that they will exert forces in various and constantly changing directions as the wheels shift their relative positions in rounding turns in the road.

Since the centrifugal force varies as the square of the speed it requires only a slight increase in the speed to make a large increase in the force exerted. For instance, if the car travels at 75 miles per hour the force is increased to 97.5 pounds, and at 80 miles, which is frequently attained, the force on each valve will be 111.3 pounds, while at only 40 miles the force is 28 pounds. In a car going at the fastest rate of speed yet attained by man, 142 miles per hour, the force exerted by the valve is nearly 400 pounds.

Considering these almost neglected forces it is easily seen that some cognizance of them should be taken the same as is done in designing balanced wheels of stationary machinery. That racing drivers are coming to realize what these neglected forces might mean in case of an accident and loss of control of the car, is shown by the fact that a famous English driver has equipped each of his tires with two valves instead of one, the valves being placed on opposite sides of the tires in order to provide a perfect balance. It is said that the car will run at 80 miles per hour and hold the road remarkably well, where before it skidded badly at high speeds and was very difficult to control. Many American drivers also balance their valves by placing metal weights on the rim or felloes of the wheels opposite the valves.

* From an article by C. E. Palmer in the "Scientific American."

* * *

MOVING PICTURES OF AUTOMOBILE BUILDING

The Ford Motor Co. of Detroit, Mich., has just finished and equipped a complete department for taking motion pictures in its plant showing how Ford cars are made. A portion of the basement under the main office building has been fitted up as a studio and demonstrating room. The equipment is complete in every detail, and contains in addition to the regular photographic equipment a motion picture machine which is used for demonstrating to dealers and others interested. The films are made here and will be sent around to the principal cities both in this and foreign countries for exhibition in regular motion picture theaters. This is the first attempt that has been made by automobile manufacturers to exhibit their product in this manner before the general public, and it is reasonable to assume that it will create an unusual interest in the already popular Ford car.

The object of the company in establishing this department was to interest dealers and prospective purchasers. When a group of Ford dealers visit the Detroit office they are shown through the plant, taken out and photographed in a group outside the office building, and then are given a luncheon, after which the motion pictures of manufacturing Ford cars are shown. This entertainment lasts the greater part of the afternoon, and in the evening the party is treated to a banquet.

Duplicates of the films showing the processes of automobile manufacture are made from the original films and are sent to the principal cities and exhibited in regular motion picture theaters. After they have gone the rounds, they are turned over to district dealers and shown from time to time as occasion requires.

* * *

The use of natural gas as fuel in steam boilers is very wasteful, as it will take from four to five times the volume of gas per horsepower-hour to produce power through the medium of steam as it would if the same power were developed in a gas engine.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

ONE-PIECE ARMATURE DISK TOOLS

Having read the interesting article in the January number of MACHINERY, on "One-piece Armature Disk Tools," I can hardly understand how good results can be expected from these dies. After twenty years' experience in designing and constructing tools of this kind, I fail to see how it is possible to punch perfect blanks concentric and free from burrs with blanking or follow dies. I would prefer the compound sub-press construction, as this method keeps the upper and lower dies in perfect alignment, and saves a great deal of time in setting up the die. We make the lower or blanking die of one solid piece of "Ketos" steel (we also use "Intra" oil-hardening non-shrinking steel), machine to the required sizes and mount the die on the faceplate of the lathe to be bored (not drilled) to size. The device for mounting the die consists of a double plate with studs, and pawl to index for the required spacing. We also bore the holes for the oblong slots in the shedder and punch pad, with the same setting of the mounting device.

The prongs or individual punches for the upper die we make separately and mill them to the desired shape with forming cutters. This method enables us to replace a punch that breaks or distorts in hardening. Using a shedder that fits these punches nicely, not only sheds the punchings, but also supports and keeps the punches from springing. In shedding blanks in this manner one can leave the holes in the lower die straight without any clearance, whereas the method described in the article referred to requires some clearance to allow the punchings to drop through the die, which roughs up the holes to some extent. The holes in the die also become larger as the die is ground down; consequently the punchings will have heavier burrs. The pilot pins on follow-type dies that are depended upon to locate the stock cannot do so exactly, since they are made smaller than the piercing punches in order to prevent them from pulling the

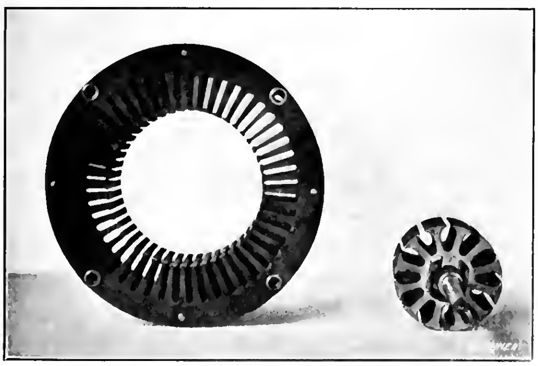


Fig. 1. A Series of Armature and Field Disks assembled—Note Perfect Alignment

blank out of the die; nor is the operator sure that the pilot pin enters the hole pierced centrally, so that it does not crowd the strip and thereby punch an imperfect blank. We are using black electrical sheet iron 0.015 to 0.019 inch thick, and make our punches 0.001 inch smaller than the dies for this thickness of stock, which gives good results. We make about fifty different sizes and styles of these, 1¼ inch to 14½ inches.

P. J. Mc.

[The chief advantage to be gained from making punches and dies from one piece of steel in preference to segments is the cheapness of construction. The method described in the foregoing criticism is the conventional one of making armature disk tools and contains nothing of unusual interest. The sectional sub-press type of armature punches and dies is not only difficult to make but is also extremely expensive. It was for this reason that the Robbins & Myers Co. decided to make its dies from one piece of steel and of the compound follow type. If this type of die is properly made and the press operator exercises the necessary care in setting up and operating, it is possible to produce blanks that are concentric and free from burrs. Fig. 1 shows this to good advantage. The series of field disks which have been clamped together look like one solid piece so exactly do the various segments conform to each other. By allowing only a small amount of clearance on the side of the die, it is possible to produce good clean disks until the dies are practically worn out.

As regards the toolmaking methods criticized in the above article, it is just as easy to machine a die in the milling machine as it is in the lathe, and, in fact, the milling machine is preferable if an accurate indexing head is obtainable. In the lathe it is necessary for the die to be trued up by means of an indicator which, of course, is only located by means of previously made prick-punch marks. Consequently, any inaccuracy in laying out will not be rectified in setting it up in

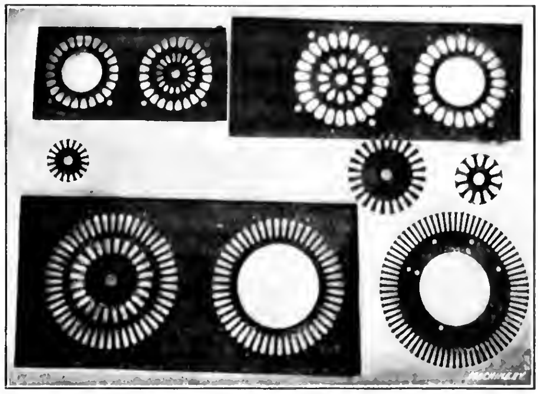


Fig. 2. Compound Punchings possible with the Solid Type of Armature Disk Tools

the machine to bore the holes. The Robbins & Myers Co. has been using the solid type of armature punches and dies for two and one-half years, and in that time has only had to repair two punches due to breakage of the prongs. In both cases repair pieces were set in with good results.

Another phase of the solid type of punch and die that is interesting is the production. This is considered to be greater than can be obtained with the combination sub-press type. With the solid type it is possible to get an armature or field disk, as shown in Fig. 2, at every stroke of the press and also to start the operation on another blank. This is impossible in the sub-press type because of the sectional type of construction used, and the prohibitive first cost. The solid type of armature disk tools is a good example of the advances made in the toolmaking art.—EDITOR.]

POSSIBILITIES OF RUSSIAN TRADE

The writer would like to add a few words to the item on page 379, engineering edition, of the January number of MACHINERY, concerning Russian export trade. It should be realized that, at the present time, Russia is recuperating from the effects of the Japanese war, and that great opportunities for American trade lie in the fact that this great country is keenly desirous of catching up with the progress of the rest of the world. To begin with, there are great expenditures for military purposes offering opportunities for trade. The government is, at the present time, building eleven large warships and twenty smaller ones. The army is very active in the development of aeroplanes and other military devices.

Russia is not so extremely backward a country as many would make us believe. There are thousands of investors and merchants familiar with developments in mechanical and other trades in other countries who are willing to take steps to develop the resources of their own country, but it is necessary that American manufacturers reach these people directly, as they do not yet seem to have the necessary push to take the initiative themselves. Advertising and direct methods for obtaining trade are necessary. Very few people seem to realize the rewards that may be waiting for the pioneers of American industries who enter Russia. The only serious competition that can be encountered is from Germany. Sweden can hardly compete with the United

States on the Russian market on account of its limited number of products*

As an example of the undeveloped state of Russia and the possibilities for further development might be mentioned the fact that there are only 120,000 miles of telegraph and 318,500 miles of telephone lines, these having been mostly constructed by Belgian and Swedish enterprises. The opportunities offered by this field alone are enormous. Russian water powers are also practically undeveloped, and there are great possibilities for turbines and electrical machinery. American agricultural machinery is used mostly on the larger estates at the present time, while the middle-class farmers hardly know of the existence of this class of implements. In addition, there are great possibilities for machinery for flour mills, beet sugar refineries, distilleries, breweries, and for the tobacco trade.

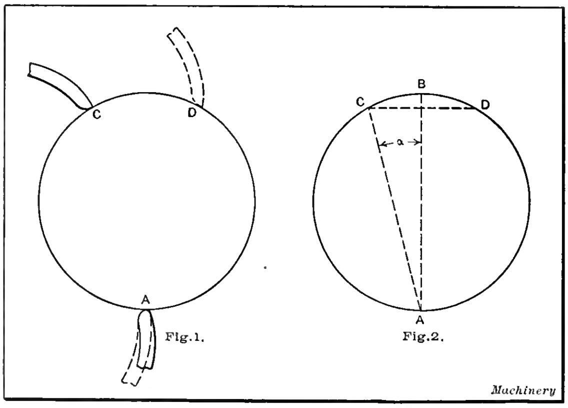
Several far-seeing concerns reached out early for the Russian market and profited thereby. As an example may be mentioned typewriters, small arms, and sewing machines. These have created a fine reputation for American products, and some firms, in fact, have had so large an amount of business that they have built factories in Russia.

It is, indeed, difficult to state all the possibilities that exist in Russia for the wide-awake American exporter. The writer can only say that if anyone has a product that has been successful in this country, he should go to Russia and try to find the same success there; also, now is the time!

L. J. W.

JUDGING MEASUREMENTS BY "DRAG" OF CALIPERS

It is evident that calipers set to 10 inches will not pass over a piece having a diameter of 10.010 inches without springing. That the distance *CD* in Fig. 1, which represents the "drag" of the calipers, depends upon the relation between the diameter of the work and the caliper setting, is equally self-evident. Probably most men who use lathes, especially when turning quite large work, sometimes rely on



Figs. 1 and 2. Diagrams illustrating how Allowances are judged by Drag of Calipers across Surface of Work

the drag of the calipers to show how much metal remains to be removed, and many veterans in the trade remember when allowances for press fits, etc., were made in this way, before the day of micrometers and vernier calipers.

I remember a man who was turning a part, the finished diameter of which was to be 20 inches. He roughed it down until the calipers dragged about 1/4 inch; then setting the tool in 0.005 inch, started the finishing chip in serene confidence that all was well. When the foreman, exasperated by the spoiling of a somewhat valuable piece, had concluded a full and free expression of his sentiments, the lathe hand quoted in his own defence what he believed to be a fact indisputable as the laws of gravitation. "Everyone knows, Mr. A., that the drag is always twenty times the oversize." As in this case the drag corresponding to 0.010 inch oversize is not 1/4 inch, but about 1 1/4 inch, his statement failed to meet with enthusiastic approval.

DRAG OF CALIPERS FOR DIFFERENT DIAMETERS

Caliper Setting, Inches	Drag for Oversize of			Caliper Setting, Inches	Drag for Oversize of		
	0.005	0.010	0.020		0.005	0.010	0.020
6	0.490	0.692	0.977	18	0.846	1.199	1.696
7	0.529	0.748	1.056	20	0.892	1.256	1.787
8	0.565	0.799	1.129	22	0.934	1.325	1.875
9	0.599	0.848	1.198	24	0.970	1.387	1.959
10	0.632	0.894	1.264	30	1.091	1.551	2.193
12	0.693	0.979	1.384	36	1.197	1.693	2.398
14	0.748	1.057	1.495	42	1.299	1.841	2.594
16	0.797	1.131	1.599	48	1.382	1.969	2.774

Machinery

It is easy to compute the distance *CD* for any given case. Referring to Fig. 2, $\frac{AC}{AB} = \cos a$, and $CD = 2\ AC \sin a$. In the instance cited, where the calipers were set to 20 inches, if the job were 20.010 inches,

$$\frac{20}{20.010} = \cos 1 \text{ degree } 48 \text{ minutes, and}$$

2×20 inches $\times \sin 1$ degree 48 minutes $= 1.256$ inch.

New London, N. H. GUY H. GARDNER

REMOVING A DENT FROM A COPPER FLOAT—A QUESTION

This contribution is submitted in the hope that some of the readers of MACHINERY may have had a similar experience and can give some information on the subject. Some years ago the writer had charge of a tool-room, and almost any old job was likely to come in. The foreman in charge (a very fine mechanic himself) brought in a copper float one morning. The float was about 5 inches in diameter and the sheet copper was brazed at about the middle. It was from the dial water gage of a steamboat and had a dent in it about 1 1/2 inch diameter and 3/4 inch deep. There were no openings in the piece and the trick was to take out this depression without drilling the hub or taking the float apart where the two halves were joined.

There was not time enough to send for a new float, as the boat was due to sail before a new one could be obtained. I was given no information as to how the work should be done and, in fact, considered that a joke was being played on me. The float was thrown on the bench and I had forgotten about it until the foreman finally called for it; then I realized that he was not joking. Well, we held a consultation but arrived at no solution and the foreman left me to figure it out. Here is the result.

The float was covered with a coating of lime about 1/32 inch thick, deposited from the feed water, and I picked up a small hammer that was used for laying out work and started to crack off the scale by way of amusement. This had not continued long before I imagined that the depression was smaller than when I started. Then I began to peen systematically around the depression, and lo and behold the dent was actually disappearing and in a short time was completely removed.

Mr. Foreman was very much surprised when the job was handed to him, and as he had said that "it was up to me" and I could worry about it, I made him guess a long time before I finally told him how the job was done. Now, I should like

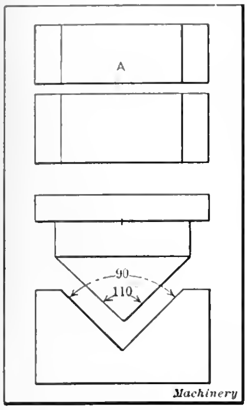
* Swedish competition is, perhaps, not to be so lightly disposed of. Sweden has made complete installations of telephone systems in a great number of the larger Russian cities in competition with the leading manufacturers both of Germany and the United States, and even nearer home it has offered United States formidable proof of its competitive qualities, in that a Swedish concern installed the complete telephone system in Mexico City in competition with manufacturers in the United States. Sweden, at the present time, and for a great many years back, has supplied Russia with most of the heavy wood-working machinery, such as saw mills, etc. used in that country, and many Swedish concerns are now establishing branch factories in Russia in order to overcome the difficulties caused by the Russian tariff. The only apparent reason why the Swedish competition might not, in the long run, be of importance would be because of the size of the country, it being too small in population to be able to supply the demands of a constantly increasing Russian market. The Swedes, however, are wide awake to the great opportunities in Russia, which many American exporters are not.

to have some of the readers of MACHINERY explain through what process the dent in this float straightened out.

Dubuque, Iowa. E. J. BUCHET

ANGLES OF ANGLE-BEAM SHEAR BLADES

J. D. Y.'s inquiry in November MACHINERY concerning angles of angle-beam shear blades calls to mind my experience in this line of work. Having described this in a contemporary some time ago, I will not go into much detail; however, I will say that by increasing the included angle of the upper or cutting blade to about 110 degrees and retaining the angle of 90 degrees at the bottom, very satisfactory results will be obtained. The reason for this is that the cutting is done gradually, beginning at the outer flanges of the angle, thus making it easier on punch, die and punch press. A further suggestion would be to do the cutting in the center *A* of two dies, as shown in the illustration, using a blade of a thickness depending on the weight and thickness of the angle to be sheared. This form of shear is excellent for this class of work and gives a very small amount of distortion in the angle.

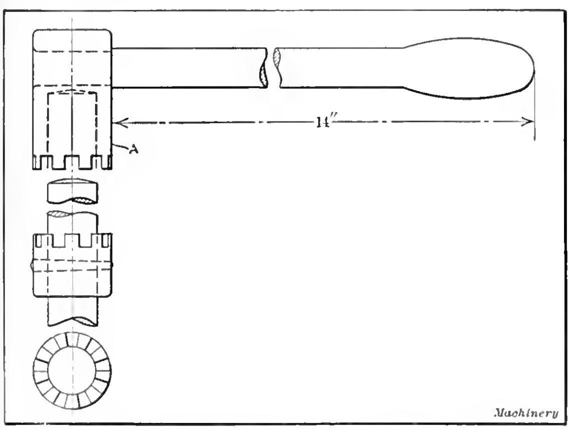


Angle for Angle Beam Shear Blades

New Haven, Conn. J. M. HENRY

HANDLE FOR CROSS-SLIDE OF TURRET LATHES

A very convenient handle for the cross-slide of a turret lathe or screw machine handling bar work is illustrated herewith. This handle is adjustable, and is therefore superior to the one sent with the machine, which is not adjustable. As the illustration shows, it is provided with clutch teeth so that by simply lifting it out of engagement the handle can be swung to any position. When two cross-slides are being used, the adjustable handle has a great advantage over the solid type. For example, if one slide is being used for cutting off finished parts while the other carries the forming tools, solid handles may interfere with each other, thus making it necessary to extend the forming tools so much as to cause chattering.



Handle for Cross-slides having Adjustment to prevent Interference between Handles on Front and Back Slides

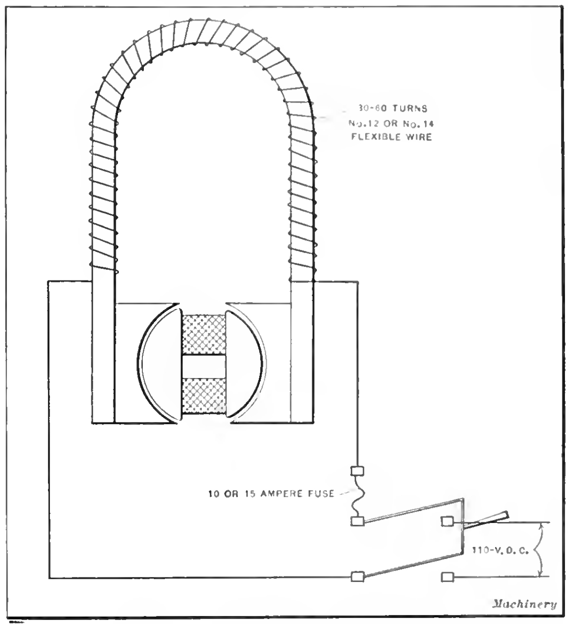
With the adjustable handles, such interference could be avoided. Another good feature is that the handle can be turned to the position that is most convenient for the operator and that enables him to exert the greatest pressure. The writer has designed and used this handle and found it a great labor saver. A handle of the solid type can be used in making the adjustable style, by simply cutting it off close to the hub ring and inserting the end in hub *A*. The particular handle illustrated has nine teeth (cut to a depth of ¼ inch) which gives all the adjustment that is required.

Pearl River, N. Y. EDWARD A. FRIEL

RECHARGING PERMANENT MAGNETS

The December number of MACHINERY has just come to my desk, and if not too late I would like to offer an answer to A. B.'s inquiry in regard to a method of remagnetizing magneto generators such as are used on automobile and motor cycle engines. These generators can be remagnetized by wrapping them with a temporary coil of from 30 to 60 turns of wire, and connecting this coil to a 110-volt direct-current circuit of considerable ampere capacity through a 10 or 15 ampere fuse and a knife switch. After the connections are made, the switch is closed, throwing the coil directly onto the line.

The fuse will be blown with some violence and the high current will force a heavy flux through the magnetic circuit and the armature. The armature, which is usually of the H-form, should be blocked in the position of least magnetic reluctance during this operation to provide for the minimum amount of magnetic flux cutting the armature winding. The proper position of the armature is shown in the diagram, which also illustrates the method of making the connections. No. 14 flexible wire and open link fuses will be found convenient and inexpensive, and a piece of sheet asbestos may be hung over the fuse to protect the workman's eyes from the flash. After the generator has been magnetized, the coil should be removed, and if flexible wire is used the same coil may be employed over and over again. The advantage of this method is that it is not necessary to take the magneto apart or remove it from the machine. This also eliminates the possibility of replacing the magnets with the polarity reversed.



Method of recharging Permanent Magnets

L. M. D.

SHRINK VS. PRESSED FITS

In answer to J. B. F.'s question in the December number of MACHINERY as to which is best, a shrink or a press fit, I would submit the results of the following experiments:

In making the rear axles of a well-known automobile, we were confronted with the question as to which was the stronger, a shrink or a press fit. This question was an-

swered by experiments as follows: The end members, brackets and housing had to be fastened securely to the steel tubing. First we tried shrinking the parts together. The tubes were turned to 2.254 inches diameter and the holes in the various members were reamed to 2.250 inches diameter and shrunk onto the tubes. Next we turned some tubes to 2.2525 inches, and the holes were reamed the same size as for shrinking, or 2.250 inches diameter. The members were then forced onto the tubes and, in both cases, were riveted with the same number of rivets. We made four axles with press fits and six with shrink fits. The axles were assembled and marked for identification and sent to the finish assembly department where they were fitted to the bodies.

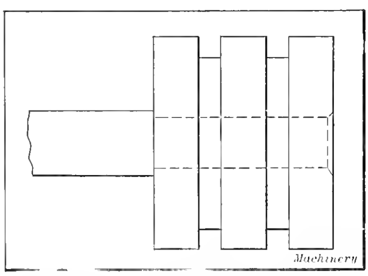
To make the story short, of the ten axles finished four were returned in less than a month and they proved to be the forced fits in each case. We never had an unfavorable report from the shrunk axles, and thereafter shrunk all parts onto the tubes and never had any complaints. The returned axles all had sheared rivets in the housing end and, in one case, the end member had sheared and was loose. This experiment was conducted with malleable iron castings. The outside diameter of the various parts was approximately 3 inches, leaving a wall about ⅜ inch thick. We afterward used Parson's white bronze, shrinking the members with the same allowance and less heat and obtained the same satisfactory results.

New Britain, Conn. W. C. Betz

Concerning J. B. F.'s problem of shrink and force fits, I would like to say that, theoretically, they would both be equal, provided the conditions were equal at the start. Theoretically, the holding power is limited by the elastic limit of the material which, in this case, would be the elastic limit of the outer member, as it is thinner than the shaft. In practice, a shrink fit will hold more firmly than a force fit because the gripping strain is equally distributed over the entire surface, while with a force fit the strain is unequal from one end to the other. This is due to the fact that the difference in diameter between the two parts must be taken care of by the compression of the shaft and the expansion of the outer member, and as the metal is not perfectly elastic, the end that goes on first will permanently set the shaft to a certain extent, so that the remainder of the fit will not grip tightly, owing to the diminished size of the shaft.

Detroit, Mich. Paul P. Vlasek

In the December number of Machinery J. B. F. asks a question in regard to the relative merits of shrink and pressed fits. In my opinion the collar which he illustrates in connection with his question should be shrunk onto the shaft. This method will be found most satisfactory where the collar or other part is relatively thin, so that there is danger of straining the metal in pressing it onto the shaft. Where a thicker piece, such as a crank disk, piston or similar part is to be secured to a shaft or rod, it is more practical to employ a pressed fit. It is a good plan to have a gage on the press so that it is possible to determine the exact pressure employed in forcing the piece into place. This insures having the fit tight enough to stand the work for which it is intended.



Small Piston to be shrunk or pressed on Rod

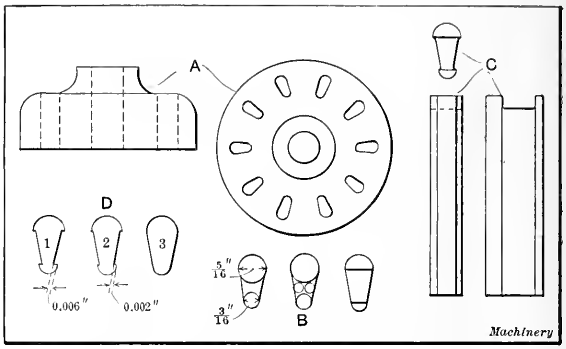
In this connection I would like to ask the most practical way of holding an 8-inch piston on its rod. Is a pressed fit or a shrink fit more likely to give satisfactory results? Will the fit become looser after the engine has run for some time and will the strain and vibration have any effect? I would also like to know how important it is to keep the rod or shaft cool while the piston or collar which is being shrunk onto it is cooling off.

W. J. M.

A BROACHING OPERATION

The method of broaching explained in the following paragraphs was worked out by the writer for machining ten holes in the core for a mold used for die-casting a small motor frame. These holes in the main core house sub-cores, as it was found impossible to produce perfect work and operate the mold in any other way. The main core is screwed to the top die, while the elongated sub-cores are fastened to a core plate. The main core is freed from the casting after the mold is separated, by the action of ejector pins, after which the sub-cores are withdrawn.

The broaching of these holes was performed by three broaches, the second and third of which varied in size by only 0.002 inch. The purpose of this was to have the third broach take a very fine cut so that the desired finish would be obtained without any other work than a small amount of filing for clearance at the back of the hole, and polishing with emery cloth. It was also important that the edges of the sub-core holes on the face of the main core should be as nearly perfect as possible; otherwise a burr would form on the casting at this point.



The Work to be broached and the Type of Broach that was used

It will be seen that these core pin holes pass through the core *A* as shown in the accompanying illustration. The core is made of machine steel and is 1½ inch thick. The core pin holes are ⅝ inch long, the maximum width being 5/16 inch and the minimum width 3/16 inch. The ends of the holes are semicircles of 5/32 and 3/32 inch radius, respectively. In laying out the work, two concentric circles were scribed on the core *A* at the required distances from the center. The next step was to draw ten equally spaced radii to locate the centers of the holes to be broached. The centers of the 5/16 and 3/16 inch semicircles were next marked with a center punch at the intersections of the two concentric circles with these radii. It may be well to mention at this point that all other machining operations had been performed on the core before starting to machine the core pin holes.

The next step was to drill ten holes of 5/16-inch diameter and ten holes of 3/16-inch diameter on the centers which were located for this purpose. These holes were then reamed. This left a wall of metal of ⅛-inch thickness between the two holes and this wall was partially removed by drilling two small holes as shown at *B*. The remainder of the wall was then broken away by pushing a cold chisel through the hole, after which the holes were ready for the broaching operations.

Three broaches were made of the form shown at *C*, the broaches being about ½ inch longer than the thickness of the core *A*. The broaches were made a few thousandths under size to provide a running fit against the remaining portion of the walls of the 5/16 and 3/16 inch holes, which served as a guide for the broaches. The cutting end of each broach was filed away to a depth of 3/16 inch at the center, leaving segments of 5/16 and 3/16 inch diameter on the broach which

served as a guide in starting it into the hole and leading it through the work.

The broaches were not stepped in the usual way, but were designed to simply cut on the end, the form of the three broaches used being shown at *D*. Broach No. 1 was cut away to a depth of 0.006 inch on each side. Broach No. 2 was cut away in a similar manner to a depth of 0.002 inch on each side. Broach No. 3 was not cut away on the sides. It will be evident that broach No. 1 leaves 0.006 inch of metal on the sides of the hole, and that broach No. 2 cuts away 0.004 inch of this metal, leaving 0.002 inch for the finishing cut taken by broach No. 3. An arbor press was used to force the broaches through the work, plenty of oil being supplied for lubricating purposes. Smooth clean holes were produced that were uniform in size and required very little finishing. The cost of the machining operation was much less than it would have been if each hole had been filed to a plug gage.

Union Hill, N. J. G. I. JOHNSON

THE SQUARE KEY VS. RECTANGULAR AND TAPERED KEYS

In an article on keys which appeared in the November number of MACHINERY, Martin H. Ball hoped to start a discussion of the subject. It is an interesting subject and it is a pleasure to me to see someone else make a start on it. Seeing the key situation in a different light does not necessarily make me right or the other fellow wrong; so let us have all the light we can. The square key, without taper, made of cold-rolled stock, fills the bill completely from my point of view. It can be bought finished to size and in convenient lengths so that it can be kept in stock. Then when a key is wanted in a hurry, as is often the case, sawing to length is all that is necessary. If the square key should be recognized as the universal standard, all squabbles as to the proportion of width and thickness would be done for. Any number of combinations can be made up for a standard of rectangular keys, but square is square all over.

Mr. Ball states that customers complain of square keys, saying that they unnecessarily weaken the shaft and hub; and broken parts returned seemed to justify their conclusion. The fact that parts were broken does not prove that the key was at fault. The shaft may have been too weak to do its work properly, and the same may be true of the hub. That is too often the case. If shafts, keys and hubs were in all cases properly designed for their loads instead of by rule-of-thumb methods, we would not hear of so many cases of hubs bursting or keys shearing. In many of my designs I have used standard safety flange couplings, but when making computations for hub and key I have often had to use two standard keys in order to keep the key stress within safe limits. And often when using a pinion that is of small diameter in proportion to the shaft I find it advisable to use two small keys in order to keep the hub stress low. In Kent's "Pocket-book" we find that common practice is to use a square key whose width and depth are each equal to one-fourth the diameter of the shaft, or as nearly as may be in even sixteenths of an inch. Ordinarily that does very well for the section of the key, but it is still necessary to make a computation to find out whether one or two keys are needed and how long they should be.

Everyone that is interested in this subject should send to the University of Illinois, Engineering Experiment Station, Urbana, Ill., for Bulletin No. 42. This bulletin contains the results of tests on numerous shafts with keyways of common sizes. On page 10 we find this significant statement, "It seems that a shaft with a single keyway of common dimensions has about the same ultimate strength as a shaft without a keyway." The statement in regard to the weakening effect of two keyways of standard dimensions must not be confused with the statement made in a preceding paragraph in regard to the advisability of sometimes using two keyways of smaller section in place of one standard keyway. To the best of my knowledge no tests have been conducted to determine the effect on the strength of a shaft of two keyways whose shearing value is equal to one keyway of standard dimensions. I have frequently used two keys in a pinion in order to keep the hub stresses down, and, of course, this means that the keys must be smaller than the standard sizes. Under such conditions I do not think the shaft is any weaker than it would be if one keyway of the regular size were cut in it. So far I have had no complaints in regard to this practice.

As an example of the use of two small keyways, consider the case of a pinion whose hub diameter is 6 inches and the shaft diameter 4 inches. The regular square key would be 1 inch thick and the remaining section of the hub left to resist tension would be only ½ inch thick. If two keys were used, each of which were ½ inch thick, the resistance of the keys against shear would be the same, and the hub would have a net thickness of ¾ inch, which represents a gain of 50 per cent. Although it is not definitely known, it appears very doubtful if the shaft has been weakened any more through cutting two ½-inch keyways than it would have been by cutting one keyway for a 1-inch key.

Experience has shown that a taper key will often produce considerable stress in the hub, tending to burst it. And also a taper key has been known to spring even quite heavy members so much as to make the machine a failure. Similar members when keyed with a square key have given a successful machine. To me, a taper key appears to be nothing more than a convenient means of tightening up a poor fit at the expense of the rest of the job. On investigation, it will be found that many of our largest makers of machinery are using the square key as their standard. The General Electric Co. might be mentioned as one of them.

Albany, N. Y. CHARLES P. WIWEKE

SEMI-AUTOMATIC TURRET FIXTURE

It was necessary to cut a fine thread on work of the form shown in Fig. 1, and as the preceding operations were performed on these pieces in a turret lathe, it was advisable to do the threading on the turret lathe also. None of the stock feed gears would produce the necessary result, and rather than make a special gear or send to the manufacturer for one, the fixture illustrated in Fig. 2 was designed. This fixture has proved not only practical, but even more economical than if the operation had been done with the feed gears and cam. Of course the device is only semi-automatic, but the threading is the last operation performed and the machine requires the attention of the operator at this point.

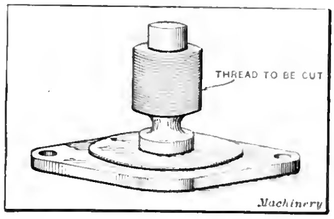


Fig. 1. Work to be threaded

It will be noted from Fig. 2 that the fixture is a sort of

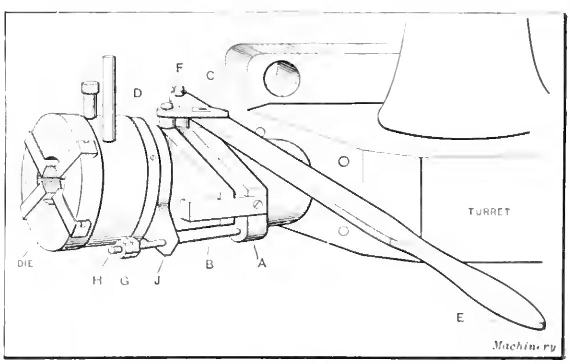


Fig. 2. Turret Fixture for threading Work shown in Fig. 1

sensitive Geometric die. The bracket *A* is fastened to the turret and the bracket *B* to the back of the die. These brackets are connected by a link *C* and stud *D* and handle *E*. The handle is fulcrumed at the point *F*, and by this arrangement the die may be fed onto the work by hand, without requiring

undue effort on the part of the operator. The turret is stationary at the end of its stroke, which does not bring the die into contact with the work, but close to it. The nuts *G* on the stud *H* may be adjusted to engage trip *J* at the desired point; this trip opens the die and allows it to be withdrawn quickly by moving back the hand lever *E*. An automatic device for resetting the die could easily be attached to the turret to make the tool ready for operation on the next piece of work.

RICHARD RUSSELL

DRILL PRESS FIXTURE

The following describes a drill press fixture which is used for holding work of irregular shape. It will be seen that the fixture consists of six bars which have shouldered studs mounted in them. The work is set on the shoulders of these

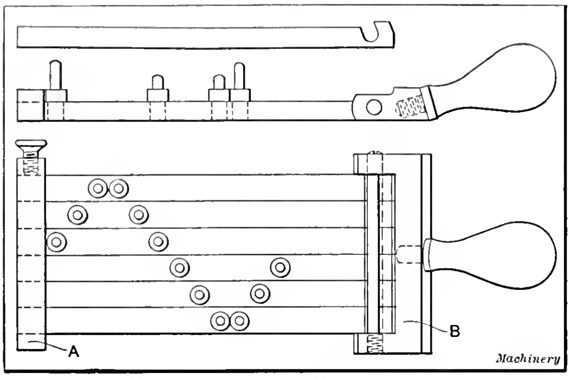


Fig. 1. Fixture for holding Drill Press Work

studs to provide clearance underneath so that the drill will not cut into the fixture. The method will be readily understood by referring to Fig. 2.

In preparing to set up a piece of work in this tool, the strap *A* and handle-piece *B* are removed. This leaves the bars free so that they may be arranged to bring the studs into the desired position, three or four studs bearing against the work as shown in Fig. 2. The handle-piece and strap

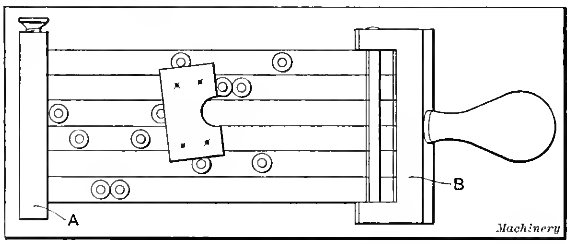


Fig. 2. Work in place in Drilling Fixture

are then replaced and the work is ready to be drilled. Before mounting in the fixture, the holes are usually centered as indicated by crosses in Fig. 2. A fixture of this kind is in the nature of a safeguard, as it does away with the danger of the operator's hands being injured through the work getting caught and being twisted around by the drill.

Kilfinane, Ireland. C. W. WHITESIDE

SLOTTING "NI-CHROME" STEEL RIBBON

In response to W. C. H.'s inquiry on slotting "ni-chrome" steel, in November MACHINERY, I do not think it is possible to produce a die that would satisfactorily slot "ni-chrome" steel ribbon. As the writer suggests, it is the toughest material to work that could be imagined. I have not had experience in this line exactly, but venture the following suggestion. In the making of the ordinary sub-treasury locks, the small flat disks that form the main part of the locking device, are slotted by means of disks of metal run at about 1500 revolutions per minute. The disks are not more than 0.100 inch thick. It was attempted at first to saw these slots, but a burr was left which made the work unsatisfactory. With just a plain metal disk, these slots are now formed, leaving practically no burr. This method was described in MACHINERY some time ago. My suggestion would be to build a machine with, perhaps, a dozen of these disks in line and a clamping arrangement to hold the ribbon down while it is being slotted, but, as I said before, this is merely a suggestion, although experiments may prove it to be of value.

New Haven, Conn. J. M. HENRY

ADJUSTABLE CLAMPS FOR T-SQUARES

In cross-sectioning drawings it is frequently necessary to keep the T-square in one position for a considerable length of time while using the triangle to cross-hatch some detail of the drawing. If the T-square slips, it means that a lot of time will be lost in erasing and then redrawing the lines over which the pen passed. To obviate this difficulty, the writer has used two forms of clamps which are illustrated herewith. The use of these clamps holds the T-square in place and leaves one hand free to use the drawing pen while the other can be used to move the triangle. In this way, quicker and better work can be obtained.

In order to use the clamp shown in Fig. 1, a slot 1 inch wide by 3/8 inch deep is cut along the left-hand edge of the drawing board. A strip of metal of the same size is then fastened to the edge of the board by means of countersunk screws, the metal being allowed to project 1/4 inch beyond the edge of the board. In this way, a slot 1/4 inch wide is left between the metal strip and the edge of the drawing board.

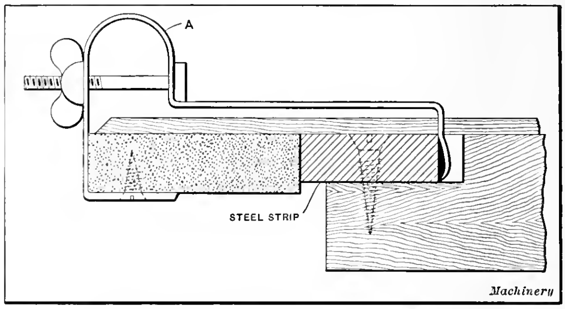


Fig. 1. T-square held by Pressure of Clamp Spring on Steel Strip

A strip of spring brass *A* is next fastened to the head of the T-square and bent to the form shown in the illustration. The right-hand end of this spring grips the strip of metal on the drawing board and by adjusting the wing nut on the bolt that is carried by the spring, the tension can be regulated to secure the necessary grip.

A simpler form of clamp is illustrated in Fig. 2. This clamp is made by attaching a block of wood to the under side of the head of the T-square, so that the combined thickness of the

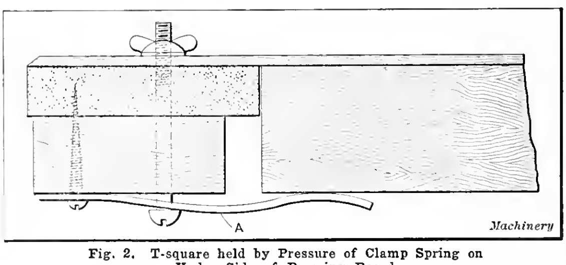


Fig. 2. T-square held by Pressure of Clamp Spring on Under Side of Drawing Board

head and block is equal to that of the drawing board. A strip of spring steel *A*, bent to the form shown in the illustration, is then fastened to the wooden block by means of a screw. The end of this spring bears against the under side of the drawing board and the desired grip is obtained by adjusting the wing nut at the top of the bolt, which passes through the head of the T-square. Although simpler than the clamp illustrated in Fig. 1, this arrangement does not work as well because the action of the spring sliding over the wood is not

as smooth as when the spring is in contact with a metal surface. Another disadvantage of this clamp is that it is impossible to hold the T-square as firmly with it.

Allegheny, Pa. MURRAY FAHNESTOCK

COMPENSATING SCREW THREADS FOR SHRINKAGE

In the December number of MACHINERY, W. B. T. presented an illustration of a chuck jaw which had shrunk 1/64 inch in pitch in hardening; the 1½-inch diameter screw to fit this jaw, which has five left-hand square threads per inch, was also illustrated. Since tool steel shrinks only 0.015 to 0.030 inch per foot of length if it is correctly handled, it is assumed that W. B. T. meant that there was a shrinkage of 1/64 inch in the entire length of the jaw—say 4 inches. The method of compensation presented in the following is applicable, however, to any amount of shrinkage and may also be used in cases where it is desired to cut screws with an odd or fractional lead.

In the case under consideration, assume that in 4 inches the lead has shrunk 1/64 or 0.0156 inch, making the length of twenty threads 3.9844 instead of 4.000 inches. Under these conditions the lead of the screw will be $\frac{3.9844}{20} = 0.19922$ inch. Consider the case of a lathe which has a lead-screw with six threads per inch. It is then necessary to find gears with a ratio of $\frac{0.19922}{\frac{1}{6}}$ to drive this screw. Multiplying this fraction by $\frac{6}{6}$ gives $\frac{1.19532}{1}$. To further simplify this fraction, divide both numerator and denominator by 4 and then multiply numerator and denominator by 10,000 which gives the following result:

$$\frac{1.19532 \div 4}{1 \div 4} = \frac{0.29883}{0.25000}$$

$$\frac{0.29883 \times 10{,}000}{0.25000 \times 10{,}000} = \frac{29{,}883}{25{,}000} = \frac{7471}{6250}$$

This fraction cannot be easily reduced further and in order to bring it to a form where it can be conveniently handled, add to the numerator and denominator two numbers whose values are such that the resulting value of the fraction will remain unchanged. For example, if to both terms of the fraction $\frac{150}{300}$ numbers are added in the ratio of 1 to 2, the value of the fraction remains the same, thus:

$$\frac{150+7}{300+14} = \frac{157+9}{314+18} = \frac{166}{332} = \frac{1}{2}$$

This process can be continued indefinitely, provided the numbers added to the numerator and denominator are in the same ratio as that of the original fraction. The fraction $\frac{7471}{6250}$ is very nearly $\frac{6}{5}$ and so $\frac{4 \times 6}{4 \times 5}$ may be added to it without changing the ratio. Performing this step gives $\frac{7495}{6270} =$

$$\frac{1499}{1254} = \frac{1500}{1255} = \frac{300}{251} = \frac{306}{256} = \frac{6 \times 51}{8 \times 32} = \frac{30 \times 51}{40 \times 32} \text{ (approximately).}$$

The result of the preceding calculation shows that we may use gears having 30, 51, 40 and 32 teeth, respectively. The lead of the screw to be cut is equal to the lead of the lead-screw on the lathe multiplied by the ratio of the product of the number of teeth in the driving gears to the product of the number of teeth in the driven gears. In the present case, the gears with 30 and 51 teeth are the drivers and those with 40 and 32 teeth are the driven gears. This gives the screw to be cut a lead of

$$\frac{1}{6} \times \frac{30 \times 51}{40 \times 32} = \frac{51}{256} = 0.1992187 \text{ inch.}$$

This result differs from the desired lead by only 0.000002 inch, which is far too small to be easily measured even if the screw to be cut was one foot in length. Gears with 30 and 40 teeth will always be available among the collection of change gears for any screw cutting lathe and a 32-tooth gear will generally be included in the collection. This leaves only one gear having 51 teeth to be cut for this particular job.

As another example, assume a case in which the hardened jaw is 3 inches long and 15 threads are exactly 2.9844 inch in length after hardening, and that it is required to drive the lead-screw (five threads per inch) with gears having a ratio of $\frac{0.19896}{0.20000}$. Simplifying, we have:

$$\frac{0.19896}{0.20000} \times \frac{50{,}000}{50{,}000} = \frac{9948}{10{,}000} = \frac{2487}{2500}.$$

The value of this fraction is so nearly unity that the same number can be subtracted from each term without seriously affecting the result. The required driving and driven gears are thus found to be:

$$\frac{2487-30}{2500-30} = \frac{2457}{2470} = \frac{27 \times 91}{38 \times 65} = 0.994737.$$

This results in an error of less than 0.001 inch per foot.

As a further example, consider a case in which it is required to cut a screw with a lead of 0.19922 inch on a lathe whose lead-screw has a lead of 0.250 inch. The ratio then becomes:

$$\frac{0.19922}{0.25000} = \frac{9961+4}{12500+5} = \frac{1993+4}{2501+5} = \frac{1997}{2506}$$

$$\frac{27 \times 74}{23 \times 109} = 0.796968 \text{ (approximately).}$$

This gives an error of only 0.00011 inch per inch. These examples are sufficient to show that with a few odd gears and a lathe—preferably with a fine-pitch lead-screw—it is possible to cut any fractional thread with very small error. The error will frequently be so slight that it is much smaller than can be determined by measurement. The reduction of the fractions to the required form will be greatly facilitated if a list of prime numbers is available for this purpose. After a little practice a set of compound gears for any required lead can be picked out very quickly. The writer uses this method to chase tap threads, cutting the lead just enough longer than the required dimension so that the pitch of the thread will be exactly right after the tap has been hardened.

Boston, Mass. L. J. RODGERS

RECHARGING PERMANENT MAGNETS

In the December number of MACHINERY, A. B. asks how to recharge a permanent magnet. The following will be found a satisfactory method:

Attach the permanent magnet that is to be recharged to a direct-current electromagnet. Allow the two magnets to stay in this way for about 45 minutes and strike the permanent magnet light blows with a hammer every few minutes. The small particles of the steel which the chemist calls "molecules" must all lie in the same direction in order for the magnet to retain its magnetism. The light blows struck with the hammer while the current is flowing sets up a vibration in the steel which enables the molecules to adjust their position so that the magnetism is retained after the magnet to be charged is disconnected from the electromagnet.

Grand Rapids, Mich. GEORGE H. HAMILTON

BRAZING CAST IRON

Mechanics who are called upon to braze cast-iron parts together will find the following a very satisfactory method. Place the pieces to be brazed in such a position that the fractured surfaces are uppermost and then heat them slowly to a temperature of about 2000 degrees F. This is the highest temperature that can be safely used on cast iron without running the risk of melting it. After this temperature has been attained, the work is allowed to cool slowly. The parts are

next clamped securely together and brought to a bright red heat. A flux, composed of the following ingredients is then applied:

Iron carbonate.................................1 part
Powdered boric acid.........................2 parts

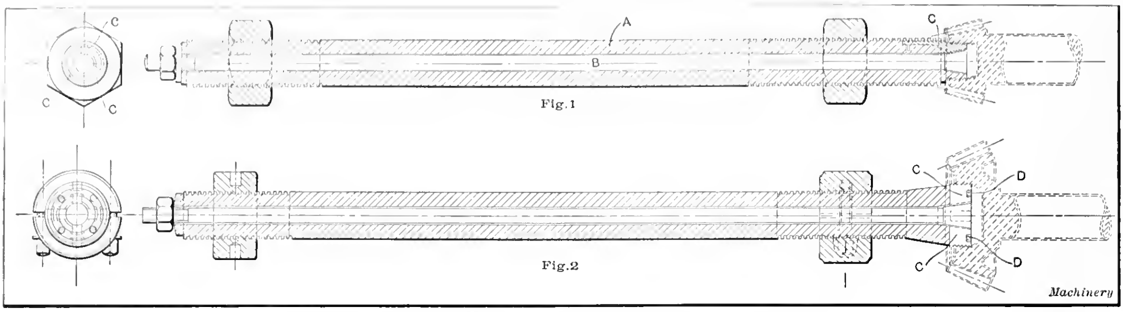
It is important for the parts to be brought to a bright red before adding the flux, which should be applied with a brass rod. After brazing, the work is allowed to cool in the air. In heating the work an ordinary gas torch is found very satisfactory.

East Orange, N. J. GEORGE GARRISON

SPECIAL ARBOR FOR BEVEL GEAR SHAPER

It is rather difficult to hold firmly in the Bilgram gear shaper, any pinion which has not a hole through it but is made solid with the shank as in the case of pinions for the rear drive of motor cars. For this reason, we have designed and have been using with success, the arbor illustrated in Figs. 1 and 2. Bevel pinions are bored and threaded, as shown to the right, so that they can be screwed onto arbor *A* which is supplied with the machine. This arbor has a hole through it to receive shaft *B*, one end of which is conical and the other threaded for a hexagonal nut. As will be seen, the end of arbor *A* which holds the pinion, has three or four notches in which are located strips or dies *C* that were threaded with the arbor. The inside edges of these strips bear against the taper end of the shaft *B*, and by drawing the shaft outward by means of the nut, the strips *C* expand, causing the pinion to be held firmly. Fig. 1 shows the arbor used for very small pinions. In this case, the expansion strips are held in place by set-screws which retain them in the arbor but allow some play. Fig. 2 shows an arbor suitable for pinions of larger size. There are four expanding strips held in place by ring *D* which is fixed to the arbor by set-screws.

Turin, Italy. C. BOELLA

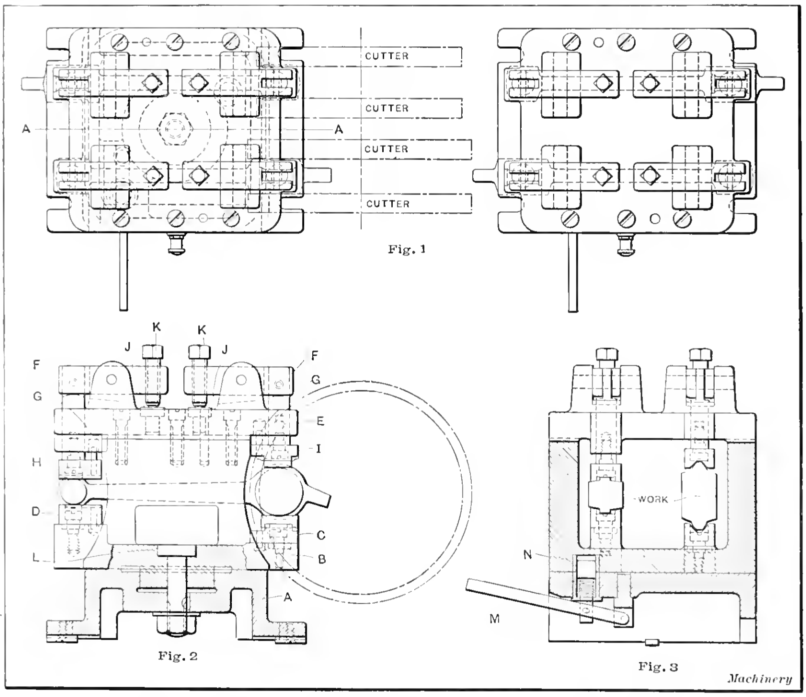


Figs. 1 and 2. Expanding Arbor for holding Bevel Gears in Gear Generator

FIXTURE FOR MILLING CONNECTING-RODS

The fixture for milling connecting-rods illustrated in Figs. 1, 2 and 3, was designed to enable work to be done in one operation on one machine that formerly required two operations on two machines. Only one operator is required for handling this work in either case, the saving effected by this fixture arising from the fact that the second machine can be used for some other work. The present method also produces more accurate work and the rate of production is increased.

The connecting-rods machined in this fixture are used on automobile engines. As they are heat-treated before machining, the metal is extremely tough but with high-speed steel inserted-tooth milling cutters, we were able to turn out from 275 to 300 connecting-rods in a ten-hour day. No time was lost in indexing the fixture or in removing the finished connecting-rods and replacing them with rough forgings, as the operator had ample time to perform this part of the work on one fixture while the cutters were at work on the rods held in the other fixture.



Figs. 1 to 3. Plan and Sectional Views of Fixture for milling Connecting-rods

Referring to the sectional view shown in Fig. 2, it will be seen that the fixture consists of a base casting *A*. A casting *B* is pivoted to the base casting and the locating V-blocks *C* and *D* are bolted to it. These V-blocks are mounted on pivots and allowed to swivel through a short distance, their movement being governed by stop-pins in the V-blocks which fit into holes in the casting *B*. This movement of the V-blocks is provided to compensate for any variation in the connecting-rod forgings, and keeps the work centrally located. The cover casting *E* is bolted to the top of the swivel casting *B*, and the clamping screws, levers *F*, posts *G* and clamping V-blocks *H* and *I* are secured to this cover casting. The clamping V-blocks are provided with the same swivel movement as the locating V-blocks, which insures the required alignment. Hardened steel pins *J* are inserted in the cover to take the thrust of the clamping screws *K*.

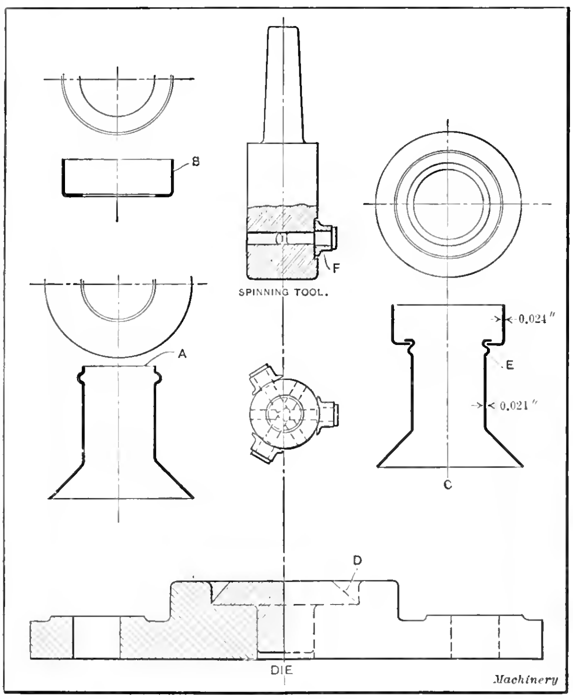
It will be seen that two connecting-rods are mounted in the fixture with their opposite ends adjacent, and the position of the straddle cutters is clearly shown in Fig. 1. The fixture is cut away sufficiently to allow the work to be fed to these cutters to machine the faces of the bearings. After one end of the connecting-rods has been machined, the lever *M* is pushed down to draw the index pin *N* free, and the casting *B* is then swiveled through 180 degrees and again located by the pin *N*. The fixture is then ready for the opposite ends of the connecting-rods to be machined. A gage, not shown in the illustration, is fastened to the base casting *A* to provide for setting the milling cutters.

Detroit, Mich. LOUIS L. ROBERTS

SPINNING TOOL FOR ASSEMBLING SHELLS

The brass shell *A* (see illustration) was to be attached to shell *B*. The regular way in which this class of work had been done was to make a split die, one-half being operated by a cam to open and close it, which allowed the work to be placed in the die. An undesirable feature of this method was that the shell was clamped, to support it, under the bead *E*, which caused the bead to be flattened.

The spinning tool *F* was devised for this work and has given good results. Besides retaining the shape of the bead, it makes a tighter joint and the production is increased over 75 per cent. The two shells, after being closed together by spinning, are shown at *C*. The spinning tool, which is used in a drill press, is run at about 500 revolutions per minute, and the vertical movement of the tool is obtained by a foot-treadle. The body of the tool is made of tool steel, hardened in oil and tempered at 495 degrees F. (brown). The rolls and pins are of tool steel, hardened in oil and tempered at 435 degrees F. (pale yellow). The rolls are an easy running fit



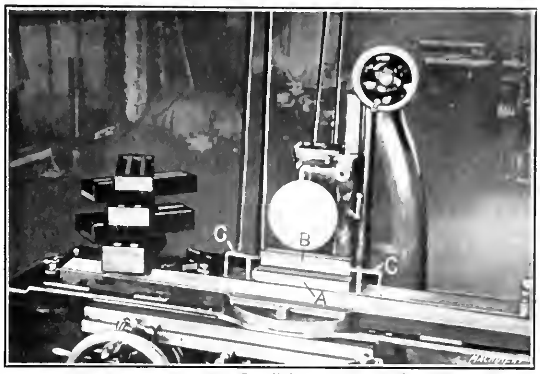
Spinning Tool and Die used for assembling Shells as shown at C

on the pins, and the pins a driving fit in the body. The die is made from cast iron and is bolted to the table of the press. The plug *D* is made of low-carbon steel and supports the inside of the shell. The shells are assembled, placed in the die and held from turning by the fingers, a slight pressure between thumb and forefinger being sufficient to hold the work while the tool does the spinning. This style of tool and die is now being used instead of the split die, except in cases where it is necessary to have the bead flattened so the inside walls will come together. W. D.

SIMPLE GRINDING FIXTURE

The accompanying illustration shows a simple fixture that was used on a No. 13 B. & S. grinder to finish accurately five sets of hardened parallels. They are shown at the left-hand end of the grinder table in hard wood boxes, which keep them in pairs and protect them from injury when not in use.

In making the grinding fixture the base *A*, which was a gray iron casting, was secured to the table by means of two 5/16-inch fillister-head screws. The base was then ground



Fixture for grinding Parallels on B. & S. Grinder

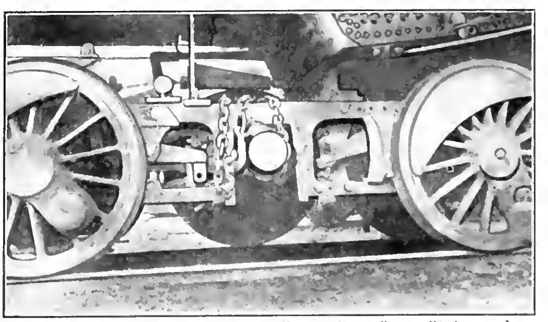
off to an accurate surface on its top face. The part *B* was next screwed to the base of the fixture and ground to an accurate finish so that its vertical face was perpendicular to the top of the base *A*. The clamps *C* were used to hold the work down and two parallel clamps were also used—one at each end—to hold the work securely against the face of the block *B*. These parallels were finished in pairs, and after being completed did not show an error of over 0.0005 inch in any direction. The sizes ranged from 3/8 by 3/4 inch to 3/4 by 1 3/4 inch, all sizes being 7 inches long.

Pottstown, Pa. CLAYTON DANE

A PECULIAR ACCIDENT

The accompanying photograph shows an accident that happened on the Birmingham division of the Southern Railway about a year ago. There are several cases on record of a pair of trucks having slipped from under a box car unnoticed, and one famous case where a whole car was lost out of a freight train without being detected until the end of the run.

The engine shown in the illustration had been stripped of all side-rods and was being hauled along with a train of cars from Atlanta to Birmingham. When the train stopped at Lincoln, Alabama, it was discovered that the left main wheel



Locomotive which lost Driving Wheel, Box, Shoe, Wedge and Pedestal Brace while being hauled in Freight Train

as well as the driving-box, shoe, wedge and bottom rest were all missing. There had been no previous indication that this wheel was loose. As is quite generally known, these wheels are pressed onto the axle with a pressure of from 100 to 150 tons, and, although they sometimes loosen after long usage, we never heard before of one working clear off the axle. The missing wheel was found twelve miles back.

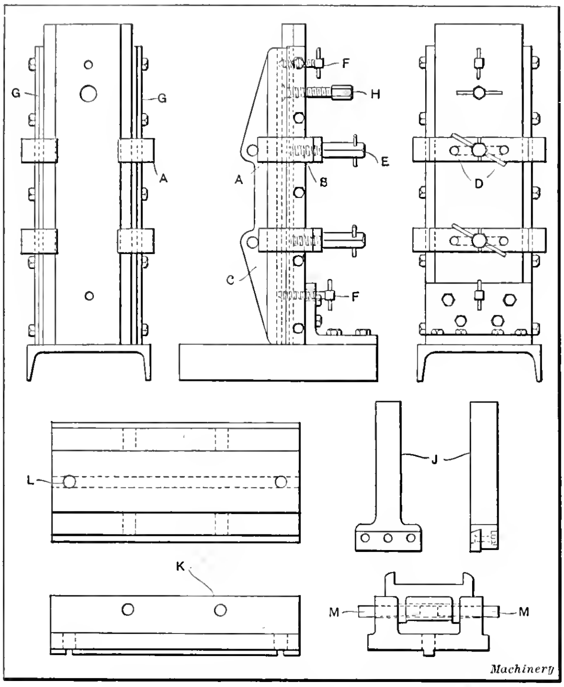
As is also well known, when an engine is being hauled by another engine, it is supposed to be attended by some person

who should have noticed this accident sooner. There was an attendant in this case but he had left his charge and was riding the leading engine. The chains shown in the illustration were put on and the engine hauled into the shop.

Birmingham, Ala. JOHN A. COOK

BABBITTING AND PLANING CROSS-HEAD GIBS

Appliances for babbitting and planing locomotive gibs, which proved very satisfactory in a Western railway shop, are shown in the accompanying illustration. The three upper views show the mandrel or fixture used for babbitting the gibs. The four U-shaped clamps *A* act as guides and hold the gib in place while being babbitted. These clamps engage shallow grooves at *B* which are cut in the back of the mandrel body. When the gib *C* is placed in position for babbitting, as shown, the clamps *A* are pushed in against stops *D* and the screws *E* are tightened. The stops *D* are provided so that the gib will be held at the proper distance from the face of the babbitting fixture. The planed surface on the back of the gib rests against the clamps so that the face of the gib is held parallel with the fixture. Screws *F* hold the gib out against the clamps.



Babbitting and Planing Fixtures for Crosshead Gibs

Before pouring the babbitt, fireclay is placed along the sides to prevent the metal from running out. This is held in place by flanges *G*. When the babbitt has hardened, clamps *A* are loosened and the gib is forced off the mandrel by the screw *H*, the side of the mandrel being slightly tapering so that the gib can be removed easily.

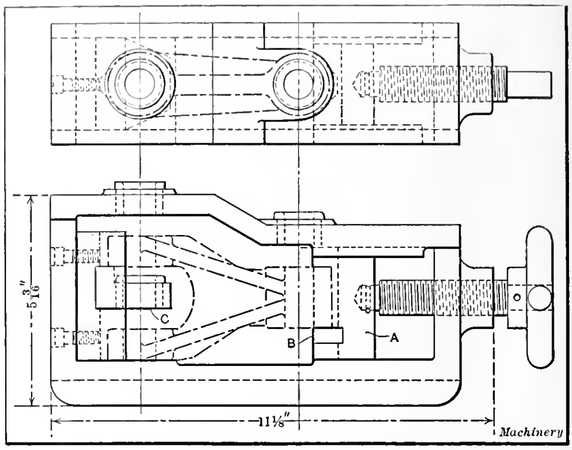
When this mandrel is used, the babbitt is distributed uniformly and the flanges have practically the same thickness, so that it is unnecessary to leave more than 1/16 inch of metal to be planed off. For this reason the mandrel is superior to types generally used, because it reduces the time required for planing.

The planing tool used for finishing the babbitted surface is shown at *J*. The cutter is fastened to the holder with three small round-headed bolts as shown. The width of the cutter is slightly less than the stand rd width of the guide so that a gib can be planed to fit a guide which has become worn. This tool has only a slight amount of clearance on the bottom, as excessive clearance causes it to gouge into the metal. The chuck or fixture used for holding the gibs while they are being planed is shown at *K*. This fixture is held to the planer table by bolts passing through holders *L* and is aligned by a tongue on the bottom. The gib is held by taper pins *M* which are driven in through the flanges at the side, as shown in the end view. The holes in the fixture are a little lower than those in the gib so that the pins will draw the gib down firmly against the top of the chuck. The planer used for this work has a cutting speed of 50 feet per minute and the gibs are planed at the rate of 5 per hour, which is three times the production obtained before these tools were made.

H. T. P.

DRILL JIG FOR FORK LINKS

The drill jig shown herewith was designed for drilling fork links. The form of these links is indicated by dot-and-dash lines in both views. The link has a round boss at one



Drill Jig for Forked Links

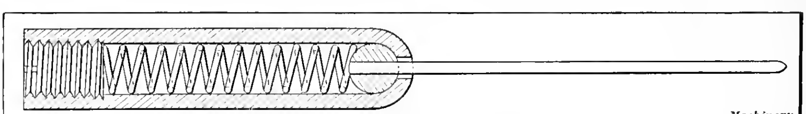
end and rounded forks at the other end. It is accurately held between two V-blocks, one being adjustable and the other stationary. The adjustable V-block *A* is clamped against the work by the star-wheel and screw shown, and it travels between finished ways, thus providing an accurate as well as rapid method of clamping.

These V-blocks have inserted steel plates *B* and *C*. The latter, which is in the stationary V-block, carries a drill bushing for drilling the lower fork, and an upper shoulder on this plate provides a support for the upper fork; thus there are two bushings in alignment for drilling the two ends. The inserted plate *B* in the adjustable block supports the opposite end of the fork link. With this arrangement, a two V-clamping jig is obtained having a three-point support. This drill jig was accurate, rapid and easily operated.

M. W. W.

INDICATOR FOR LOCATING CENTER PUNCH MARKS

An indicator for use in locating center punch marks is shown in the accompanying illustration. This form of indicator can be used on the milling machine, boring mill or drill press, and in the writer's opinion is a particularly efficient tool. The trouble with most instruments of this class



Simple Form of Indicator for locating Center Punch Marks

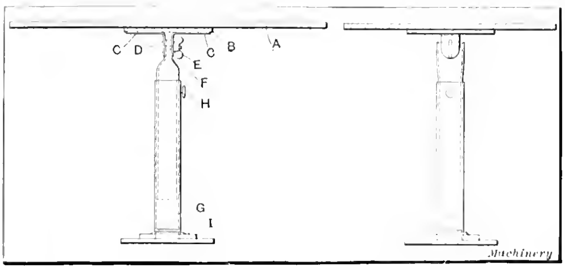
is that the body is not in perfect alignment with the hole; but with the present design, the hole can be lapped and the outside ground in accurate alignment with it.

Milwaukee, Wis. W. BUTZLAFF

AN INEXPENSIVE DRAWING BOARD

The accompanying illustration shows a cheap and satisfactory drawing board which may be made by almost any one at a small cost. The writer has used a board of this description for some time, and found that it meets all requirements that a more expensive one does. The cost of the complete outfit, including a little work that had to be done outside, was about $5.

Referring to the illustration, *A* is the drawing board. A board *B*, about 15 inches square by 1 inch thick, is secured to the under side of the drawing board by five or six wood screws, in such a way that the grain of the wood in the two boards is at right angles. The plates *C* are made of flat steel, 1/4 inch thick by 2 1/2 inches wide. Each of these plates is fastened to the board *B* by means of three wood screws.



Design for an Inexpensive Drawing Board

Holes are drilled in the lower edge of these plates for a 1/2 inch carriage bolt, the hole in one plate being filed square to receive the head of the bolt *D*. The nut *E* on this bolt is an ordinary wing-nut, which may be obtained in any hardware store.

The support *F* is made of a piece of ordinary 3-inch wrought iron pipe, two feet in length. One end of this pipe is hammered flat so that it will fit between the plates *C*, and the hole is drilled to receive the bolt *D* which holds the table to the support. The lower section of the support *G* is a piece of 3 1/2-inch iron pipe, one end of which is screwed into a standard 3 1/2-inch floor flange *I*. The height of the drawing board can be regulated by adjusting the position of the pipe *F* in pipe *G*, and then screwing up the binding screw *H*. The flange at the end of the support is screwed to a board which should be about 18 or 20 inches square.

It will be readily seen that the design of this drawing board makes it possible to have it set at any desired angle. When the board is not in use, it may be folded down into a vertical position and then pushed over against the wall, where it occupies very little space. The pipe sizes referred to were selected because the outside diameter of the smaller pipe fits nicely in the inside diameter of the larger one. Furthermore, the standard flange used on the larger pipe is heavy enough so that it will hold the table without requiring it to be screwed down to the floor.

Indianapolis, Ind. FRED E. HOSMER

HARDENING DRAFTSMEN'S RULING PENS

During my experience as a draftsman, I have found that even the highest-priced ruling pens do not always have the proper temper to hold a satisfactory point for any length of time. If a pen is too soft, it requires frequent touching up with a hone and as is well known, one or two improper strokes will spoil the result of the most careful effort to obtain a good working point. I use the following treatment for sharpening a pen. First use an ordinary stone of close medium grit. With such a stone and the proper care, a pen can be brought to a very satisfactory point. In order to be sure that the pen is of the desired hardness, I use the following method of hardening: After the pen has been sharpened, the screw is removed and the pen heated with a Bunsen burner or any other gas flame which does not smoke. The flame of an ordinary gas range can be used with satisfactory results. The heating is commenced at the point, care being taken to turn the pen continually in order to have both points evenly heated. The pen is heated slowly until a bright red is obtained about 3/16 inch back from the point.

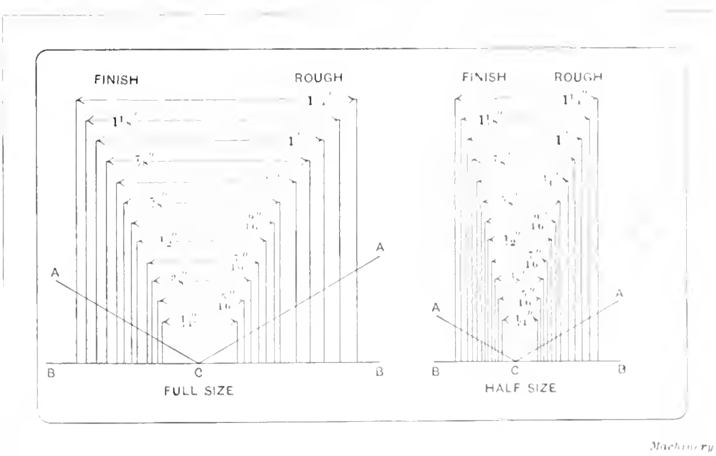
I have found that the best way of quenching the heat is by thrusting the point of the pen into a cake of beeswax to a depth of about 3/4 inch. If beeswax is not obtainable, a cake of clear castile soap is almost as good. The pen is left in this position until the wax sets around it and is then allowed to cool for about an hour, after which it can be removed and the wax cleaned off with gasoline or benzine. The point is then brought to a final finish by using a fine oilstone. Of course, the original polish will have been spoiled by this treatment but it may be easily restored by using a piece of crocus cloth.

Fort Wayne, Ind. HOMER R. TALMAGE

LAYING OUT HEXAGONAL HEADS

The accompanying illustration shows a convenient method of laying out hexagonal heads and nuts and the following gives a brief description of the way in which a diagram of this kind is laid out. On *BC* lay off from *C* distances equal to one-half the length across the flats of the heads and nuts most commonly used. The distances on one side of *C* are made to represent the finished sizes and on the other side of *C* the rough sizes. Next, draw lines to form the 30-degree angles *ACB*. Then draw vertical lines from the points laid off on *BC* and connect the top of these verticals on the "finished" side with the tops of the corresponding sizes on the "rough" side. Mark each horizontal line with the diameter of the bolt which the line represents.

It will be evident that with the compass set from the point *C* to the proper point on the line *BC*, a circle can be drawn, around which the plan of the head or nut can be laid out. To draw the side elevation without the plan, the compass is set from the point *C* to the intersection of the proper vertical line with the line *AC*, which represents one-half the distance across the corners. This distance is then laid off from the center line of the bolt. The compass is then set from the proper point on the line *BC* to the intersection with the line *AC*, which represents one-half the side of the head or nut, and this distance is laid off on each side of the center line of the bolt. After these dimensions have been secured, the head or nut can be laid out in the ordinary way.



Half and Full Size Diagrams for laying out Heads and Nuts

I use a piece of bristol board carefully laid off with fine lines. The size of the card is made 2 1/4 by 4 1/4 inches. I have found that two charts, one full size and the other half size, are most convenient for my work, but the same principle can be applied to other scales.

Barberton, Ohio. L. F. PARKER

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

UNIVERSAL TYPE METAL

R. O.—I have heard of a new type metal that can be successfully used for linotype machines, monotypes and for stereotyping, and would like to know the constituents.

A.—You doubtless refer to a new alloy compounded by George R. Wagner, chief linotype machinist of the *New York World*. This alloy is said to work equally well for linotypes, monotypes and stereotypes. It consists of lead 82 per cent, antimony 13 per cent and tin 5 per cent. It is not patented.

HIGH-SPEED STEEL JIG BUSHINGS

C. R.—Is it practicable to use high-speed steel for jig bushings? What are the advantages of high-speed steel for this purpose?

A.—The advantages that would result from the use of high-speed steel for jig bushings would hardly seem sufficient to warrant its use. The high cost of high-speed steel and the difficulty of working it would seem to make its use practically prohibitive. The question is submitted to readers for discussion.

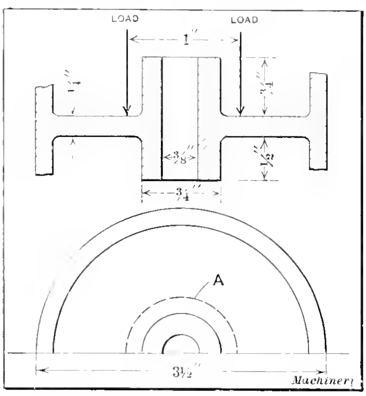
PRESSURE REQUIRED TO UPSET COLD STEEL

W. J. S.—How much pressure is required to upset a 3/8-inch round rod of machinery steel, the head formed to be 5/8 inch diameter?

A.—Experiments made by William Kent and recorded in his "Mechanical Engineers' Pocketbook" indicate that soft steel rivets require a pressure of about 100,000 pounds per square inch for cold heading. If the maximum diameter of the head on the rod is 5/8 inch, its cross-section area is nearly 1/3 square inch; hence, a maximum pressure of 30,000 to 33,000 pounds would be required to form the head.

CALCULATING STRESSES IN MALLEABLE IRON PLATE

W. N. A.—I would like to know how to proceed in calculating the stresses in the malleable iron plate illustrated herewith, when a load of 1000 pounds is applied on the circumference of a circle A 1 inch in diameter. Do the bosses 3/4 inch high and 1/2 inch high increase the strength of the plate? Would this be considered a circular plate fixed at the edge, with a concentrated load in the middle and a radius of 1/2 inch? There is a 3/8-inch rod passing through the boss in the middle of the plate and it is possible that the load may create a tendency for the metal to deflect and grip this rod. What I would like to obtain is formulas that will show the deflection and the stresses in the metal in order to be able to determine whether the design is capable of safely supporting the load of 1000 pounds.



Malleable Iron Plate in which it is required to determine the Stresses

Answered by W. L. Cathcart

A.—Only general answers can be given to these questions for several reasons. First, the diaphragm supporting the load is, technically, an unstayed "flat plate," circular and fixed at the edge, and the theoretical analysis of the resistance to bending of such plates is as yet unsatisfactory. Second, the plate in question has a central hole with bosses or stiffening rings, and this modification materially affects the results from such formulas as have been deduced. Third, while both strength and rigidity are required in this design, the plate is only 1/4 inch thick and it is to be made of malleable iron. For castings no thicker than this, the composition and heat-treatment of this material are usually such that it is far from stiff and is capable of much distortion without rupture—that is, it is strong but not rigid. However, the following discussion of the general principles affecting the design will be of service in judging its fitness for the work.

Stresses—General Methods

Formulas for the stresses in unstayed plates can be deduced in several ways. Thus—following Merriman's method—let Fig. 1 represent a circular plate of radius r and thickness t, supported at the edge and carrying a uniform load of p pounds per unit of area of the upper surface. The total load is then

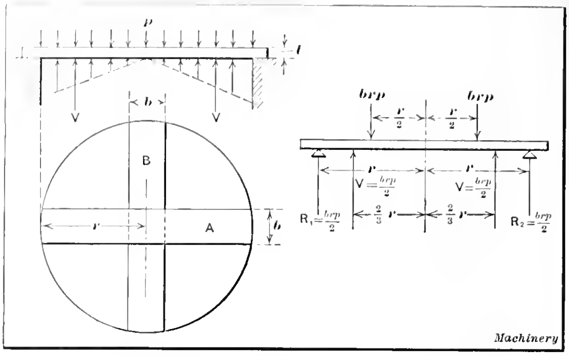


Fig. 1. Diagram showing Method of determining Stresses in Plate

$\pi r^2 p$ and the length of the support of this load is $2\pi r$. Hence, the reaction of that support, per unit of length, is $\dfrac{\pi r^2 p}{2\pi r} = \dfrac{r p}{2}$.

Now, take an elementary strip A of width b, whose center line is a diameter. The area of this strip is $2br$, the total load on it is $2brp$, and the reaction at each end is $\dfrac{brp}{2}$ or brp for both ends. Since, to support a load $2brp$, only reactions of brp are thus available, there must be, for equilibrium, upward resisting shearing forces at the sides of the strip equal to brp, the remainder of the load.

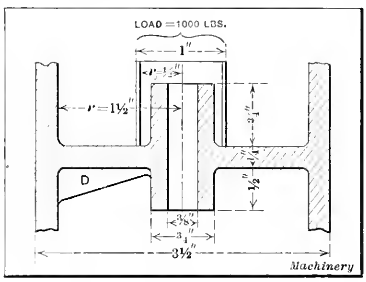


Fig. 2. Cross-section through the Plate

As the load is uniformly distributed, the intensity of these shearing forces is zero at the middle of the beam and increases at a uniform rate to the supports. Hence, their resultant V acts at a distance $\dfrac{2r}{3}$ from the middle or through the center of gravity of the triangle which they form. The upward and downward system of forces thus constituted is shown at the right-hand side of Fig. 1. The maximum bending moment, which is at the middle of the beam, is $M = \dfrac{b r^2 p}{3}$.

The corresponding stress is:

$$S_1 = \frac{M c}{I} = \frac{6 M}{b t^2} = 2 p \frac{r^2}{t^2} \qquad (1)$$

This is, however, an apparent and not a true stress, since allowance must be made for the modifying effect of similar strips crossing A at the center. Thus, for a strip B at right angles to A, we have a similar stress S_2, equal to S_1, but per-

pendicular to it. Rupture generally occurs on the lower or tensile side of the plate. For that side, the true maximum tensile stress is then $T = S_1 - eS_2$, in which e is the factor of lateral contraction. The mean value of e for iron and steel is 1/3. Substituting this value and those of S_1 and S_2, we have for a supported plate:

$$T = \frac{4\,r^2\,p}{3\,t^2} \qquad (2)$$

For a plate fixed at the edge, the determination of T is much more complex and cannot be given here. In such plates, this stress is, however, about three-fourths of that given by Equation (2) or:

$$T = \frac{r^2\,p}{t^2} \qquad (3)$$

Stresses due to Concentrated Loads

The method of analysis given above is general and can be modified to determine the stresses due to concentrated loads. For the case in question, as shown by Fig. 2, a load of 1000 pounds is concentrated concentrically on a circumference whose diameter is 1 inch. For these conditions, with a supported plate having no central hole or bosses, the formula becomes:

$$T = \left(\frac{4}{3}\,\text{hyp. log.}\,\frac{r}{r_o} + 1\right)\frac{P}{\pi\,t^2}$$

where T = safe working tensile stress;
r = radius of plate;
r_o = radius of load circle;
P = load in pounds;
t = thickness of plate in inches.

In this case, the radius r is $1\frac{1}{2}$ inch, $r_o = \frac{1}{2}$ inch, and $r \div r_o = 3$, the hyperbolic logarithm of which is 1.1. Substituting and transforming:

$$T = 0.77\,\frac{P}{t^2} \qquad (4)$$

for a supported plate. Taking three-fourths of this result, as in Equation (3), we have, for a plate fixed at the edge:

$$T = 0.58\,\frac{P}{t^2} \qquad (5)$$

For malleable iron in tension, average values are: ultimate strength, 40,000 pounds per square inch and elastic limit, 18,000 pounds. Taking 5 as a factor of safety, the safe working stress $T = \frac{18{,}000}{5} = 3600$ pounds per square inch. Substituting this value and $P = 1000$ in Equation (5) we have:

$$t = 0.4 \text{ inch} \qquad (6)$$

While this theoretical formula gives, in general, a greater thickness than is usual in practice, this discrepancy diminishes with thin castings, in which several elements combine to lessen the margin of safety.

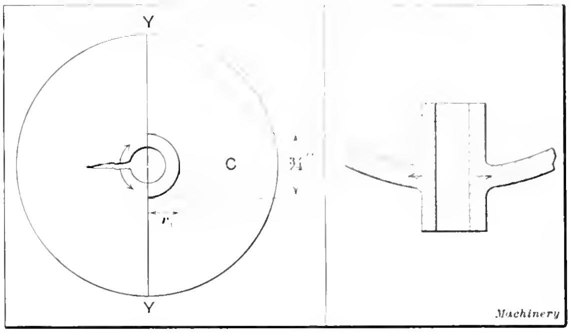
Central Hole and Bosses

A central hole, not reinforced by bosses, of course weakens the plate. This is shown conclusively by Formulas (1) and (2). Owing to the interaction of the stresses through lateral contraction, the relation between the stress in strip A, before it is crossed by strip B, and its stress after that crossing is as 2 to 4/3. That is, the crossing and consequent support lessen the stress in A, not only at the center but throughout its whole length. Since the hole is relatively small, the bosses make up, partially or wholly, for this loss of strength. In the first place, when a plate thus centrally perforated is tested to destruction, as shown at the left-hand side of Fig. 3, there is a circumferential stress at the edge of the hole, so that the plate fails by radial tearing. Therefore, any thickening of this edge will provide more metal and lessen the stress per square inch. It is evident that the wider the boss—that is, the greater the radius r_1—the better, in this respect. Again, take any elementary diametral strip, $\frac{3}{4}$ inch wide, as C in Fig. 3. At the middle on the diameter YY, there is $3/16 \times 2 \times 1\frac{1}{2} = 9/16$ square inch of metal, as compared with $\frac{3}{4} \times \frac{1}{4} = 3/16$ square inch at any other part of the strip. Finally, the location of this additional metal also increases the strength of the plate, since it increases the depth of the imaginary beam C at the bosses, and the strength of a beam of rectangular cross-section varies directly as the square of its depth.

As to the possibility of the bore contracting and gripping the rod passing through it: in order to bend, the plate must stretch—always at the lower surface, and, with ductile metal, on the upper side as well. This stretching will produce a radial tensile stress in the boss where it joins the plate, as shown in Fig. 4, and this stress will tend to increase, not decrease, the diameter of the bore. For such metal and diameters, a calculation of this stress would have no value. The difference between seizing and a close working fit would be measured in thousandths of an inch, and such minute dimensions can be computed effectively only for material like gunsteel whose composition, heat-treatment, and behavior under strain are known in detail.

Summing Up

Owing to reinforcement by the bosses, the plate is at least as strong as if it had no central hole. Then, considering it as a solid plate, Formula (6) shows that, as designed, it has



Figs. 3 and 4. Possible Results of Excessive Stresses on Plate

but 60 per cent of the required thickness. On the other hand, for heavier castings, this formula gives thicknesses which are too great; also, a low working stress has been used in the calculations; and finally, the reinforcement of the bosses may stiffen the plate sufficiently to make the designed thickness enough for strength.

The difficulty in deciding is due mainly to the thinness of the casting. In heavier plates, malleability makes the iron capable of resisting shock without material bending or breaking, but in thin castings this characteristic is usually carried to an extreme, so that the metal becomes soft and pliable. Further, slight changes in the proportion of silicon or in the treatment during melting and annealing may, with these thin castings, make a marked difference in their physical characteristics. If maximum lightness is desired, a practical way to secure it would be to make a trial casting with a moderately thick plate and the bosses as wide as possible. Then, test the plate, and, if no noticeable deflection appears, machine off a thin layer of metal, and test it again. The loss of the "skin" in this process will not affect the strength of the plate to a greater extent than the removal of any other layer of equal thickness. As a last resort, if the design will permit, the plate may be ribbed underneath, as shown at D in Fig. 2.

Questions and answers of general interest only are published. All inquiries must be accompanied with name and address to receive attention. Compliance will enable some answers to be made by mail if not deemed suitable for publication.—Editor.

* * *

The application of centrifugal force to clothes and metal chips for the extraction of water and oil, is well known, but not so well known is the use for pressing certain materials such as cork. It has been found impossible to compress scrap cork into cylindrical shapes, because of the friction of the material on the sides of the container. In a centrifugal apparatus, however, compression to any form is readily accomplished. Long cylinders of granulated cork are formed without trouble; each particle of cork is impelled outward by the centrifugal force and neither external nor internal friction of the material hinders the compressive action.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GRIDLEY AUTOMATIC MULTIPLE-SPINDLE DRILL

In developing the Gridley automatic multiple-spindle drill, the intention of the Windsor Machine Co., Windsor, Vt., was to produce a machine applicable to the rapid drilling of parts which are difficult to handle on other types of machines. Tests which have been conducted on these machines in the builder's factory show that there is also a marked saving of floor space in addition to a reduction of time, as compared with other methods that were previously considered satisfactory.

The Gridley automatic multiple-spindle drill is, in reality, a vertical turret machine adapted for drilling, reaming, counterboring and facing a variety of classes of work. The design differs radically from other drilling machines in that the spindles are adjustable both radially and circumferentially, thus enabling all spindles to be located for operation at a common center or at different points, as may be required for various classes of work. Holes can be drilled cutting into each other or as far apart as the capacity of the machine will allow. The spindles are individually adjustable, so that any tool may be placed in position to work to

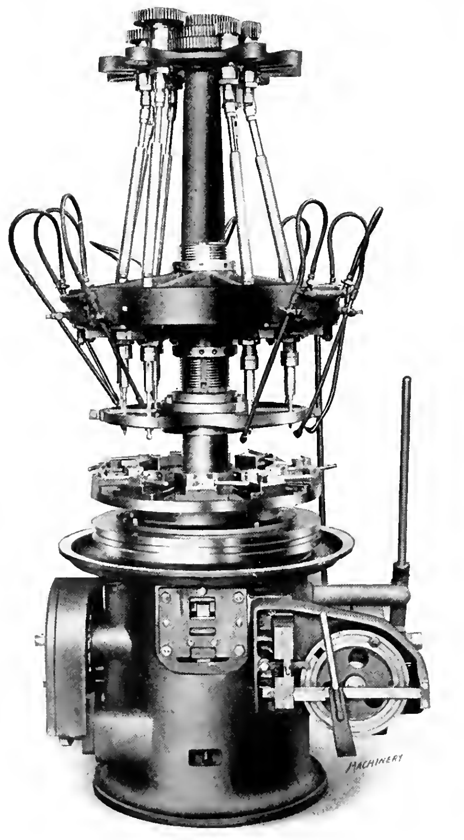


Fig. 1. Front View of Gridley Automatic Multiple-spindle Drill

any depth, regardless of the position of other tools. As all spindles are supported from the center column and distributed around an entire circle, the thrust on one side is balanced by the thrust at the opposite side. This relieves the center column of undue strain, and any tendency for heavy feeds to spring the machine is practically eliminated.

Front and side views of the machine are shown in Figs. 1 and 3, and Figs. 2 and 4 show closer views of the work-table and guide bushing holders that are employed on these machines. It will be seen that the work is held in chucks or suitable fixtures mounted on a rotating work-table which revolves around the center column. As it is necessary to have one position of the work-table idle for the purpose of

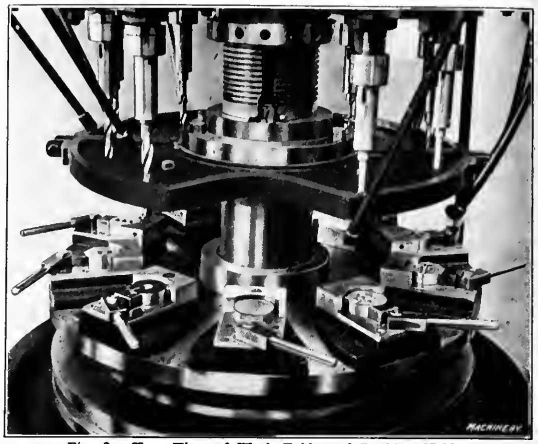


Fig. 2. Close View of Work Table and Bushing Holders shown in Fig. 1.

removing the finished piece and inserting a fresh blank, one more chuck or fixture is used than the number of spindles on the machine. This idle or loading position is clearly shown at the center in Figs. 1 and 2, where it will be seen that the blank has been placed in the fixture ready for the first indexing. In this case the machine is operating on a small threading die. The die shown to the right of the loading position is finished and will be removed when the table has advanced one point; a fresh blank will then be mounted in place ready for the cycle of operations that is to be performed on it.

The necessary number of spindles can be built into the machine to meet the requirements of the class of work to be operated upon, from five to nine spindles being the usual number. In order to divide the time of the successive operations as uniformly as possible, it is sometimes advisable to use two or more spindles working in the same hole, each of which machines a portion of the whole depth. The table indexes one point each time it is lowered from the tools, and one finished piece of work is produced each time the table moves upward. The time taken to produce the piece is that of the longest operation plus the idle time required to bring the work to the tools in the next position. Each individual spindle can be geared to the correct speed for the tool which it carries, and in cases where extra heavy service is required of one or more tools, special spindles of heavy construction can be used for these operations.

In drilling a layout of holes, to insure accurate spacing between them either of two methods of holding the drill bushings may be used. When only a few of the drills or other tools need guide bushings, holders carried by adjustable vertical and horizontal arms are employed. This arrangement is clearly shown in Fig. 4. In cases where a large number of holes are to be drilled, a plate is used which extends around the central column of the machine, the plate being located between the work-table and the spindles. There are large holes in this plate, one of which is in line with each of the spindles. Adjustable bushing holders which can be quickly set in the required position are clamped over these holes. In changing from one job to another it is only necessary to change the bushing holders, and on some classes of work it is necessary to change but one or two of the holders. This is the arrangement which is shown on the machine illustrated in Figs. 1 and 2. For drills and some other tools, hardened steel bushings are used. Other tools which have only short

flutes work more advantageously in bronze bushings which locate the tools properly and prevent all tendency to chatter when the machine is working at high speed.

Little difficulty is experienced in setting up the machine for operation on different pieces of work. The tools are inserted in their holders and a perfect sample of the piece to be machined—finished to the required size and form—is placed in the chuck or fixture. The table is next advanced by hand until the piece is located at the point under the first spindle, where the sequence of operations commences. The spindle is then swung into exactly the required position and the guide bushing fastened in place. After raising the table to its highest cutting point, the spindle is adjusted vertically in order that the hole may be machined to the proper depth. This operation is repeated for each spindle until all of the tools have been properly located.

By referring to the table of spindle speeds, the proper gears are next placed on the center shaft and spindles, and the

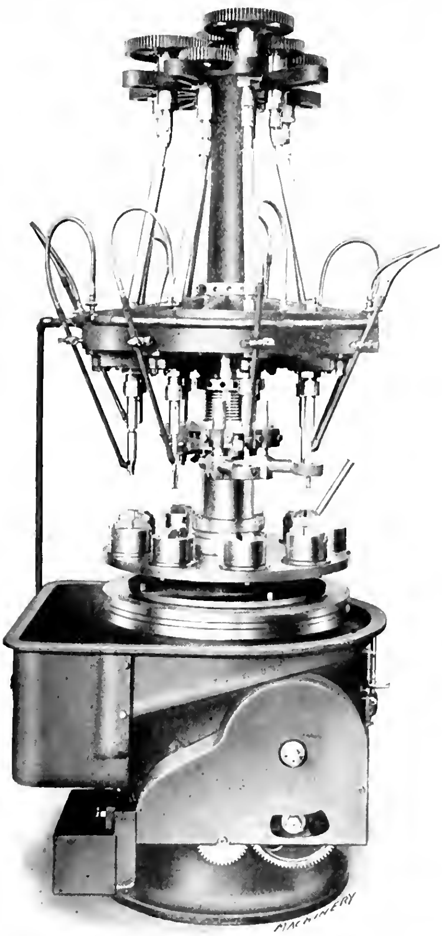


Fig. 3. Side View of Gridley Automatic Multiple-spindle Drill

gears brought into mesh. The change gears which give the different speeds for the vertical center shaft are located in the case at the lower left-hand side of the machine in Fig. 1. The change gears giving the different feeds to the table are also located in this case. After the proper speed and feed gears are in place, the table should be brought up to the position where the first tool of the set nearly touches the work. At this point, a cam-pin on the operating disk should be set to throw out the fast feed clutch; this will allow the feed gears to drive the table at the proper feed. After the table has reached its highest point and the tools have finished cutting, the second cam-pin on the operating disk should be set to throw in the fast feed clutch. The machine is then ready to start working.

The Gridley automatic multiple-spindle drill is equipped with a gear-driven oil pump, an oil tank and a separate oil supply pipe with an adjustable nozzle to deliver lubricant to each cutting tool. The arrangement of the piping, flexible tube connections and nozzles will be readily understood by

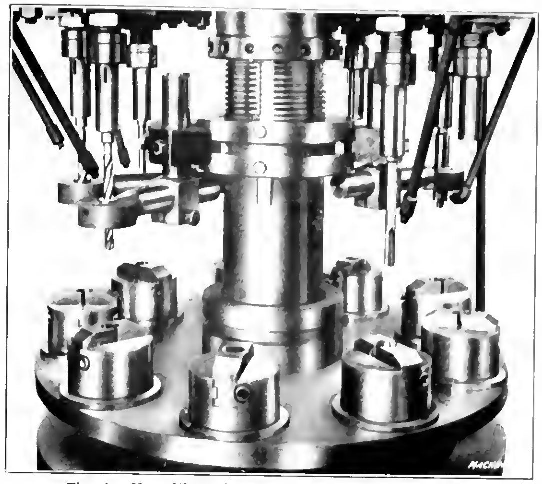
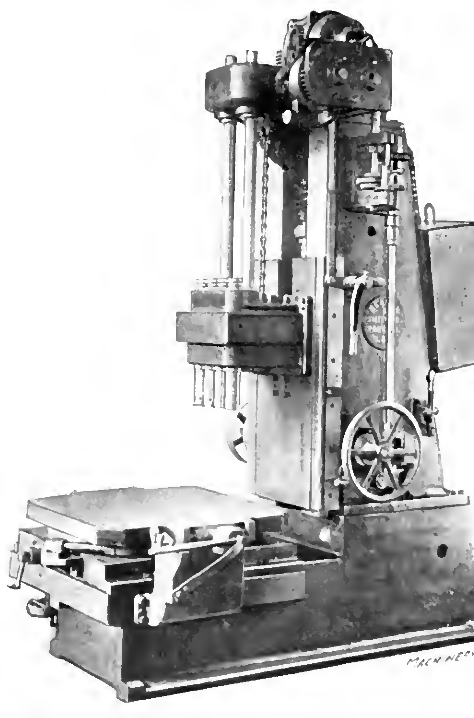


Fig. 4. Close View of Work Table and Bushing Holders shown in Fig. 3

referring to the illustrations. The machine is equipped with a self draining drip tank and strainer of liberal size. There is ample room for removing chips without requiring the oil guards to be disturbed in any way.

BEAMAN & SMITH BORING MACHINE

The Beaman & Smith Co., Providence, R. I., has recently added to its line a vertical spindle cylinder boring machine which is shown in the accompanying illustration. It will be



Beaman & Smith Four-spindle Cylinder Boring Machine

seen that this machine has four spindles, but these machines are built with either three, four or six spindles. The spindles run in taper bearings lined with hard bronze, means being provided to compensate for wear The head is carried by a counterbalanced saddle which has a vertical movement of

29½ inches. The spindles have automatic feed and automatic stops are provided to trip the feed at the required point; quick power movements are also provided.

The work is set up on a revolving work table 36 inches square. There are two index points, and the finished work, which is held in suitable fixtures, can be removed from the idle position while the boring operation is being performed on a casting in the operating position. This feature provides for keeping the machine in almost continual operation. The table is supported on ball bearings so that it is easily revolved. The machine is driven by a 7½ horsepower motor and transmission of power to the spindles is through a train of spiral and spur gears.

ROWBOTTOM CAM MILLING MACHINE

The Rowbottom Machine Co., Waterbury, Conn., has recently perfected a universal cam milling machine which is adapted for cutting all types of cams. It is said to be the first cam cutting machine which has been designed with the cutter head carried on a vertical slide. Several important advantages are secured through this construction, among which the following may be mentioned: The roller which governs the movement of the cutter head is always kept in

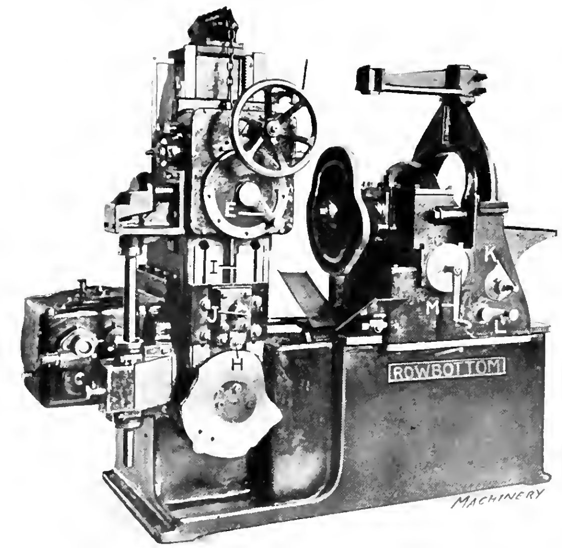


Fig. 1. Front View of Rowbottom Universal Cam Milling Machine

contact with the former cam through the action of gravity. When the cutter head works in a horizontal plane there is frequently a tendency for the cutter to creep or "flinch" away from the work, especially when difficult sections of the cam are being machined. Another advantage of the vertical cutter slide is that the chips and dust produced in cutting drop away from the work as fast as they accumulate.

Referring to Figs. 1, 2 and 3, it will be seen that the cam to be milled is held on a mandrel carried by the work head. This head may be supported with the mandrel in either a horizontal or vertical position as shown in Figs. 1 and 3. For milling plate or face cams, the mandrel is held horizontally, and for machining cylindrical cams the vertical position of the mandrel is employed. When using the mandrel in the vertical position, the outboard support is used; this support may be removed from the machine when it is not needed. The change from the horizontal to the vertical position is effected by first removing the support under the faceplate and then swinging the head down. The bolts which were formerly employed to secure the head in the horizontal position are now located in the proper position to clamp the head vertically. These bolts enter holes in the work head slide at the place where the faceplate support was formerly secured.

The machine is driven through a single pulley which is belted to a two-speed countershaft. The single driving pulley is equipped with a Johnson clutch, which is operated by the lever *A* located on top of the gear-box in Fig. 4. This lever is within easy reach of the operating position and provides for instantly starting or stopping the machine. The small lever *B* operates a sliding clutch between two bevel gears, and by throwing this lever to the forward or reverse station, the clutch is engaged to drive the machine right- or left-hand

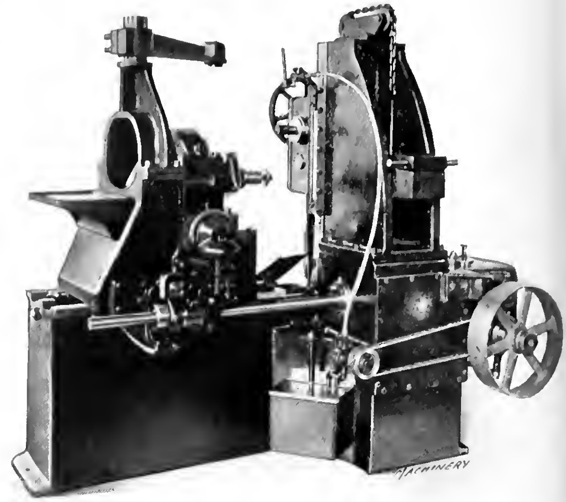


Fig. 2. Opposite Side of Machine shown in Fig. 1

as desired. There is also a neutral station for the lever *B*, in which position the clutch is out of engagement with both gears. It will also be seen that there is a lever *C* mounted at the rear of the gear-box which is provided with four stations. This lever operates a cone of gears in the gear-box to give either of four speed changes, and as the driving pulley is belted to a two-speed countershaft, there is a total of eight changes of speed available. Each of the speeds for the

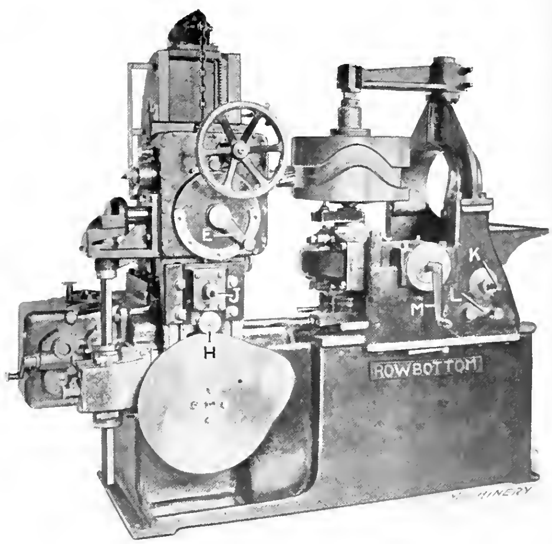


Fig. 3. Rowbottom Machine engaged in milling a Cylindrical Cam

former spindle and work spindle obtained in this way are necessarily the same in order to maintain the proper relation between the cutter and the work.

The last of the four operating levers in Fig. 4 is shown at *D*; it will be seen that this lever has three stations, the central one of which is the neutral position, while the other two stations provide forward and reverse rotation for the cutter spindle. An ingenious mechanism is used to obtain four

speed changes for the cutter spindle, and as in the case of the former and work spindles, there are eight available cutter speeds, owing to the drive being taken from a two-speed countershaft. An important feature of this cutter spindle speed changing device is that all changes are obtained through a single lever, which is shown at *E* in Figs. 1 and 3. These changes of speed are obtained through a sliding gear transmission which is shown in detail in Fig. 5. Referring to this

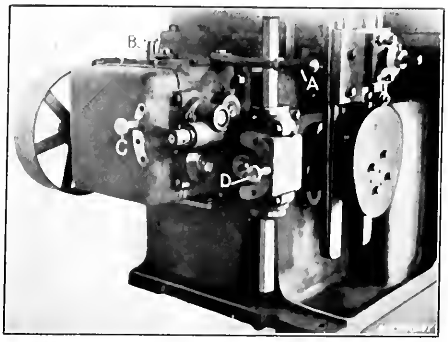


Fig. 4. Close View of Gear-box on Rowbottom Cam Miller

illustration, it will be seen that there are four pairs of gears; the four gears carried on the cutter spindle are fixed longitudinally and the same applies to the gear at either end of the driving shaft. Each of the driving gears *F* and *G* are splined to the shaft and provided with positive clutches, by means of which they may be connected to the gears at either end of the driving shaft. The longitudinal movement of these gears is controlled by fingers carried by two cam operated slides, and either of the gears *F* or *G* may be engaged directly with a gear on the cutter spindle or the clutch on either of these gears may be engaged with one of the gears at the end of the driving shaft which is always in mesh with the spindle gear. In any case, there is one of the four pairs of gears in mesh which provides for transmitting the motion to the cutter spindle at the required rotative speed.

It was mentioned that the movement of the driving gears *F* and *G* in Fig. 5 was controlled by fingers carried by a cam operated slide. The arrangement of this cam mechanism is shown in Fig. 6, the cam being operated by the lever *E* which is also shown in position on the machine in Figs. 1 and 3. The slides which move the gears *F* and *G* along the driving shaft are operated by the rollers *N* and *O*, Fig. 6, which run in a cam groove shown in this illustration. When the lever *E* is in the central station, both clutches and gears are disengaged, and consequently there is no rotation of the cutter spindle. By moving the lever *E* to the first station to the left

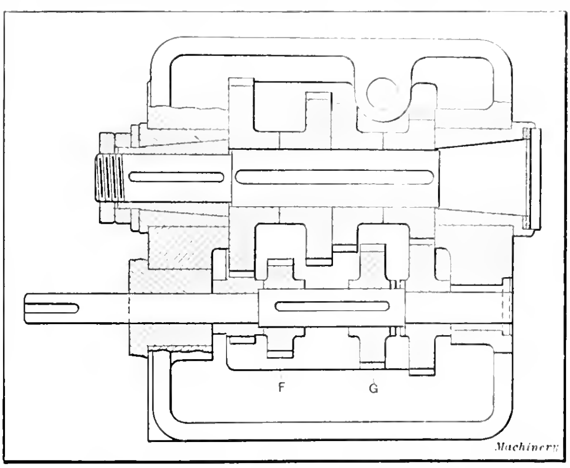


Fig. 5. Change Gears for varying the Cutter Spindle Speed

of the neutral position, point *P* on the cam groove has moved around to the roller *N* and has caused this roller to be moved toward the center of the cam. This results in a corresponding movement of the slide, which, in turn, throws the gear *F* into mesh with the gear on the cutter spindle. By moving the lever to the second station to the left of neutral, the point *R* on the cam groove has reached the roller *N*; this causes the roller *N* to be moved away from the center of the cam, and, in turn, the fingers on the slide move the gear *F* so that the clutch member on this gear engages the gear to the left of it, thus making the left-hand gear on the shaft the driving gear. By moving the lever *E* two stations to the right of the neutral position, the points *Q* and *R* in the cam groove are successively brought up to the roller *O* and cause the gear *G* to drive two of the gears on the cutter spindle as previously described for the gear *F*. In addition to the eight changes of speed obtainable through the gearing, an independent geared speeder is provided for use when small sized cams are being milled.

One of the features of this cam milling machine is that flat former plates are used for all types of cams. When the rise of the cam to be milled is relatively steep, it is advisable to use a former plate which is double the size of the work, if such a proceeding is practicable. The former plate is bolted to the end of the former spindle, and as the plate revolves it pushes the entire cutter slide up through its action upon the roller *H* shown in Figs. 1 and 3. This roller is mounted on an auxiliary slide which is connected to the main cutter slide by a screw adjustment, shown at *I* in Fig. 1. This screw adjustment is operated by a crank on the end of the squared shaft *J* to move the cutter slide on the bearings of the column, thus providing for operating the cutter at any desired distance from the center of rotation of the work-spindle. A scale is provided on the column which shows the distance that the cutter has been set from the center of the work-spindle. The adjustment for the depth to which the cutter enters the work is made on the work slide, the squared shaft *K* being provided for this purpose. This shaft has a micrometer collar so that when the work is brought up so that it just touches the cutter, this collar may be set at zero, after which the work is fed to the cutter to provide for milling to the required depth.

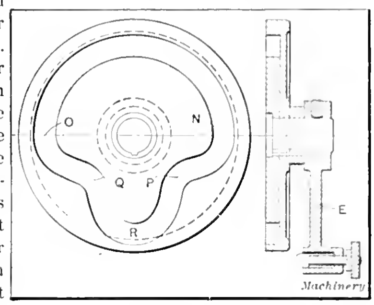


Fig. 6. Cam Mechanism for changing the Cutter Speed Gears

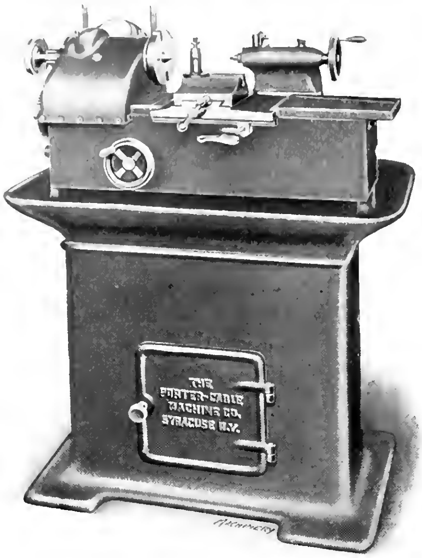
A convenient feature of this machine is the provision that is made for changing the relative position of the cutter and cam blank that is being milled. Suppose it was desired to alter the position of the cam groove slightly from that arbitrarily fixed by the location of the driving pin which passes through the work into the faceplate. The first step would be to move the lever *L*, Figs. 1 and 3, to the neutral position, which disengages the clutch that drives the work-spindle. The lever *M* is next turned through 1/12 of a revolution, after which the clutch is reengaged by the lever *L*. This clutch has 12 teeth and the result of this operation has been to re-mesh the clutch one tooth ahead of its former position. By means of the gearing in the work head, the resultant movement of the work relative to the cutter amounts to 1/4 degree. Power is transmitted to the work head by means of the horizontal shaft shown at the back of the machine in Fig. 2, and horizontal movement of the head on the ways of the machine is obtained through a horizontal screw. By reversing the direction of rotation by means of the lever *B* in Fig. 4, the work head may be traversed either toward or away from the cutter. The total length of a cylindrical cam that can be cut is represented by the traverse of the work head.

No lubricant is used on the cutter, but a strong blast of air is employed which serves to remove all chips and keep the cutter cool. This air blast is found to be an excellent substitute for lubricant even when the machine is engaged in cutting tool steel cams. However, there is a pump provided on the

machine and lubricant may be used if desired. This machine is very rapid in operation and is found satisfactory for milling practically any type of cam which is of a size within its range. The capacity is for face cams up to 28 inches in diameter, box cams up to 32 inches in diameter, and cylindrical cams up to 24 inches in diameter, with an 11-inch throw. The weight of the machine is 4500 pounds.

PORTER-CABLE LATHE

Quite a departure from standard practice has been made in the design of the lathe illustrated herewith, which is a recent product of the Porter-Cable Machine Co., Syracuse, N. Y. This machine is primarily designed for manufacturing operations on short pieces having a maximum length up to 12 inches. The machine gives excellent results when operating on work held between centers and is also well suited for a variety of small chuck and faceplate work. In developing this lathe, the idea was to produce a machine capable of handling the classes of work referred to, and at the same time save the purchaser from paying for a machine of larger size than he requires and one which occupies an unnecessary amount of floor space. This result is made possible by the application of an overhanging tailstock which travels on its own dovetail ways at the rear of the bed. This arrangement enables the carriage to be constructed on the plan of a milling machine table. The bed is 32 inches long and as it is not open at the top it is exceptionally rigid. The ways are protected at all times by the chip guards fastened at each end of the carriage, the front guard passing under the headstock.



Porter-Cable Lathe for Short Work on Centers or Small Chuck Work

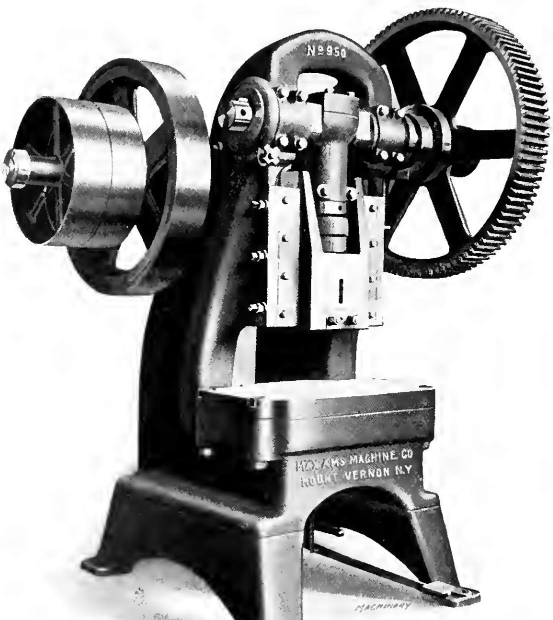
Both hand and power feed are obtained by means of a rack and pinion located nearly under the center of the carriage. This pinion is integral with a vertical shaft extending down through the bed, where it is connected through suitable gearing and a positive clutch to the regular change gears at the end of the lathe. Threads from 5 pitch down to the finest may be accurately cut. The feed in either direction can be automatically disengaged by the adjustable trip located underneath the carriage, and when thrown out the carriage may be run along by hand to the full limit of its travel without removing any stops.

The spindle is exceptionally heavy and can be furnished for use with a plain center or a set of draw-in collets for handling bar stock up to ⅝ inch diameter. The drive, which is of ample power, is obtained by a bevel gear and small pinion running at a high rate of speed, thereby permitting the use of a light belt. The gears are entirely enclosed, and as they run in oil the drive is very smooth and quiet. When it is necessary to change the spindle speed, this can be done in a moment by changing the driving pulley, the difference in the length of the belt being taken care of by the compensating countershaft. A valuable feature of this lathe is that the carriage can be run back underneath the tailstock, thus making it unnecessary to have the tail spindle extended when taking cuts near the dead center or for short work. This is also found to be a convenient feature for such operations as filing, polishing and taking measurements, as the carriage may be run entirely out of the way without disturbing the tailstock. Means are provided for adjusting the headstock sidewise in order to keep the centers in proper alignment. A reservoir for cutting lubricant is located in the upper part of the base and a cupboard in the lower part of the base is provided for keeping tools, gears, etc. For work within its range, the efficiency of this machine is equal to that of a 14- or 16-inch lathe, and it costs considerably less and also effects a saving in floor space.

AMS OPEN-BACK PRESSES

A new line of open-back presses has recently been placed on the market by the Max Ams Machine Co., Mount Vernon, N. Y. The distinguishing feature of these machines is their rugged design which is said to give them the strength of straight sided presses of corresponding size; in addition, strip stock can be fed from the side. Large sheets can be passed through the opening in the back of the press.

The frame is symmetrical in form and adequately ribbed to secure the required rigidity. The die space and the opening in the back of the press are of large size. The bearings of the slide are of ample proportions. A cap clamp, flange or dovetail for holding the punches may be provided according to the requirements of different users. The shaft is machined from a hammered steel forging and adequate provision is made for lubricating the bearings. These presses are particularly adapted for use in the manufacture of the parts of typewriters, locks, hinges and various other hardware and sheet metal specialties. This line of presses comprises eight different sizes and the patterns have been constructed in such a way that the design can be modified to suit the requirements of the different classes of work on which the machines will be used.



Ams Open-back Press

THE PROVIDENCE SHAPER

It has always been conceded that for accurate planing of machine parts having long surfaces that must be square or parallel with each other, it is necessary to use a standard planer. But on many jobs the planer is too slow and cumbersome to give very satisfactory results, owing to its inability to reverse on short strokes when operating at high speed. The slow adjustment of the cross-rail and head also reduces the efficiency of a planer when operating on such work. It has been generally recognized that for efficiency of operation on work that comes within its range, the shaper is a most desirable tool because its mechanism and all adjustments are conveniently controlled.

In designing the Providence shaper, the endeavor of the Providence Engineering Works, Providence, R. I., has been to combine the features of both the planer and shaper in a single machine; at the same time many special features have been added which increase the efficiency with which it operates. It will be evident from the illustrations that the design follows the general lines of an open-side planer, but the cross-rail is supported from the column at the left-hand end instead of at the right, which is the usual practice with open-side planers. Located in this position, the column is not in the operator's way. The open-side feature enables the machine to work on pieces that are too long to go through the housing of an ordinary planer, and also makes both ends of the work visible all of the time, so that the cutting tool can be set to a line at the beginning of the stroke instead of at the end of it. All of the operating handles for controlling the changes of feed and speed are within reach of the operator without requiring him to leave his position at the front of the machine. The head has horizontal, vertical and angular feeds secured through a sliding pinion that may be mounted on either the horizontal or vertical feed-screw, the pinion meshing with the gear on the main feed shaft. The usual type of stroke adjustment is employed.

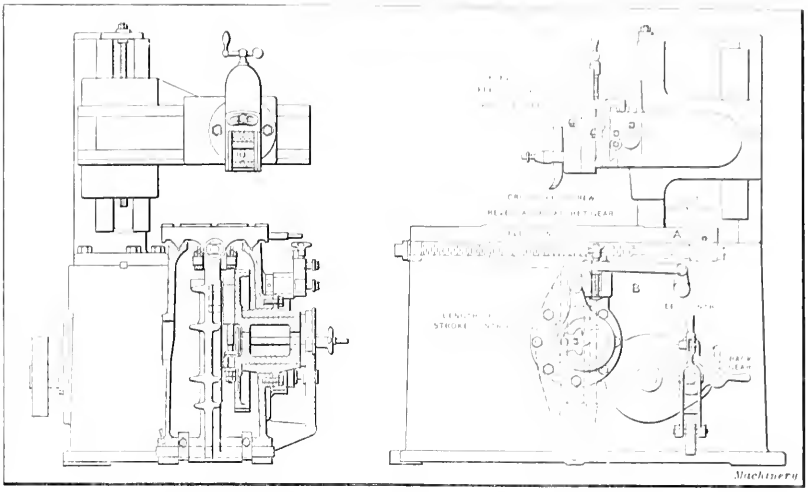


Fig. 3. Design of Machine showing Arrangement of Feed Mechanism

The frame and base of the machine are of box section, and the column is of similar construction. The cross-rail is counterbalanced by a weight located inside the column. Special attention is called to the design of the bearing of the cross-rail on the column. This bearing is longer than it is

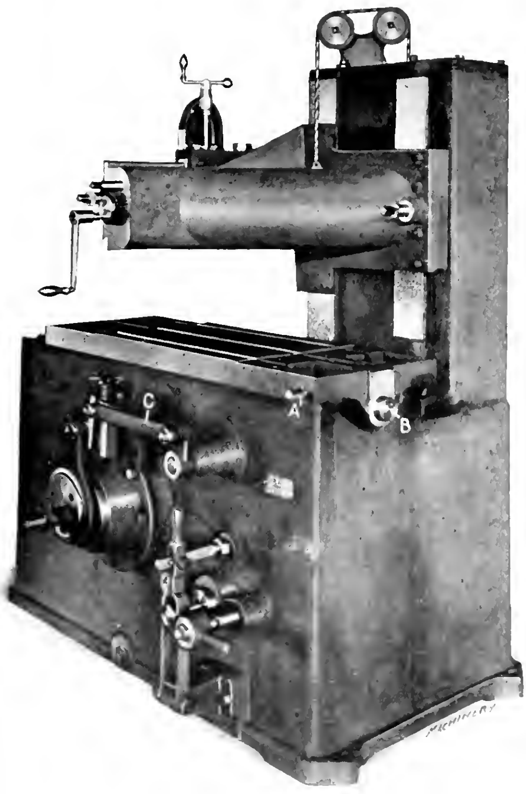


Fig. 1. Front View of Providence Shaper

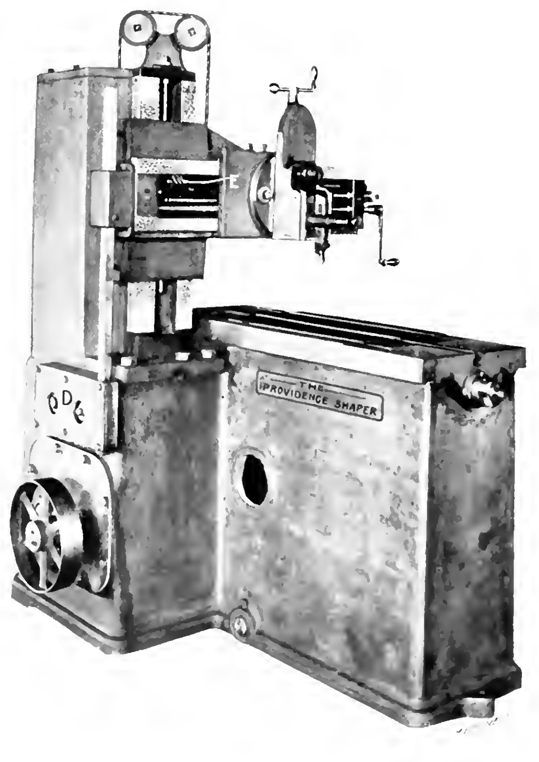


Fig. 2. Opposite Side of Machine shown in Fig. 1

wide in the ratio of $2\frac{1}{4}$ to 1. The cross-rail is secured in any desired position by drawing in the spring gib by means of a clamping bolt located at the back of the cross-rail. Tightening this bolt draws the cross-rail back against the face of the column and eliminates the chance of any play between these two members.

The positioning of the table is secured by means of a crank operated adjusting shaft *A* at the side of the table. This shaft works in conjunction with a pair of spiral gears which turn the main adjusting screw *B* beneath the table. This screw turns in a nut that moves the table to the desired position. The nut is gibbed in placed so that it acts as a support for the screw, the construction being such that there is no chance of deflection.

The motion is transmitted to the feed shaft through the rocker arm *C*, Fig. 1, the rate of feed being regulated by the star wheel. The motion is transmitted by a pair of spur gears located in the case *D* at the opposite side of the machine to the rack operating gear. By this means, the rack is operated to transmit the motion to the feed shaft running through the cross-rail. The feed operating gear is located on the opposite end of this shaft, and this gear transmits the motion to either the cross or vertical feed-screws by a sliding gear. This arrangement will be better understood by referring to the line cut, Fig. 3. The cross-rail is raised by a crank operated shaft *E*, Fig. 2, the position of which is fixed at the top of the cross-rail. This shaft provides for quickly raising or lowering the cross-rail to any desired position, the motion being transmitted to the vertical elevating screw through a pair of spiral gears.

The gear-box is of the unit type construction. By loosening the bolts on the flange of the case, the entire gear-box may be removed with the gears intact. The inner end of the gear-box is fitted over the end of the driving shaft bearing bushing, giving adequate support and insuring accurate alignment. The gears are of wide face so that ample strength is provided.

The principal dimensions of the machine are as follows: Stroke of table, 24 inches; horizontal travel of tool, 19 inches; vertical feed of tool, 6 inches; vertical adjustment of cross-rail, up to 16 inches; travel of saddle on cross-rail, 19 inches; distance from table to cross-rail when up, 16 inches; number of changes of table speed, 6; strokes of table per minute, 10 to 100; ratio of power gearing (maximum) 60 to 1; ratio of power gearing (minimum) 6 to 1; net weight of machine, 4400 pounds. Mr. James Coulter, vice-president of the Providence Engineering Works, Providence, R. I., is the designer of this machine.

STANDARD STEEL SHAFT HANGERS

The accompanying illustration shows the 1914 model of the "Pioneer" steel shaft hanger manufactured by the Standard

The "Pioneer" Steel Shaft Hanger

Pressed Steel Co., Philadelphia, Pa. The construction of this hanger includes features which represent the result of an experience of ten years in the manufacture of steel hangers and, in addition, several new features have been added. The use of steel in hanger construction insures a high degree of strength, which not only adds to the durability of the hanger but is also a factor in eliminating industrial accidents. Another noteworthy feature is the ease with which this type of hanger may be erected owing to the fact that the frames weigh much less than the corresponding size of hangers made of cast iron.

LENNOX SERPENTINE SHEAR

The accompanying illustration shows the Lennox serpentine shear that is a recent product of the Lennox Machine Co., for which Joseph T. Ryerson & Son, 16th and Rockwell

Lennox Shear having a Capacity for cutting Material up to No. 10 Gage

Sts., Chicago, Ill., have the sales agency. This machine is particularly designed for both straight and irregular cutting operations on sheets and plates. The frame is a steel casting of spiral construction designed to provide the necessary clearance when cutting material of unlimited length or width. Both straight cuts and "in and out" curves with a minimum radius only slightly larger than the diameter of the shear blades can be handled. All of the gearing is carried by the spiral steel frame which is mounted on a substantial base. All gears have cut teeth, and cast-iron gear guards are provided to avoid the possibility of accidents.

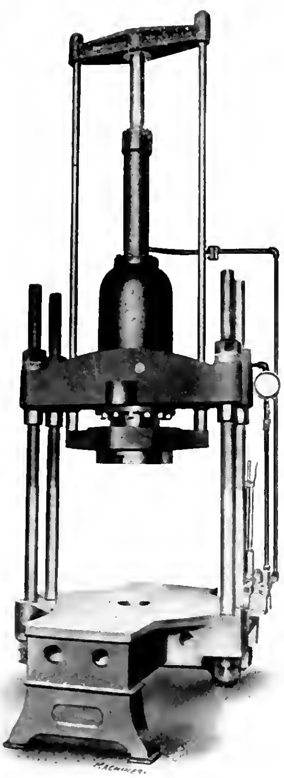
The blades are made of high-grade tool steel and set in such a way that there is very little distortion of the work in cutting. The upper cutter is positively driven while the lower cutter is mounted on an adjustable sleeve so that its position may be varied in cutting material of different thicknesses. There is also a cam movement provided which enables the lower cutter to be dropped sufficiently to permit the removal of sheets without reversing the machine. The cutters have a flush fastening on their shafts with no nut projecting out to interfere with the work. The knurled edges of the cutters feed the sheet automatically into the machine. A tool steel pin is provided to take the end thrust on the lower cutter shaft.

Where a number of sheets are to be cut to the same pattern, a templet may be bolted to the work; such a templet is then followed by guiding it against the top cutter. It will be seen that the machine is driven by means of a two-speed

pulley which gives a slow speed for intricate cutting and a high speed for simpler work. The main driving shaft is extended and squared on the end so that a crank may be used for turning the machine by hand if power is not available. The shear shown in the illustration has a capacity for cutting material up to No. 10 gage. Other sizes of these machines are made with capacities for cutting material up to 16 gage, up to 1/4 inch and up to 3/8 inch. All machines are arranged for either belt or hand power, or for direct-connected motor drive.

HYDRAULIC STRAIGHTENING PRESS

The accompanying illustration shows a 250-ton hydraulic straightening press recently built by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. This machine is primarily intended for straightening structural steel shafts and bars, but it can also be employed for a wide range of work in the machine shop, being particularly suitable for bending, forcing, broaching and similar operations. The stock space can be varied from a minimum of 20 inches to a maximum of 48 inches. It will be seen from the illustration that the strain rods are threaded on their upper end and provided with nuts on both the upper and lower sides of the cylinder bearings.



Hydraulic Straightening Press

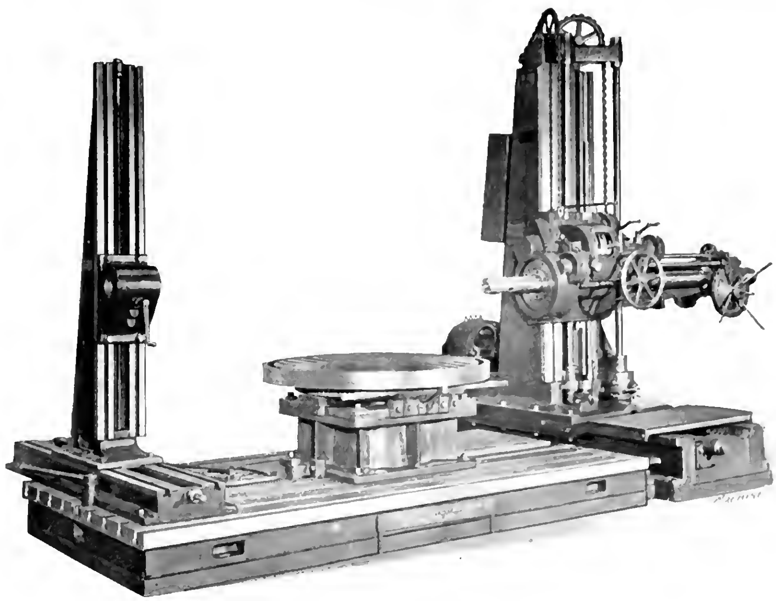
When it is found desirable to increase the stock spaces of the press a block of some suitable material is placed between the ram and the pressure bed. The upper nuts on the strain rods are then set to the desired point and the pressure applied. This action raises the cylinder until its bearings come in contact with the nuts. When the work is of such a character that it requires a smaller space, the block is still kept between the ram and pressure bed. In this case, the lower nuts are adjusted to the desired point while the pressure is still on. The pressure is then released, thus allowing the cylinder to drop to the desired point. The upper nuts are then screwed down against the cylinder bearings. In order to provide for raising and lowering the cylinder, the pipe connections have swing joints. T-slots are provided in both the ram head and bed of the press for use in attaching bending blocks, forms or dies. The body of the press provides for holding the work for bending between centers having a maximum distance of 72 inches.

It will be seen that the bed has a hole in the center which permits the press to be used for broaching, for forcing wheels on or off shafts and for similar operations. The diameter of the ram head is 20 inches and it has a run of 20 inches. The length of the press bed over all is 72 inches, while the width of working space is 26 inches. Steel is used throughout its construction. The pressure capacity of this press is 250 tons.

The four-way poppet operating valve applies the pressure to either the main pressure ram or the return ram in the pull-back cylinder, and at the same time permits the water or oil used in operating the press to return to the pump reservoir from the cylinder on which the pressure is released. This valve is operated by a single lever which has three positions. In the first position, the pressure on the main pressure ram is applied and the pressure released on the return ram. In the second position, the pressure is applied on the return ram and released on the main ram. In the third or neutral position, the pressure is held with the rams at any point in their travel in a stationary position. A five-way, high and low pressure, double-acting valve can be furnished if desired.

DETRICK & HARVEY BORING MACHINE

The illustration shows a standard No. 2 boring machine built by the Detrick & Harvey Machine Co., Baltimore, Md., which is equipped with a thread chasing attachment and a rotary table with a removable sub-base. The standard form of outboard bearing is also provided. The removable sub-base is shown in position beneath the rotary table, but when so desired this sub-base may be removed and the rotary table placed directly upon the floor plate of the machine.



Detrick & Harvey Boring Machine with Thread-chasing Attachment and Rotary Table

The thread chasing attachment is driven from the feed and is located on the rear of the saddle horn. The design is such that the chasing attachment cannot be thrown into action at the same time that the spindle is feeding. The arrangement of the change gears is similar to that used on a lathe and can be furnished to cut any required thread.

The rotary table is 60 inches in diameter, the rotary motion being hand operated. As previously stated, the sub-base can be removed from beneath the table to enable the table to be brought down closer to the floor plate. The height from the top of the table to the floor plate is 27 inches with the sub-base in position and 15 1/2 inches when the table is set directly on the floor plate. The table can be moved along the floor

plate by means of a rack and pinion operated by a lever. The rotary table is graduated to ½ degree to facilitate accurate setting.

BROWN CONTINUOUS RECORDING INSTRUMENT

The Brown Instrument Co. and the Keystone Electrical Instrument Co., Philadelphia, Pa., are placing a continuous recording instrument on the market for use as an electrical pyrometer. The instrument can also be employed as a recording volt-meter or ammeter. In its design, particular care has been taken to produce an instrument of as simple construction as possible, and at the same time to make it of the most compact form. The case of the instrument is only 15 inches high by 8 inches wide, and it projects out from the wall or switchboard a distance of 7 inches. The space occupied has been considerably reduced by placing the clock mechanism behind the record chart instead of to one side of it; the record chart is the only part shown on the face of the instrument.

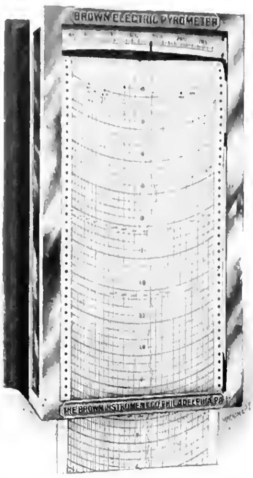


Fig. 1. The Brown Continuous Recording Instrument

A two month roll of record paper is used, which can be supplied with an inked ribbon to make a dotted ink record, or the record can be made on coated paper which entirely does away with the use of ink. It is only necessary to wind the clock once a week and to change the roll of record paper once in two months. The instrument in Fig. 1 shows a ten-hour record on the chart and a scale is placed above the record so that the indications are easily read at all times. The paper also has the scale printed on it for direct reading. Fig. 2 shows an instrument with the door open so that the interior construction may be more clearly seen. It is only necessary to open the case once every two months when the roll of record paper is changed.

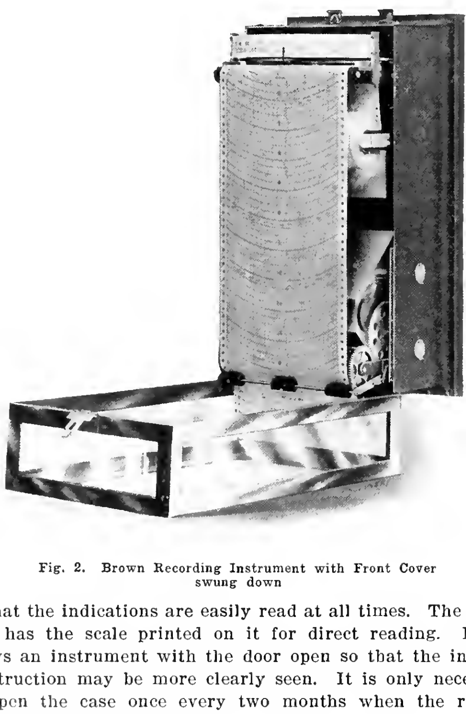


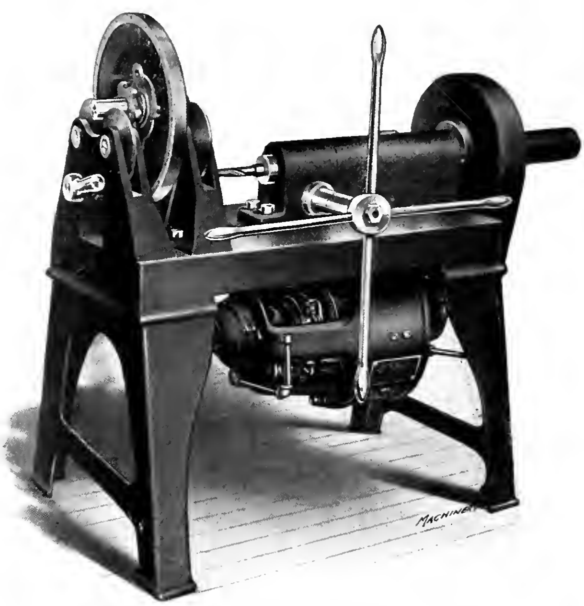
Fig. 2. Brown Recording Instrument with Front Cover swung down

This recording instrument will prove particularly useful as an electrical pyrometer used in conjunction with thermocouples, for resistance thermometers for measuring temperatures, or for recording the voltage or current in an electrical circuit. As the d'Arsonval type of direct-current instrument used is of the frictionless type to prevent lag in the readings, it will be seen that a particularly sensitive and accurate instrument is secured.

ROCKFORD COMBINATION DRILLING AND BALANCING MACHINE

Where the practice of balancing flywheels, armatures, and other rotating parts by removing the stock by drilling is employed, a great amount of time is lost in transferring the work from the drill to the balancing ways in order to determine whether the required balance has been secured. The accompanying illustration shows a combination balancing and drilling machine which has been developed by the Rockford Tool Co., Harrison Ave. and 11th St., Rockford, Ill. This machine eliminates the necessity of moving the work back and forth between the drill press and balancing ways, after each hole has been drilled, and as cases are not uncommon where eight or ten holes have to be drilled before the required balance is secured, the saving effected will be readily appreciated.

The arrangement of the machine will be easily understood from the illustration, where it will be seen that the part to



Rockford Combination Drilling and Balancing Machine

be balanced is carried on an arbor supported on rotating disks. These disks are hardened and ground and the pivots run on ball bearings which insures a very sensitive movement. The work can be clamped in place and a hole drilled, after which it is released and the balance tested. Subsequent drilling operations are performed by merely retightening the work, this operation being repeated until the required balance is secured.

SIMONDS IMPROVED HACKSAW BLADE

A new "hard edge" flexible hacksaw blade has been put on the market by the Simonds Mfg. Co., Fitchburg, Mass. The chief feature of this blade of importance to users is that it will do the cutting work of the regular hard blade, and in addition is so flexible that it can be bent a great many times without breaking, thus eliminating a large percentage of the breakages that every user of hacksaw blades expects. The Simonds "hard edge" flexible blade is made in the standard lengths and numbers of teeth per inch.

POTTER & JOHNSTON AUTOMATIC PISTON AND PISTON-RING MACHINES

The Potter & Johnston Machine Co. of Pawtucket, R. I., has recently developed a special automatic piston and piston-ring turning machine, known as the No. 2 P. This machine is intended for use by automobile manufacturers in turning eccentric and concentric piston-rings, as well as in turning the pistons themselves. Any diameter of piston from three to eight inches and up to twelve and a half inches long may be turned, and piston-rings of any width and from three to eight inches diameter are turned and cut off automatically from the piston-ring sleeve. The machine is entirely automatic in operation, the attendant simply placing the piston on the draw-back arbor and starting the machine. The turning and grooving are then automatically done. Similarly, on piston-rings, the piston-ring sleeve casting is held in the chuck and the entire casting turned up, boring out the center and turning the outside eccentric, at the same time marking each ring at the thin spot for separating, as well as cutting off the entire number of pistons automatically. A general view of the machine is shown in Fig. 1, while in Fig. 2 the machine may be seen as viewed from the rear. In both these views the machine is shown set up for piston-ring turning. Figs. 3 and 4 are plan views of the machine with the tooling equipment necessary for piston-ring turning and piston turning, respectively.

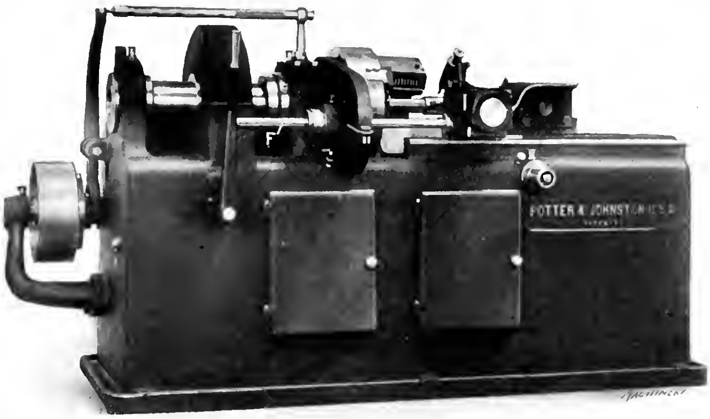


Fig. 1. Potter & Johnston Automatic Piston and Piston-ring Machine

From Fig. 1 it will be seen that, in general, the machine resembles the Potter & Johnston automatic chucking machine, except that it is simpler, the different feeds, speeds and attachments being eliminated from this machine, and everything is done to make it extremely powerful and simple on the operations for which it is intended. Power is carried to the driving shaft by a thirteen-inch single pulley drive. The driving shaft is supported by an outboard bracket and also fitted with a friction clutch so that the machine may be started and stopped independently of the drive.

As may be seen in Fig. 2, the gear-box from which the machine is controlled is at the rear and by its means the forward feeding of the tools is effected; a quick return movement to the tools in the ratio of 65 to 1 is provided for, and also the gears may be put into a neutral position so that no feeding of the cutting tools will take place. The general design of the gear-box is the same as that employed on all Potter & Johnston machines, but is much simpler because there is not the range of feeds and speeds to be provided for. The forward feeding of the tools is accomplished by planetary gearing in which there are two gears side by side varying by one tooth, and meshing with them is a planetary pinion that travels around these two gears, gaining a tooth at each revolution, thus causing one of the gears and hence the feed to advance by this amount. When in the neutral position, no feeding taking place, the ratchet and latch that gives the feed are disconnected, and the position is called the "latched-up" position. For the return motion, a clutch is thrown in, connecting the back-shaft directly with the reverse gear and causing the tool to return at a speed sixty-five times greater than the advance.

From the intermediate shaft, gearing transmits power to the main spindle directly through a large driving gear. This gear is encased as may be seen in the photograph. The driving spindle is 5¾ inches diameter and has long bearings, giving it ample power and long life. The spindle speed is constant and fixed according to the diameter to be turned, any variations in speed being obtainable through change gears. The oiling system is located over the gear-box (see Fig. 2) and from the central reservoir, tubes run to the important bearings. Each tube is fitted with an independent regulator to govern the supply of oil to the individual bearings.

The back-shaft, which may be seen at *A* in Fig. 2, transmits motion to a cross-shaft through bevel gearing, and then by a worm and worm-wheel to the turret drum-shaft. A friction clutch is located beyond bearing *B* so that in case of excessive strain on the cutting tools, the friction clutch will slip and save the mechanism from injury.

The turret drum-shaft and turret drum are, of course, within the machine and directly under the turning slide *C*. The cam-plates on this turret drum are of hardened steel and thus have a long life. The turning slide corresponds to the ordinary turret slide, but does not rotate as in the chucking type of machine, its working face always being presented to the work. The turning slide carries the cutting arbor *D*, and actuates its forward movement. The rocker arm *E* upon which the cutting-off tools are mounted is actuated by a face-cam on the turret drum-shaft.

At the front of the machine is the eccentric driving shaft *F*. This is driven by a pair of spur gears from the main driving spindle, and transmits motion to the eccentric turning slide that provides the motion for the eccentric turning. Referring now to the plan view, Fig. 3, the operation of the tools may best be observed. Here the eccentric driving shaft is shown at *F*, working in an eccentric bushing *G* that gives the in and out motion through a vertically operating slide *H* to the cutting tool slide *I*. On the end of this cutting tool slide is the eccentric turning tool *J*. Mounted at the left of the eccentric tool slide is the automatic marker that locates the thin point on each ring and marks it so that it can be correctly cut. This marker bracket is shown at *K*, and the marking plunger *L* is operated through a connection with lever *M* which is, in turn, operated from cam *N*. This cam follows the eccentricity of the piston-ring being turned and has an abrupt drop at the thin point, allowing the marker plunger *L* to come in quickly and make an impression upon the piston-ring at the low point. A spring in this marking tool is, of course,

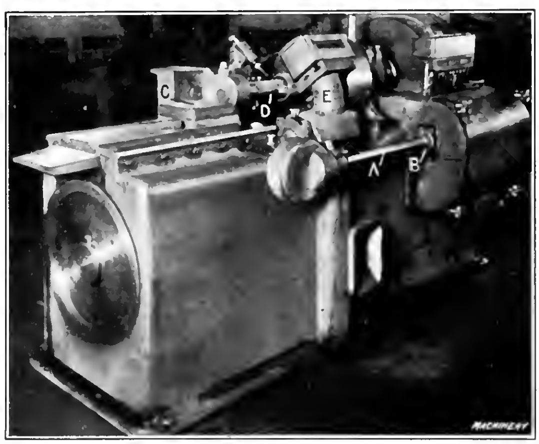


Fig. 2. Opposite Side of Machine shown in Fig. 1

necessary to cause the tool to cut into the ring. In addition to being held and supported by the turret slide, the eccentric turning tool and its bracket and the automatic marker are well supported by a bearing plate *O* which has a continuous bearing upon the steel plate that is bolted to the top of the front way of the machine.

The operation of the machine when working on piston-rings is as follows: The piston-ring sleeve casting is held in machine and the thirteen rings are turned, marked and cut off in 4½ minutes.

The cutting-off tools carried by the rocker arm are first adjusted and set in position in a removable block that is, in turn, held on the rocker arm. This block, with the tools intact, can easily be removed at any time for resharpening and the block returned without affecting the adjustment of the machine in any way.

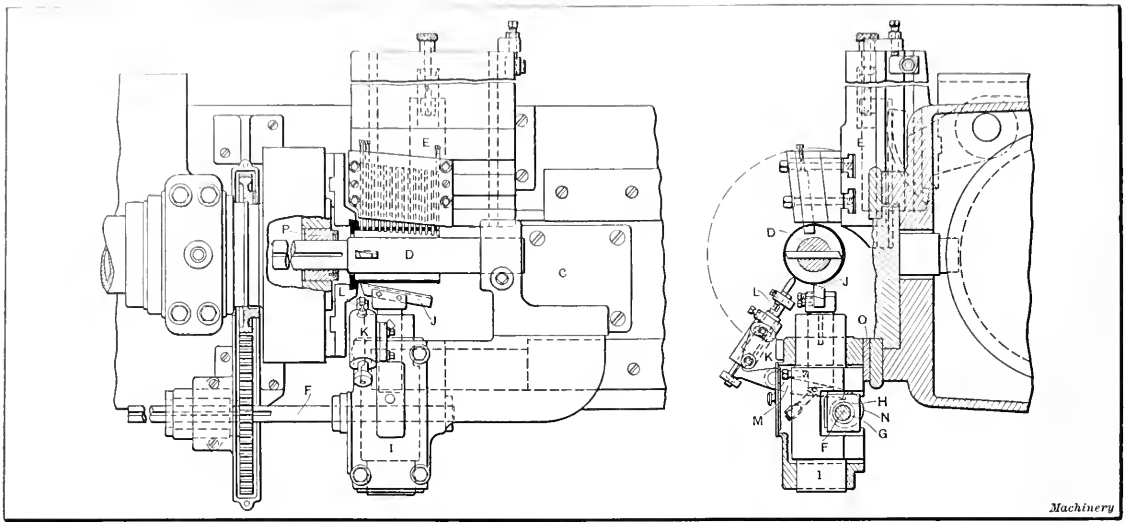


Fig. 3. Plan View of Machine tooled for turning Piston-rings

the universal chuck upon the main spindle of the machine. The boring bar is held on the turret slide and its inner end is piloted in the bushing *P* which may be seen in the line illustration, Fig. 3. This bushing is fitted with a felt washer which keeps dust and chips out of the bushing. The concentric boring tool is, of course, located in the boring bar as shown. The eccentric turning tool is firmly bolted in the eccentric turning slide and receives its motion in the manner just described. As soon as the eccentric turning tool has

When working on pistons, the tool set-up is about as shown in Fig. 4. Here the piston is shown at *A*, being held in place upon the spindle nose *B* by means of a cross pin *C*, passing through the wrist-pin hole, which is drawn back by a draw-back bar *D*. The draw-back bar is quickly operated by means of lever *E*. The pistons are bored and turned on the open ends before coming to this machine. When used for piston-turning, no eccentric turning slide is necessary, so the bracket supporting the eccentric turning and marking fix-

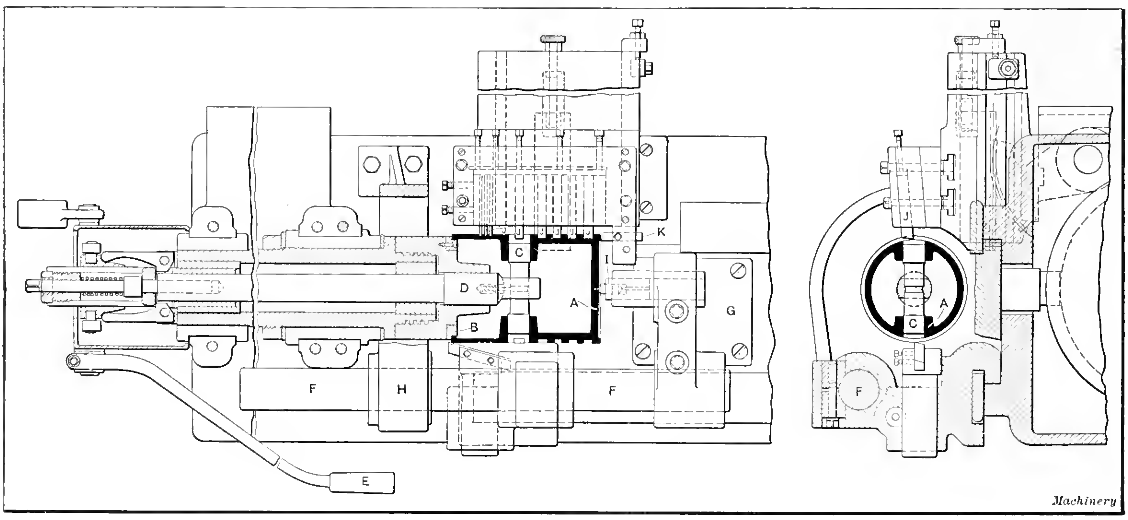


Fig. 4. Plan View of Machine tooled for turning Pistons

commenced its cut, the rocker arm with its multiple set of cutting-off tools comes in from the rear. This is clearly shown in Fig. 3, and as the cutting tools are set each slightly ahead of the other, the rings are separated about as soon as the outside portions have been turned and marked. An idea of the speed at which piston-rings are made may be gathered from the fact that a casting which will make thirteen piston-rings, 5/16 inch wide and 4 1/4 inch diameter, is put into the

tures is removed. The turning bar *F* is operated from the turning slide *G* and its outer end is piloted in a bracket *H* bolted to the frame of the machine. By thus piloting the turning tool, great stiffness is secured. A centering tool is located at the front of the turning slide. The grooving tools *J* and the end turning tool *K* are operated from the rocker arm, these being substituted for the cutting-off tools used in piston-ring turning. As in the case of piston-ring turning, the

different operations on the pistons are performed simultaneously, being centered, faced, turned and grooved at the same time.

In accordance with recognized practice, pistons are finished on this machine in two operations, roughing and finishing, sufficient time being allowed to elapse between these operations to insure accuracy. The turning time for pistons, 3¾ diameter by 3¾ inch long, is 6 minutes. This includes roughing and finishing.

STANDARD ROLLING MILLS

The accompanying illustrations show two rolling mills which constitute an addition to the line of machines manufactured by the Standard Machinery Co., Elmwood Ave., Auburn, R. I. The machine shown in Fig. 1 is a light mill with rolls 5 inches diameter by 8 inches face width. This machine is equipped with a constant-speed motor used in connection with a special Cutler-Hammer controller which allows the mill to be started and stopped by a foot treadle.

Beneath the bed of the machine there is an oil switch which is connected to an automatic switch shown in the illustration; this arrangement allows the operator to press down and lock the treadle on the special treadle stand which has a shoulder on it. When the rolling operation is finished, the treadle is pushed to one side, allowing it to snap back through the action of a spring and thus shut off the current from the motor. Exclusive of the motor train, the machine is driven through a triple train of gearing which includes the intermediate and driving trains on the machine proper with cut steel herringbone gears in the housings. The motor pinion is of rawhide and meshes with a cut steel gear on the driving shaft. The teeth of all of the gears are cut.

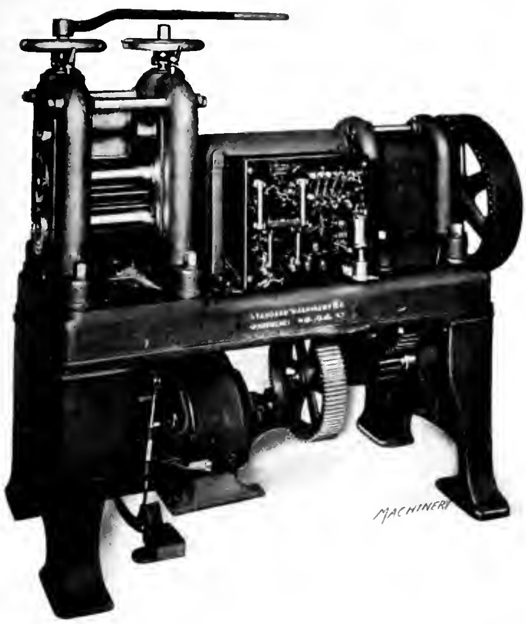


Fig. 1. Standard Rolling Mill with Constant Speed Motor Drive

The machine is equipped with hardened and ground rolls of special Krupp steel. These rolls have hardened and ground journals which run in the Standard roller bearings. The face of the rolls are mirror lapped. The housings are fitted with handwheels with micrometer dials. The principal dimensions of the machine are as follows: Sizes of rolls, 5 inches diameter by 8 inches face width; back gear ratio, 16 to 1; floor space occupied, 7 by 2½ feet; weight of machine, 3600 pounds.

Fig. 2 shows a machine which is a modification of the rolling mill illustrated in Fig. 1, the former machine being arranged for belt drive. The special features of this machine consist of making the bed all one piece and doing away with the legs and bearing bracket below the separate bed. This construction makes a self-contained machine of the same dimensions as the one previously described. All of the bearings are bronze bushed. The clutch is of the cone type and permits the mill to be started and stopped without requiring the operator to use his hands, the clutch being thrown in and out by means of a spring mechanism on the driving shaft.

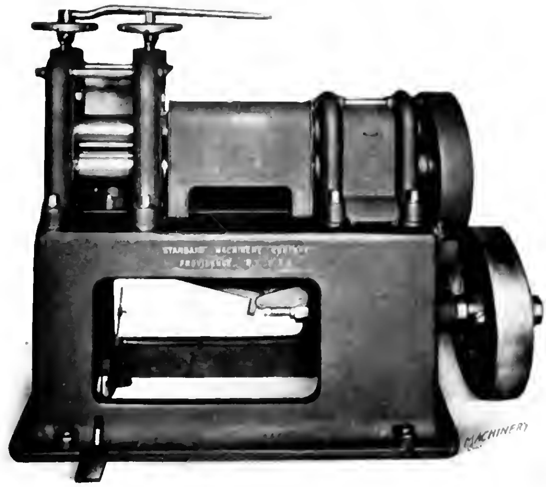


Fig. 2. Same Type of Mill arranged for Belt Drive

KNIGHT DUPLEX MILLING MACHINE

The light duplex milling machine illustrated herewith is a recent production of the W. B. Knight Machinery Co., 2019-25 Lucas Ave., St. Louis, Mo. This machine has been designed for manufacturing work where it finds application on many light jobs that can be milled on two sides simultaneously. The duplex machine cuts the operating time exactly in half, and as a second setting of the work is saved, the chucking time is also reduced 50 per cent. Among the classes of work which this machine will handle, the following may be mentioned: milling the frames of typewriters, adding machines, cash registers and similar parts where lugs occur in pairs and are to be finished on opposite sides of the casting; and milling flats, squares and hexagons on shafts, tools, etc. The work may either be handled by putting a number of

Knight Duplex Milling Machine for Light Work

pieces vertically in a jig and passing them between two end mills to finish opposite sides simultaneously, or by bringing the heads closer together and driving two cutters in opposite directions with one cutter above the other.

As the machine is particularly designed for the class of work which has been referred to, the longitudinal feed of the table is the only one required. The table is provided with a quick return at 7½ times the feed. The feeds and speeds are obtained through gears which are fully enclosed, and the feed and adjustment screws are fitted with graduated collars. The spindles run in adjustable bronze bearings. Both the uprights carrying the spindles are controlled by one handwheel which moves them toward or away from each other simultaneously. This handwheel has a graduated set collar to indicate the distance that each head has moved. The heads can be raised or lowered on the uprights, independently of each other and graduated scales on the vertical ways and graduated set collars on the vertical screws facilitate an exact adjustment which is matained by means of lock nuts. Both the uprights and saddle carrying the table are also clamped to the bed of the machine by means of lock nuts.

Gears contained in the bed of the machine provide six changes of spindle speeds, the same gear box controlling both of the spindles. The drive is through gears which transmit power from the single clutch pulley at the end of the bed. At the opposite end of the machine from the driving pulley there is another gear box which controls the longitudinal feed of the table. There are six all-geared feeds instantly obtainable, the feed range being from 0.008 to 0.060 inch per revolution. Both sets of change gears run in oil and all levers controlling changes of speeds and feeds are conveniently located at the front of the machine. Adjustable gibs are used to compensate for wear between the spindle heads and the uprights. The principal dimensions of the machine are as follows: maximum distance between spindles, 22 inches; height of spindles from bed, 2 inches to 9 inches; range of spindle speeds, 50 to 400 R. P. M.; working surface of table, 8½ by 32 inches; longitudinal table feed, 24 inches; floor space occupied, 73 by 73 inches; net weight of machine, 1550 pounds.

This machine is to be exhibited at the Boston Auto Show, Mechanics' Bldg., March 9 to 14.

WHITCOMB-BLAISDELL GEARED HEAD LATHE

The Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., has recently added to its line of lathes a geared head machine which is illustrated herewith. The changes of spindle speeds on this machine are obtained through sliding clutches which are so arranged that it is impossible to engage two speeds at the same time. The idea in bringing out these machines was to meet the demand for a powerful geared head lathe which is adaptable for either single pulley drive from the lineshaft or direct-connected motor drive through a constant-speed motor. The design combines the features of simplicity and durability.

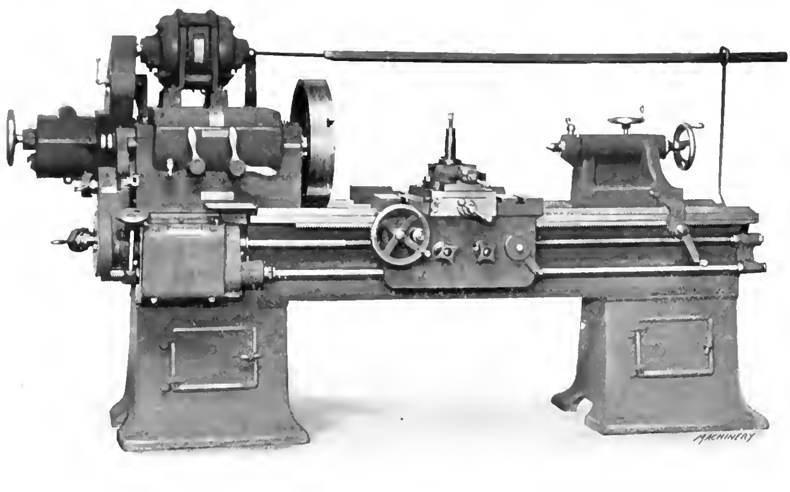


Fig. 1. Whitcomb-Blaisdell Geared Head Lathe with Single Pulley Drive

A noteworthy feature of these machines is that the spindle may be stopped, started or reversed from the operating position without requiring the use of a countershaft or reversing motor equipment. This feature is obtained through the application of two clutches and gearing located in the reversing friction gear box at the head end of the lathe. Although a single speed motor is entirely satisfactory it is, of course, possible to use a 2 to 1 or 3 to 1 variable speed motor, but the variable speed motor is by no means necessary. In addition to the reversing geared headstock, these machines include all of the regular features applied on Whitcomb-Blaisdell lathes. The line includes machines ranging from 14 to 30 inches.

ALLEN SOCKET FILLISTER SCREW

In the November, 1910, number of MACHINERY, the safety set-screw made by the Allen Mfg. Co., Inc., 135 Sheldon St., Hartford, Conn., was illustrated and described. This company has recently brought out a fillister-head screw which is turned

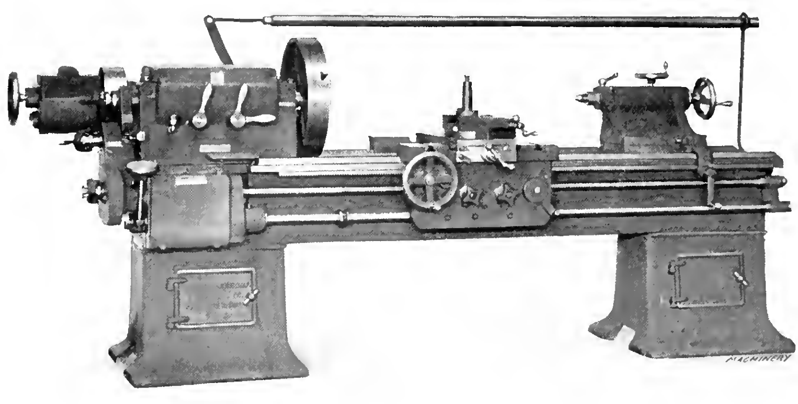
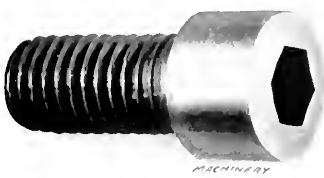


Fig. 2. Whitcomb-Blaisdell Lathe with Electric Motor Drive

by a key fitting in a socket in the head; one of these screws is illustrated herewith, and little description will be necessary to point out its features. This form of screw will stand up under hard service where the slotted head screws soon become so badly worn that it is very difficult to turn them. Anyone who has had any experience in turning ordinary fillister-head screws with a screwdriver knows that the slot often becomes battered in a way which makes the screw very difficult to turn.

The application of the socket head idea on fillister screws enables the screw to be turned up fully as tight as an ordinary

hexagon headed capscrew. As no clearance is necessary around the head, these screws can be conveniently used in many places where there would not be sufficient clearance for a hexagon headed screw. The heads of the Allen fillister screws are trimmed so that the head and body are in perfect alignment. Screws of this kind improve the appearance of a machine and constitute a good "talking point." At the present time the Allen Mfg. Co. is making screws of this kind in sizes ranging from 3/16 to 3/4 inch, and in any length. Other sizes will be added to the line from time to time.

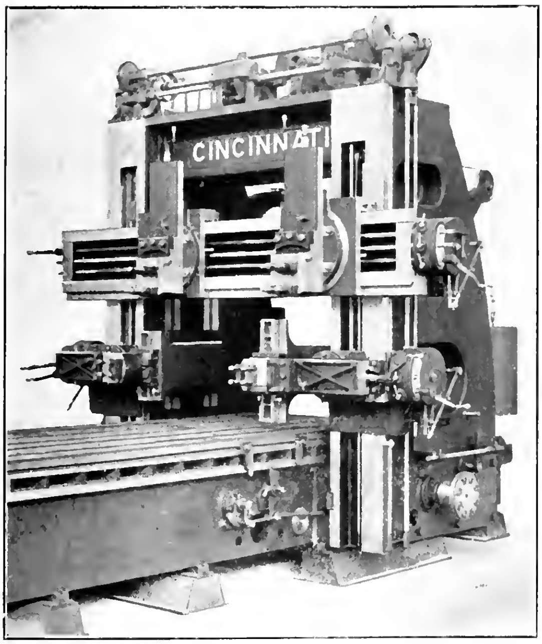


Allen Socket Fillister-head Screw

CINCINNATI LOCOMOTIVE CYLINDER PLANER

In the January, 1914, number of MACHINERY a large size planer built by the Cincinnati Planer Co., Cincinnati, Ohio, was illustrated and described. The accompanying illustration shows a machine of similar design which has been built for planing locomotive cylinders. This machine has a capacity of 72 by 72 inches and has rapid power traverse to all heads in any direction. All movements are independent of each other and can be operated whether the table is in motion or not.

The special feature of this machine lies in the provision of the auxiliary side head supports. The heads are provided



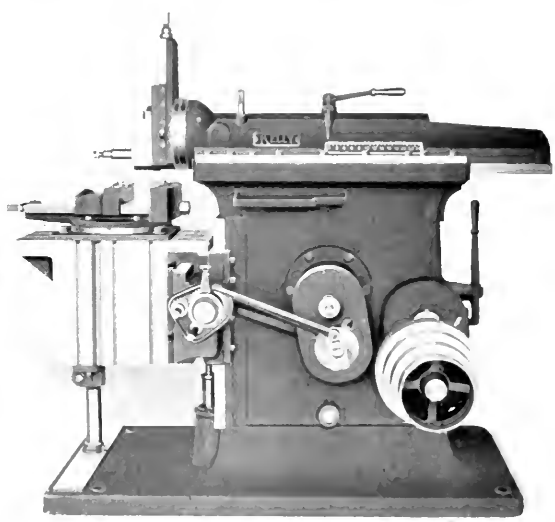
Cincinnati 72 by 72-inch Locomotive Cylinder Planer

with extra brackets which are rigidly bolted to the inside of the housing; these brackets support the slides while the machine is engaged in planing the frame fits and similar operations. They are adjustable for height and can be used in any position between the top of the table and the bottom of the cross-rail. A sliding shoe fits the front face of the brackets and has a dovetail on it which the cross-slide fits. This construction eliminates all twisting strains on the face of the housing caused by the long overhung slide and the upward pressure of the tool. These special brackets can be easily removed from the machine, thereby converting it into a standard planer. This planer is built in various sizes and lengths.

R. A. KELLY SHAPER

The accompanying illustration shows a shaper which constitutes a recent addition to the line of machines manufactured by the R. A. Kelly Co., Xenia, Ohio. The feed on this machine is through a ratchet and plunger mechanism, the ratchet being covered over the greater part of its circumference. The stroke of the pawl is always the same amount, so the feed depends upon the number of ratchet teeth that are exposed. The ratchet cover is prevented from turning, through the action of a spiral spring that holds it just tight enough so that it can be turned by hand.

The shaft which carries the ratchet cover is fastened to a

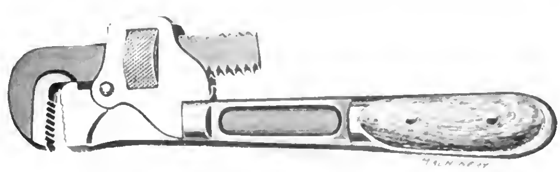

R. A. Kelly Shaper

radius rod, the other end of which is fastened to the radial gear guard carrying the lower feed gear. When the cross-rail is raised or lowered, the shaft carrying the ratchet cover rotates just enough to keep the same number of teeth in the ratchet exposed. In this way the cross-rail may be lowered from the highest to the lowest position or *vice versa* and no adjustment is needed.

The advantages of this feed mechanism are that it may be started, stopped, changed from a maximum to a minimum or reversed when the machine is in motion, without requiring any moving part to receive attention from the operator.

SMITH PIPE WRENCH

The accompanying illustration shows the Smith "perfect handle" pipe wrench which is a recent product of H. D. Smith & Co., Plantsville, Conn. The feature of this wrench is the handle which is both strong and convenient for the


Smith "Perfect Handle" Pipe Wrench

operator to hold. The swell at the end of the handle prevents the hand from slipping off and the wooden inserts make it comfortable to use in extremely hot or cold weather.

BRIDGEFORD AXLE LATHE

The accompanying illustrations show a center drive gap axle lathe with two carriages, which the Bridgeford Machine Tool Works, Rochester, N. Y., has recently designed for use

in railroad shops. This machine is intended for turning journals of car axles without removing the wheels, and as it is equipped with two carriages, both ends of the axle may be finished simultaneously. This means a considerable saving of time taken to machine a pair of journals. In other respects, the construction of the present machine is similar to that of the regular line of axle lathes built by this company.

The most satisfactory method is to place the machine in a pit so that the axles with the wheels attached to them can be placed on the centers with very little trouble. The driving gear, which is two pitch with a face width of 5 inches, is completely encased and runs in heavy bronze bearings scraped to an accurate fit. It is furnished with drivers for driving the axle, these drivers operating on the same principle as the self-centering style drivers furnished with the standard Bridgeford axle lathes. The driving gear is in two pieces, tongued and grooved together and secured by four heavy hinged bolts and nuts. These bolts are easily operated by means of a socket wrench and less than one-half turn of each nut is sufficient to release the gear so that it may be opened to allow the entrance of the wheels and axle. The upper half of the driving head operates on a heavy hinge stud in the front of the machine. To lift the head, the pull pin is pushed into place and the nuts are released. An eye-bolt is placed on the upper half of the head and a rope with counter-weights is used to lift and lower the head.

The machine is driven by a constant-speed pulley and there are three geared changes of cutting speed. The gears are of steel with cut teeth and run in oil, the changes of speed being accomplished by shifting levers conveniently located on the case. From the speed box, the power is transmitted to the driving head by a shaft located inside the frame of the machine. All driving shafts are of high-carbon steel and run in scraped bronze bearings.

There are four instantaneous changes of feed ranging from 1/16 to 3/16 inch per revolution of the axle. The gears in the feed box are of steel and run in oil; they are operated by a lever placed at the center of the lathe. The tailstocks have bearings 24 inches in length on the bed; they are secured in position by four heavy bolts and binders and the spindles may be adjusted by means of screws and handwheels. The carriages are driven by a splined feed shaft and the direction of the feed is changed at the apron. Each carriage is independent of the other. The carriages have a bearing 30 inches in length on the vees and they also have a bearing at the back of the bed which takes the forward thrust, thus overcoming the tendency to raise the carriages from the vees when the burnisher is used.

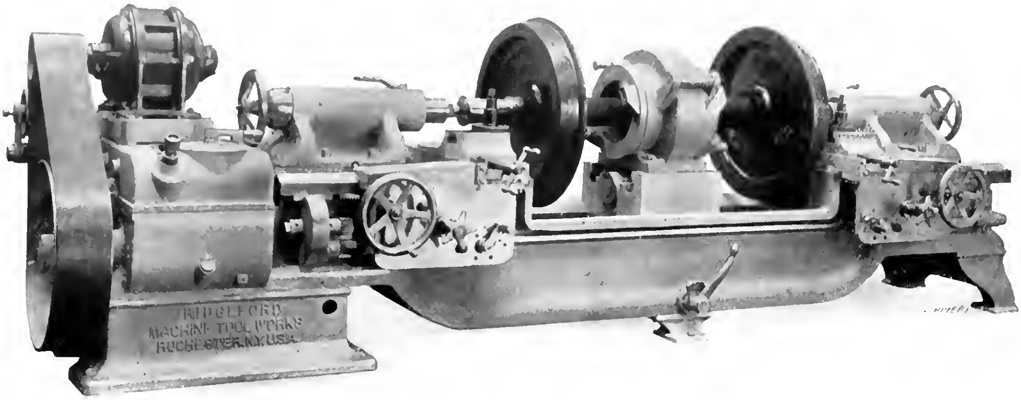


Fig. 1. Bridgeford Axle Lathe equipped with two Carriages

The bed is of rigid construction, strongly reinforced with cross ties to provide the required rigidity. The principal dimensions of the machine are as follows: Minimum distance between centers, 54 inches; maximum distance between centers, 105 inches; swing over ways, 27 inches, over the carriages, 13½ inches and in the gap, 45 inches. Fig. 2 shows a machine equipped with two extra inside carriages for refinishing locomotive and tender axles with inside bearings. Such a machine is exceptionally useful for all kinds of axle repair work. The weight of a lathe equipped with two carriages is 16,000 pounds and a lathe with four carriages has a net weight of 18,000 pounds.

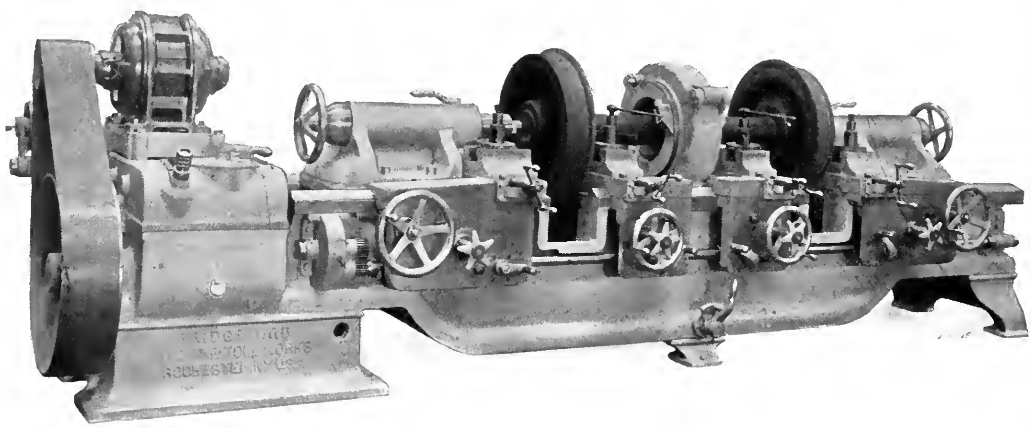


Fig. 2. Bridgeford Lathe with Regular Carriages and Two Extra Inside Carriages

PEDRICK PORTABLE MILLING MACHINE

The notable features of a portable milling machine which has recently been placed on the market by the Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa., are the simplicity of its design, the adaptability of the machine for operation on a variety of classes of work, and the provis-

ion for driving by motor, belt or hand as desired. In a portable tool of this character, simplicity of design means less weight, greater convenience of operation and lower cost. For these reasons, automatic feed has been omitted on the No. 1 machine, hand adjustment for the longitudinal and cross traverse being provided, which serves every purpose. The No. 2 machine, which is considerably larger and intended for a wider scope of work, has automatic feed.

In designing this machine, particular care has been taken to have the construction of ample strength. The spindle bearing is proportioned to give rigid support and to have the desired durability; the bed is ribbed in the center and has removable posts at both ends. These posts may be taken out if necessary when setting up the machine, as there are cases when they would interfere with a wrench used for tightening the holding nuts inside the base. There are a number of elongated slots in the base to provide for attaching the machine to the work. An important feature of the design is that the machine will mill a surface level with the surface on which it is attached or several inches below it. The machine does not "smother" the job and it will face a small valve seat just as easily as one of the maximum size that it is capable of machining. The machine will work with equally satisfactory results in either a horizontal or vertical position.

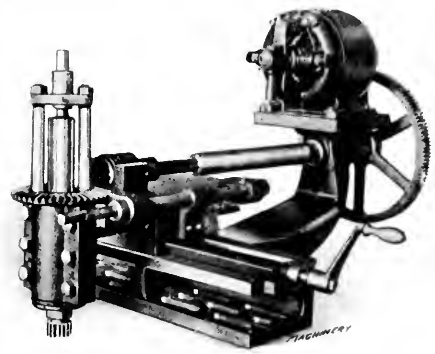


Fig. 1. Pedrick Portable Milling Machine

The spindle and quill revolve together and there are no shoulders or collars to wear and allow the cutter to flinch away from the work. Another feature is that when the cutter is no larger than the diameter of the spindle, it may be lifted out of the bearing with the spindle to enable the cutter to be sharpened or a new one to be used. This is accomplished by merely loosening two nuts and is found to be a particularly convenient feature of the machine, because if a cutter is working in a small deep chest where there is not sufficient room to reach in and unscrew it, it is not necessary to remove the entire machine. The spindle has a standard taper so that an ordinary cutter may be used.

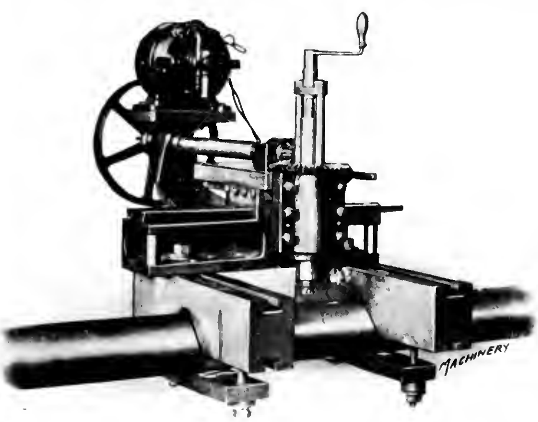
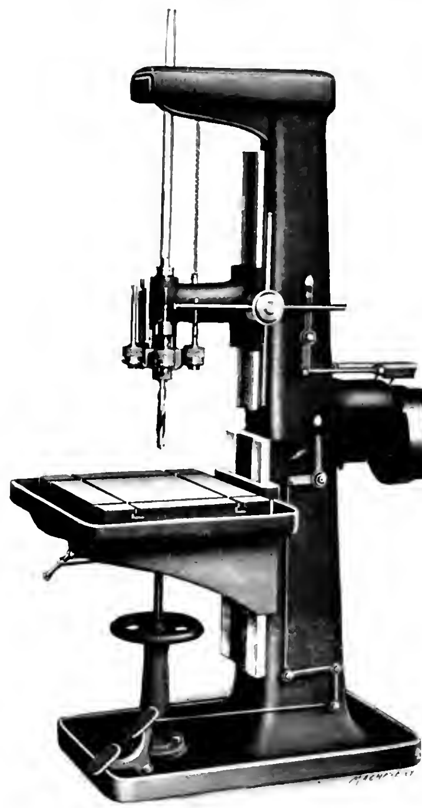


Fig. 2. Pedrick Machine milling a Keyway in a Shaft

The telescopic driving shaft works smoothly and quietly throughout its full range, and is of ample strength to meet the requirements of any service for which the machine is intended. The No. 1 machine will face a surface up to 12 by 8 inches in size, and the spindle has a vertical adjustment of 6 inches. The direct motor drive is arranged as shown in the illustrations, and a machine equipped in this way is a self-contained unit that may be used in close quarters and easily set up. Besides using the machine for milling seats in pumps and engines, or pads on large frames and housings, it is found to constitute a very convenient means of machining keyways in shafts. While not particularly designed for the purpose, this machine may also be used for drilling.

ROBBINS MULTIPLE-SPINDLE DRILL

The Taylor quick-change multiple drill press illustrated herewith is a recent product of the Robbins Machine Co., Worcester, Mass. This drill was designed to meet the demand for a machine of the sensitive drill type with sufficient power to handle work beyond the capacity of a sensitive drill press, and at the same time operate quicker than a standard upright drill. It will drive a 1¼-inch drill as easily as the ordinary sensitive drill press will handle a ¾-inch drill. The feed is by hand, and when large drills are to be used at high speed, compound gearing in the sliding head can be quickly engaged to increase the pressure of the drill and decrease the pressure required on the hand lever. This enables a large drill to be forced to its full capacity by the application of a limited amount of hand pressure. The reverse motion of the spindle is of unusual strength and provides ample power to handle reasonably large taps.



Taylor Quick-change Multiple-spindle Drill

The machine is driven by spiral gears running in oil, and all gears that are subjected to excessive strain are made of heat-treated nickel steel. The quick-change gear-box is arranged for four spindle speeds and one reverse speed for tapping. The spindle speeds are quickly changed without requiring the machine to be stopped. The sliding head affords quick action in raising or lowering the spindles for tools of different lengths.

The quick-change drill chuck is designed to hold five tools such as drills, reamers, counterbores, taps, etc., which are required for performing successive operations on a piece of work. This chuck provides for rapidly moving any tool to the working or idle position without stopping the machine. When the tool to be used is swung to the operating position it is securely locked and held in perfect alignment with the driving spindle. The power is applied through a combination clutch and friction device, and the greater the strain on the tool the more powerful the drive becomes. When the machine is in operation all tools in the chuck are idle with the exception of the working tool. The clutches for holding the tools in the chuck are made to fit either No. 1, 2 or 3 Morse taper shanks.

The machine is ball bearing throughout and is practically noiseless in operation. The principal dimensions are as follows: distance from center of spindle to face of column, 10 inches; maximum distance from table to spindle, 30 inches; traverse of table, 12 inches; traverse of spindle, 16 inches; size of work-table, 18 by 24 inches; diameter of spindle, $1\frac{1}{4}$ inch; and net weight of machine, 1200 pounds.

MURCHEY PIPE THREADING DIE

The accompanying illustrations show a pipe threading die which has recently been placed on the market by the Murchey Machine & Tool Co., Porter and Third Sts., Detroit, Mich. The important feature of the design of this die consists of the four circular chasers which are similar in shape to circular forming tools. These chasers are provided with a series of annular V-grooves properly spaced for the pitch of the thread that it is desired to cut.

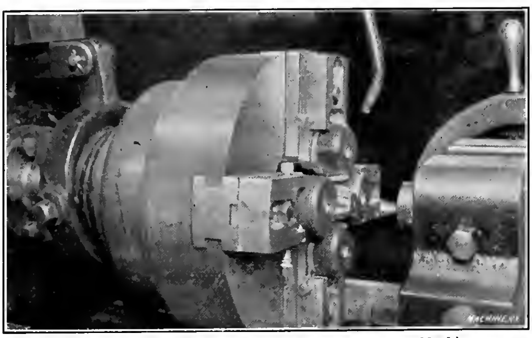


Fig. 1. Murchey Pipe Threading Die set up on a Machine

The circular chasers are carried by slides which fit in T-slots in the die head, the construction being clearly shown in Fig. 1. Interposed between the top faces of these slides and the chasers, there are adjusting plates, each of which has nine holes which are equally spaced. Three pins held in the chasers fit into these holes and adjustment of the position of the chasers is effected by loosening the square screws, lifting the chasers up and turning them around so that the three pins enter another set of holes. The cutting edge of the chasers is then set in the correct relation to the center of the work by adjusting the set-screws in the slides.

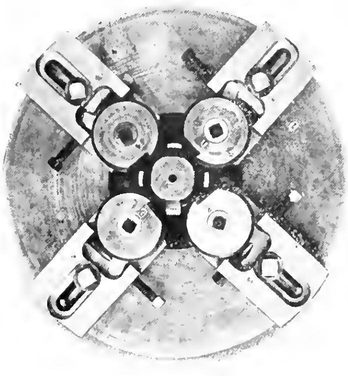


Fig. 2. End View of Murchey Pipe Threading Die

In order to cut the thread on a taper, the top faces of the slides against which the chasers are held are beveled. This serves to throw the chasers to the required angle. Different diameters of pipe are threaded by the substitution of circular blocks of varying lengths in semicircular grooves provided in the top face of the die head and the lower surfaces of the slides. The chasers can be resharpened until practically the entire circumference is ground away so that their life is much longer than that of the ordinary type of die chasers. A reamer is shown in Fig. 2 which is held in the die head to remove the burrs from the end and hole in the pipe.

STOCKBRIDGE KNIFE GRINDER

The time spent in removing and replacing the knives of planers and jointers used in wood-working shops constitutes a large part of the time involved when it is necessary to take them off for grinding. This is a difficult and unsatisfactory method, and is often done hurriedly and improperly, with the result that the machine when started up operates inefficiently and produces a poor grade of work. This is especially true of the thin hard knives used on cylindrical head planers which are almost impossible to grind and reset in perfect alignment for the entire length of the head.

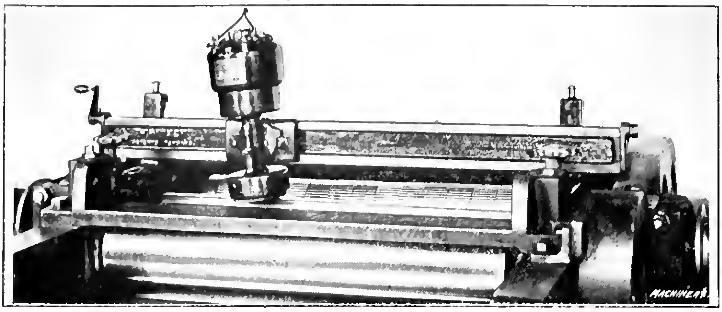


Fig. 1. Use of Stockbridge Grinder in sharpening Planer Knives

In the "Quicsharp" grinder, which is a recent product of the Stockbridge Machine Co., Worcester, Mass., these difficulties are avoided by providing a grinder which enables the knives to be sharpened while in place on the machine. The grinder is motor-driven, the motor being mounted on the head and supplied with a current from an ordinary lamp socket. The saddle has a split nut attached to it which engages the feed-screw located at the top of the bridge. The saddle can be fed across the entire length of the bridge in either direction and at any desired speed. The bridge is supported at the ends or at intermediate points by two angular brackets, which are bolted to the bed of the wood-working machine, and hold the grinder perfectly rigid. The wheel is cup-faced and can be raised or lowered by a thumb-screw to grind the required amount from the knives. The wheel is fed automatically to a positive stop. The grinder head is pivoted at

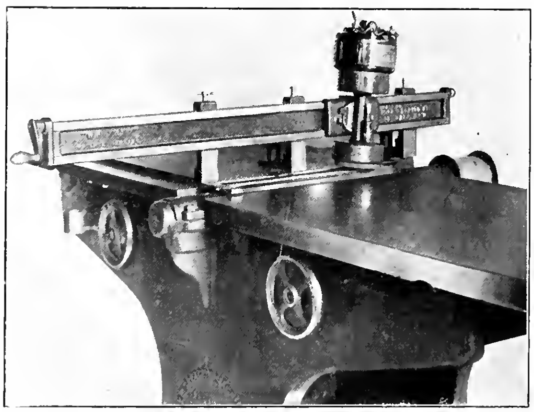


Fig. 2. Stockbridge Grinder sharpening Jointer Knives

the center and can be tilted to either side of the perpendicular; it is held in place against a stop, giving the same angle on each side of the perpendicular. With the head tilted, the knives are ground concave. A positive stop holds each knife in exactly the same relative position to the wheel; therefore, each knife must be ground true. Figs. 1 and 2 show this grinder in use on a planer and on a jointer, and reference to these illustrations will show the way in which it is used, making further description unnecessary.

DERIHON PORTABLE HARDNESS TESTING MACHINE

The illustrations presented in this connection show a portable machine for conducting the Brinell hardness test, which consists of making an impression with a hardened steel ball 10 millimeters in diameter, by the application of a pressure of 3000 kilograms. Fig. 1 shows the machine ready for the test with the lever resting on the shaft. The piece to be tested is placed on the table of the machine, which is then raised until the piece is in contact with the ball. This done, the lever is pulled slowly over so as to give a progressive pressure which is registered by a small manometer until 3000 kilograms is applied. When this figure is reached the lever is slowly returned to its former position and the test is completed. Under normal conditions it is usually sufficient to move the lever through an angle of 45 degrees to obtain the required pressure of 3000 kilograms.

With each machine a small piece of steel is furnished in which a standard impression has been made, the size of the diameter being stamped on it. This standard piece is of

Fig. 1. Machine ready for making Test

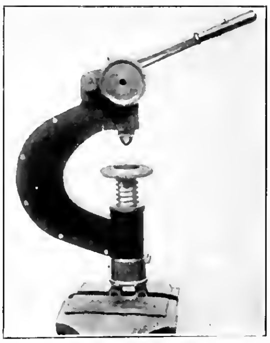


Fig. 2. Arrangement of Gears at Rear of Machine

special air-hardening chrome-nickel steel. The accuracy of the machine can be easily controlled by making an impression beside the standard impression. The construction of the machine is based on the principle of elasticity of the frame, which for this purpose has been constructed in the shape of a horse-shoe. The power produced by the pressure of the ball on the test piece has a tendency to open the frame to a certain degree in proportion to this power. The shape of the frame has, therefore, been specially considered in order to have it as elastic as possible. The pressure exerted of 3000 kilograms does not change the resistance or elasticity of the frame, as it is made of steel having an elastic limit of 242,000 pounds per square inch and a pressure of 3000, 4000 or even 5000 kilograms does not work it above 10 kilograms per square millimeter or 1442 pounds per square inch. Under these conditions, repeated tests even in large numbers do not alter the calibration of the machine.

The deflection of the frame being relatively weak (1 to 1.5 millimeter), a register, the construction of which resembles a metallic manometer, is installed in the hollowed out part of the frame. By means of a needle and a graduated dial, the deflection and therefore the pressure exerted in making the test can be quickly and easily read. To adjust the machine, all that is necessary is to open the head enclosing the mechanism above the frame. Should the machine ever get out of adjustment, a comparison should be made on the standard test piece, and when an impression of the same diameter has been made, the needle is brought over the figure "3000" by means of the small adjusting screw. This adjustment, however, would only be necessary through some accidental cause independent of the operation of the machine under normal usage. Fig. 2 shows the arrangement of the gears at the rear of the machine. This machine is placed on the market by H. A. Elliott, 507 Majestic Bldg., Detroit, Mich.

SCULLY-JONES ADJUSTABLE SPACING COLLAR

Fig. 1 shows the "Wear-ever" adjustable spacing collar for use on milling machine arbors, which is a recent product of Scully-Jones & Co., 319 Railway Exchange Bldg., Chicago, Ill., and Fig. 2 illustrates the method of using these collars. The "Wear-ever" collar was designed primarily for use in connection with manufacturing operations on milling machines, where two or more cutters on an arbor must be spaced at a specified distance from each other. Those familiar with the application of straddle or gang cutters in milling machine operations know that it is sometimes necessary to grind the sides of the teeth. This necessarily changes the distance between the faces of the cutters, and in order to maintain the required dimensions of the work, compensation must be made for the amount which has been removed from the cutters by grinding. This is sometimes done by carrying solid spacing collars of assorted lengths in stock. But if the exact size cannot be found among the collars on hand, it is necessary to grind down a collar that is too long or to shim up one that is too short. While this is being done the milling machine is standing idle.

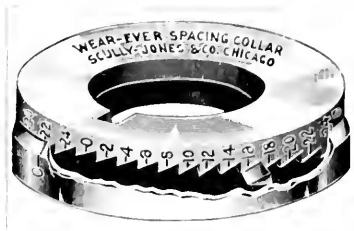


Fig. 1. Scully-Jones Adjustable Spacing Collar

The "Wear-ever" collar is designed so that the thickness may be varied up to 0.024 inch, this adjustment being divided into twelve steps of 0.002 inch each. It will be seen from Fig. 1 that the collar is provided with three sets of graduations ranging from zero to 24 by even numbers, each graduation being opposite a notch in the collar. These notches are arranged on cam surfaces, and corresponding notches in each of the three series of graduations are engaged by a tooth. In making the adjustment, the collar is moved around so that the teeth engage with the proper spaces to give the required expansion of the collar on the arbor. The adjustment is quickly made, and after the collar has been set it is exactly as rigid as a solid collar. The advantages of the "Wear-ever" collar may be briefly summarized as follows:

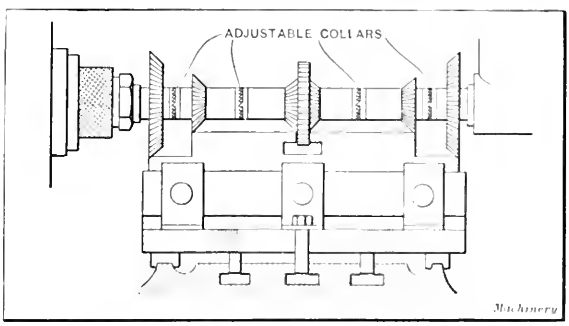


Fig. 2. Use of Scully-Jones Adjustable Spacing Collars

they are made in sizes down to less than ½ inch in width and are capable of standing up under hard service; it is impossible for chips to interfere with the operation of the collar, and the first cost is low so that a shop can afford to purchase them for any work upon which they could be used to advantage.

LOWE "LAST-WORD" INDICATOR

Henry A. Lowe, 1371 E. Eighty-eighth St., Cleveland, Ohio, is now manufacturing the "Last word" test indicator which is illustrated in Figs. 1 and 2. Fig. 1 shows the indicator carried on the ball joint toolpost shank, and this illustration also shows an auxiliary clamp which is provided with the instrument. This clamp enables an instrument to be removed from the toolpost shank and set up on the needle of a surface gage as illustrated in Fig. 2. There is ball joint connection between the toolpost shank and the indicator, which provides adjustment to meet the requirements of a great variety of work.

Fig. 1. Lowe Test Indicator carried on Ball-joint Toolpost Shank

The contact lever has a hardened taper-head stud for a bearing, which provides adjustment for wear. There is a small tapered hole through the contact ball, and contact points of special shape can be fitted into this hole to meet the requirements of special classes of work. In many cases the ordinary contact ball is quite satisfactory without providing any auxiliary point.

The mechanism of this indicator has been worked out to give the magnifying power of 100, and at the same time the instrument is of remarkably small size, which will be appreciated when it is known that the weight is only $1\frac{1}{4}$ ounce. The dial is graduated to read in 0.001 inch. This instrument can be quickly changed from the toolpost shank to the needle of a surface gage to adapt it for surface plate work, or back to the toolpost shank for lathe, shaper, planer, grinding or milling-machine work. It is adaptable for use on a great variety of tool-room and machine-shop operations.

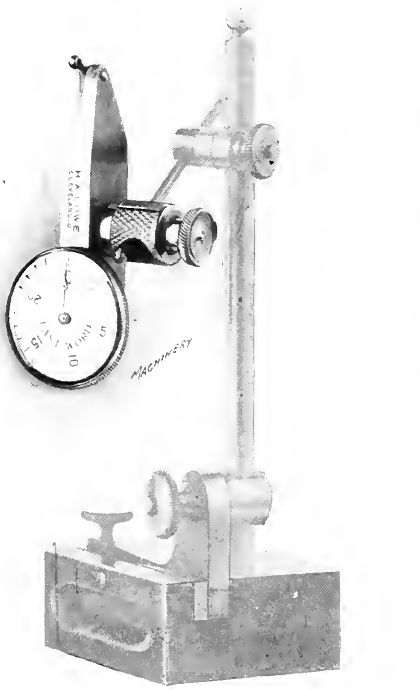
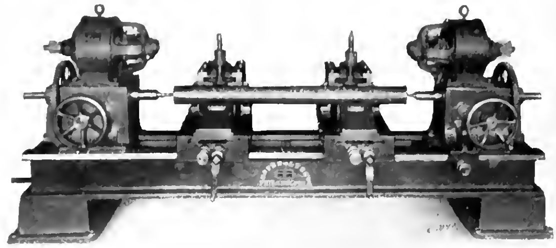


Fig. 2. Lowe Indicator mounted on the Needle of a Surface Gage

ESPEN-LUCAS AXLE CENTERING MACHINE

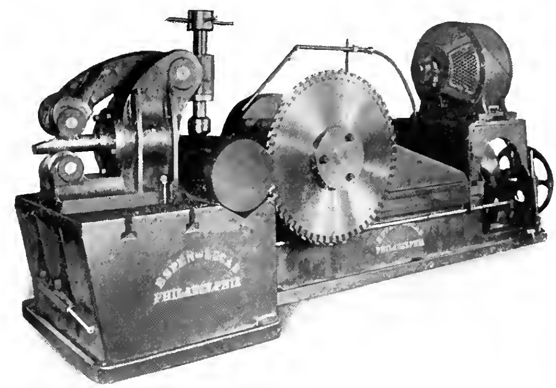
The Espen-Lucas Machine Works, Front & Girard Aves., Philadelphia, Pa., has recently placed a double-end axle centering machine upon the market. This machine is intended for centering both ends of axles up to 7 inches in diameter by 8 feet long. The machine is arranged with two spindles which are driven independently by 2-horsepower motors. On head is stationary and the other adjustable for centering axles from 5 to 8 feet in length. The two cradles are provided with rollers for centering the axles and heavy clamps for holding the work rigidly in place. The weight of the machine is about 11,000 pounds.



Espen-Lucas Double End Axle Centering Machine

ESPEN-LUCAS COLD SAW

The accompanying illustration shows a heavy type of cold saw which is one of the recent products of the Espen-Lucas Machine Works, Front & Girard Aves., Philadelphia, Pa. This machine is equipped with a saw blade 60 inches in diameter and has a capacity for sawing round or square bars up to 20 inches thick. The feed and speed variations are so arranged that the machine can be used for sawing at an advance of 6 inches per minute. The drive is through a main shaft, a phosphor-bronze worm-wheel and a crucible steel worm running in oil. The spindle extends for the entire width of the carriage and the saw blade is bolted directly against the driving gear, an arrangement which practically eliminates torsional strain between the driving gear and the saw blade.



Espen-Lucas Cold Saw Machine

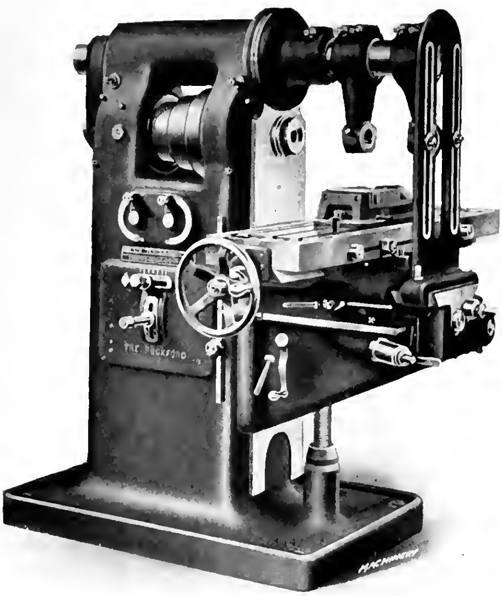
The feed is obtained from a geared friction plate controlled by an automatic lock-nut lever, by which any change in the advance of the saw can be made while the machine is in operation. The saw carriage also has a quick return movement controlled by the same lever. An automatic stop for controlling the traverse of the carriage is also provided. Any type of saw blade including the inserted tooth or solid high-speed steel blades may be used.

Compressed air or screw clamps are provided for use on this machine, depending upon the requirements of individual cases. For handling stock rapidly where multiple cuts are to be made, this saw is equipped with a stock feed attachment which will handle bars of any length up to 20 feet. The usual form of drip pan furnished on machines used for sawing smaller sizes of stock has been eliminated in the

present instance and a reservoir substituted in the foundation. The machine is belt-driven from a 35-horsepower motor and weighs 50,000 pounds approximately.

ROCKFORD HEAVY PLAIN MILLER

The Rockford Milling Machine Co., Rockford, Ill., is now manufacturing the No. 2 heavy double back geared cone type plain miller which is illustrated herewith. This machine is of exceptionally heavy construction, the approximate weight being 3750 pounds. The back gears are enclosed in the column and operated by two levers which afford a very convenient



Rockford No. 2 Double Back Geared Plain Miller

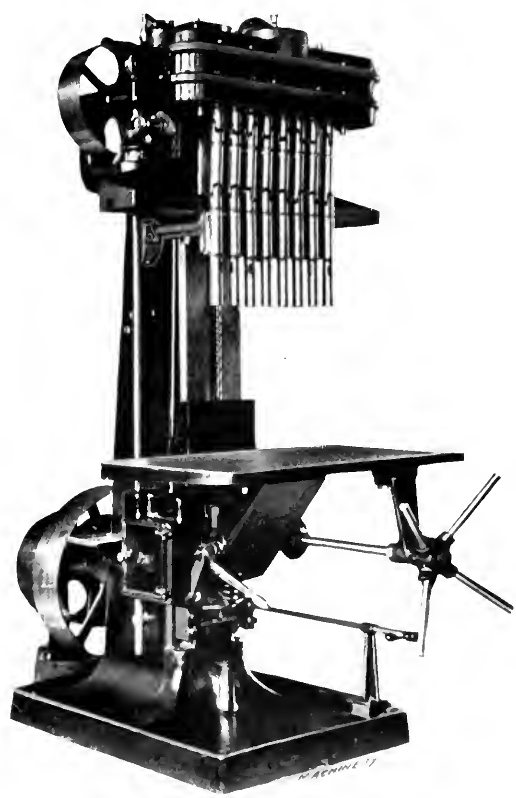
and practical control. The machine is equipped with a flanged support for the overhanging arm, which has been designed by this company; this support stiffens the construction and increases the cutting capacity of the machine. The diameter of the overhanging arm is 4 inches.

The table is provided with a quick return movement operated by a handwheel and clutch, and the handwheel can be thrown in instantly at any desired point. A wrench can be used on the squared shaft at the opposite end of the table. The table measures 50 by 11½ inches over all, and is provided with three ⅝-inch T-slots; there are also oil grooves on the sides and oil pockets at the ends of the table. All feeds are automatic. The spindle is bored No. 11 B. & S. taper, and is made of crucible steel; it runs in phosphor-bronze bushings which have tapered journals fitted with oil retainers. Wear is compensated for at the rear of the spindle by means of a nut. There are eighteen speed changes ranging from 17 to 392 revolutions per minute, and fourteen changes of feed ranging from 0.005 to 0.175 inch per revolution. Feed reverse levers controlling all feeds are located on each side of the knee. The regular equipment of the machine consists of a plain vise, a flanged support for the overhanging arm, two arbor supports and the necessary wrenches. The design has been carefully worked out to secure the maximum rigidity.

FOX MULTIPLE-SPINDLE RAIL DRILL

The No. 3 Fox multiple-spindle rail drill illustrated in this connection has been developed to meet the demand of engine builders for a high-speed multiple-spindle machine for drilling and boring push-rod holes, valve stem guide holes and cages. Particular attention has been paid to the design of the vertical adjustment for each spindle with the view of keeping the cutting edge of all tools in the same plane. This is a feature which users of the machine will appreciate. The base, column and gears for changing the speeds and table feeds are of the same construction which has been used in the past on Fox multiple-spindle drilling machines. The gears are cut from solid 35-point carbon steel blanks, which are pack-hardened and heat treated. The bearings for the gears are subsequently ground, giving the most perfect construction possible. The principal bearings in the machine are bronze bushed, and the main driving pulleys run on Hyatt roller bearings.

Rails of various lengths are furnished with this machine to meet the requirements of individual cases. The rails are made with either a tongue which fits grooves in the adjusting arms to keep all spindles in positive alignment, or the tongue may be omitted from the rail, giving universal adjustment to each spindle. The rail is an exceptionally heavy casting ribbed to provide the necessary rigidity. The gear case containing the driving pinions for the spindles provides a double bearing for each gear in the case. The gears are of 6 and 8 pitch, with broad faces. The regular gear case is bored for a maximum of twelve spindles and when less than this are furnished with the tool, the extra holes are plugged up; it is thus possible to add additional spindles should they be required at any time. The drill spindles, spindle bearings and adjusting arms are of patented con-



Fox Multiple-spindle Rail Drill

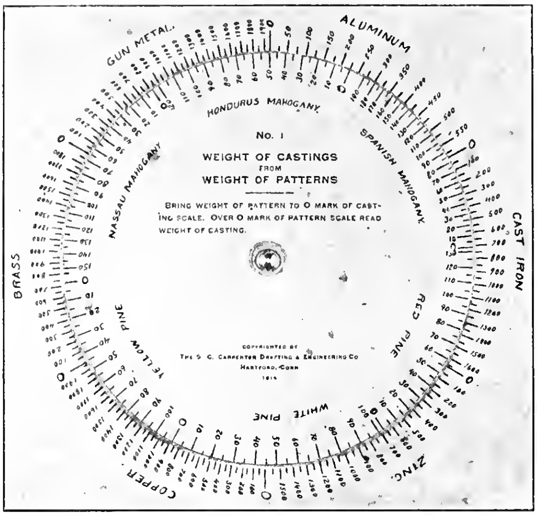
struction, which gives a wide range of vertical adjustment. This adjustment is obtained without changing the set position of the arm. The spindle bearings have a T-slot milled for their entire length and fit into the slotted end of the adjusting arms. T-bolts working in the slots in the bearings secure them to the adjusting arms and provide for adjusting the spindles vertically.

The universal joints used in these machines are made with every friction surface hardened. An oil pocket is provided in the center of the block, giving perfect lubrication. The table regularly furnished on this machine has a surface 24 by 38 inches in size and is equipped with a hand pilot wheel

for raising or lowering. A single lever is provided for manipulating the power feed; pulling up on this lever engages the feed and pushing down on it disengages the feed. An automatic trip lever is provided for automatically throwing out the feed. There are six changes of feed ranging from 0.5 to 5.0 inches per minute; four changes of drill speed are available, depending on the size of drills used. The floor space occupied by this machine is 6 feet by 2 feet 6 inches; the height is 7 feet 8 inches; and the net weight of the machine is 3288 pounds. This machine is a recent product of the Fox Machine Co., 16 Front St., N. W., Grand Rapids, Mich.

CARPENTER CALCULATING CHARTS

The accompanying illustration shows one of a series of eight calculating charts which have recently been brought out by the S. C. Carpenter Drafting & Engineering Co., 49 Oakland Terrace, Hartford, Conn. It will be seen that this chart is intended for finding the weight of castings of different metals from the weight of the patterns from which they are made, the chart being laid out for a number of different kinds of wood commonly used in pattern making. Other charts of this series which are likely to be of interest



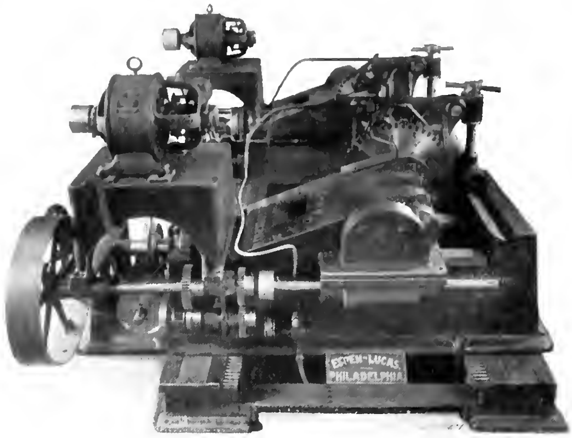
Carpenter Chart for calculating Weight of Castings from Weight of Patterns

to readers of MACHINERY are as follows: Chart No. 2, which gives areas and circumferences of circles with diameters varying by 1/16 inch, and the squares, cubes, square roots and cube roots for each 1/16 inch up to 1 foot; chart No. 3, which gives drill, drill rod, wire and machine screw sizes; and chart No. 4, which gives the sides, angles and area of right angle triangles up to 10 inches base.

ESPEN-LUCAS DUPLEX COLD SAW

The duplex cold saw illustrated herewith is a recent product of the Espen-Lucas Machine Works, Front & Girard Aves., Philadelphia, Pa. This machine is intended for cutting off both ends of axles at the same time, and for this purpose it is equipped with two 32-inch inserted tooth saw blades. The machine has a capacity for sawing off both ends of from twelve to fifteen 9-inch axles per hour. The speed and feed variations provide for sawing at an advance of 6 inches per minute. The cutting capacity is only limited by the nature of the steel that is being cut and the endurance of the high-speed steel cutters in the saw blades.

The machine is driven through a train of compound gearing, a steel worm and a bronze worm-wheel. The gearing and other parts of the machine are liberally proportioned to provide ample strength. The main bed and table are held together by heavy webs and the saw carriages have bearings of ample size on the base of the machine. The saw blades are bolted directly to the driving gears which are forged integral with the ends of the spindles. This arrangement practically eliminates the torque between the driving gear and the saw and enables the spindle bearings to extend for the entire width of the saw carriages. This drive is a strong feature of the machine. All of the gears, spindles and shafts, etc., are cut and turned from high carbon hammered steel forgings. All bearings are bushed with bronze and the thrust



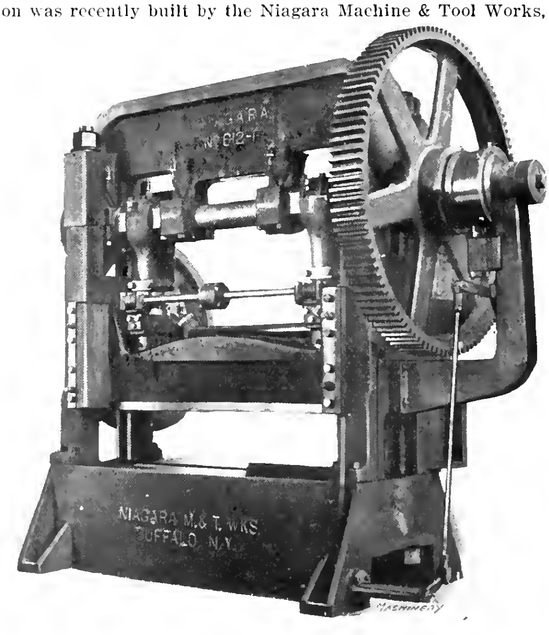
Espen-Lucas Duplex Cold Saw

of the driving worm and other revolving parts is taken up by roller thrust bearings.

The feed is variable and automatic, being controlled by an automatic stop which regulates the depth of cut up to the full capacity of the machine. The saw carriage is equipped with automatic power return and an automatic starting device which leaves the operator free to give his whole attention to the feeding of axles to the machine and removing them when finished. Pumps are provided to furnish a liberal flow of cutting compound to the saws. The machine is driven by 15-horsepower electric motors and weighs approximately 30,000 pounds.

NIAGARA DOUBLE CRANK PRESS

The large double crank press illustrated in this connection was recently built by the Niagara Machine & Tool Works,



Large Niagara Double Crank Press

Buffalo, N. Y. This machine is intended for punching and forming operations met with in steel car work, but the ma-

chine is also suitable for a wide range of heavy stamping operations. The bed, housings and arch are held together by means of four steel tie-rods 4½ inches in diameter which are a shrink fit in the parts which they connect. The same convenient method of adjusting the slide and gibs is provided that is employed on other large presses of this company's manufacture. The motion of the press is controlled by a hand lever operating a powerful jaw clutch. The working surfaces of the three jaws of the gear hub—as well as the clutch collar—are faced with hardened tool steel pieces. An automatic device is provided to stop the slide at the highest point of its stroke. Presses of this type are built in different sizes; the machine shown in the illustration measures 84 inches between the housings and has an approximate weight of 50,000 pounds.

* * *

STATUS OF THE PFAUTER PATENTS IN THE UNITED STATES

Referring to the note appearing on page 478 of February MACHINERY, engineering edition, in reference to the Pfauter patents on gear-hobbing machinery, we wish to state that this seems to have been misleading, some of our competitors assuming that they are now in a position to offer gear-hobbing machines with the differential for cutting spiral gears in the American market also. In order to correct this misunderstanding, we call attention to the fact that the United States patent which was granted to Herman R. Pfauter under date of January 2, 1900, has still about three years to run. Anyone selling or offering for sale gear-hobbing machines equipped with differential gearing for cutting spiral gears will infringe the existing Pfauter patents, and Mr. Pfauter is fully prepared to prosecute any such infringement.

New York City SCHUCHARDT & SCHUTTE

* * *

NEW MACHINERY AND TOOLS NOTES

Heating Forge: Word Brothers, San Francisco, Cal. A forge heated by oil which was particularly designed for heating rock drills; this forge is also adapted for general blacksmith work.

Roller Bearing: Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa. A new type of Sells roller bearing in which the sleeve is split and clamped over the shaft by two split collars.

Finishing Tool: Western Tool & Mfg. Co., Springfield, Ohio. A tool for finishing work in the lathe, shaper or planer which consists of a forged shank to which a steel disk which constitutes the cutter is bolted.

Drill Head: Edward Board, 619 Filbert St., Philadelphia, Pa. A four-spindle drill head designed for drilling four holes simultaneously at an angle of 45 degrees. This head is particularly designed for machining the burners of gas stoves.

Time Recorders: Baird Equipment Co., Chicago, Ill. Three types of time recorders intended for use in marking employe's weekly cards; daily job tickets; single, three or seven day job cards, or for use as a watchman's time detector.

Magnetic Chuck: O. S. Walker & Co., Worcester, Mass. A multiple pole magnetic chuck which is similar in general construction to previous types of magnetic chucks of this company's manufacture. Each pole is energized by an individual coil.

Punch and Shear: J. W. Grace Co., Burlington, Vt. A hand operated punch and shear equipped with two sets of blades. This shear will handle flat bars up to 3 by ½ inch in size. The punch has a capacity up to a ½-inch hole pierced through a ½-inch iron plate.

Facing Arm: H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa. A universal swiveling facing arm on which the tool-holder swivels through a complete circle and can be clamped in any position. The facing arm can be applied to either end of the bar.

Tool Racks: The New Britain Machine Co., 64 Bigelow St., New Britain, Conn. A line of steel tool racks with seamless sheet metal trays pressed from No. 16 gage steel. Racks of this type are mounted on wheels where it is desired to provide for moving them from place to place.

Circular Slide Rule: Lucien E. Picolet, 19 S. 9th St., Philadelphia, Pa. A circular type of slide rule particularly intended for performing the operations of multiplication, division and the extraction of square and cube roots. The results obtained with this rule are claimed to be as accurate as those obtained with three place logarithms.

Brazing Compound: Phillips-Laffitte Co., Philadelphia, Pa. A compound known as "Unifonte" for brazing cast iron. With this material any mechanic can braze broken cast-iron parts and produce a joint which is claimed to be stronger than the original material. "Unifonte" consists of a chemical paste which is used in connection with flux and spelter.

Pneumatic Drill: Ingersoll-Rand Co., New York City. The improved "Little David" pneumatic drill of this company's manufacture is equipped with roller bearings for the connecting rods and crankshafts which run in ball bearings. In other respects the drill is of similar design to the preceding model which has been manufactured by this company.

Cutting-off Machine: Grant Engineering Co., Detroit, Mich. A machine with a capacity for cutting stock up to 4 inches in diameter. The work remains stationary and is cut by a revolving cutter head which is worm driven. The speed of the head is automatically accelerated as the tools travel toward the center, thus maintaining a constant peripheral speed.

Thread Rolling Machine: The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. A reciprocating machine for rolling threads on very small screws. This machine has automatic feed, and the capacity is for blanks up to an approximate diameter of 1/16 inch. The feed mechanism is so designed that short work can be handled to excellent advantage.

Belt Pole: Edward Wilbur, 125 Summer St., Boston, Mass. A belt shifting pole designed to eliminate the use of ladders in shifting belts, and at the same time to facilitate the rapidity with which shifts can be made. The pole is 9 feet long, and has a fork at the upper end, one prong of which passes under the belt while the other acts as a fulcrum on the edge of the pulley.

Boring Mill: Cincinnati Planer Co., Cincinnati, Ohio. A boring mill of lighter construction than the machines previously built by the company. The features of the present machine are centralized control, complete guarding of all dangerous parts of the mechanism, a housing of increased rigidity, and double bearings for the table pinion. Machines of this type are built in 6, 7 and 8 foot sizes.

Planer Type Surface Grinder: Newton Machine Tool Works, Inc., Philadelphia, Pa. A line of heavy surface grinders intended for grinding locomotive radius links, tongue pins, armor plate, etc. The abrasive wheel remains in a fixed position while the work held in pneumatic chucks is traversed back and forth on the table. The wheel is adjusted for the full depth of cut and full width in one operation.

High-speed Hacksaw: Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. A high-speed hacksaw similar in design to the machine described in the June, 1911, number of MACHINERY. The present machine, however, is not provided with the cross-feed movement for advancing stock ready for a subsequent cut after a piece has been cut off. The capacity of the machine is for 6-inch square bars.

Plain Grinding Machine: Modern Tool Co., Second and State Sts., Erie, Pa. A small size grinder for manufacturing purposes. In designing this machine particular attention has been paid to features which will lessen the cost of production of work which requires grinding. The machine is known as a No. 8 size, and has the same capacity as the No. 1 universal grinding machine of this company's manufacture.

Self-opening Die: George Overton, 821 E. 167th St., New York City. A self-opening die of simple construction which has four chasers carried in blocks. In operation, the die travels over the work until the turret slide comes against its stop, when the die is opened through inertia. If preferred, an internal stop in the die shank can be set so that the end of the work will strike it and cause the die to be opened.

Two-speed Hacksaw: W. Robertson Foundry & Machine Co., Buffalo, N. Y. This company is now equipping its hacksaw machines with a two-speed mechanism designed to give suitable speeds for cutting tool and soft steels. In this way a maximum amount of service is obtained from the blades. The two speeds are obtained through a set of screws consisting of a twin gear mounted on a crankshaft which meshes with either of two pinions on the driving shaft.

Vertical Lathe: Bullard Machine Tool Co., Bridgeport, Conn. A 6-spindle vertical automatic lathe of the station type. The machine is equipped with independent work-tables, independent tool heads, cross feeds for all boring and turning cuts and a positive maximum feeding pressure for each tool head. All dangerous parts of the mechanism are adequately guarded and positive stops are provided for the tool head movements which work to 0.001 inch. A retarding mechanism is provided for indexing the spindle carrier and a controller interlocks all of the automatic movements. The

time of machining a piece on this vertical lathe is the time of the longest operation plus the time of one indexing. The weight of the machine is 16,000 pounds.

* * *

CENTRALIZED CONTROL RADIAL DRILLING MACHINE

Centralized control of machine tools has received a growing amount of attention of late years. High cutting efficiency is another equally important requirement. It has been the aim of Messrs. J. Archdale & Co., Ltd., Ledsam St., Birmingham, England, in the machine here illustrated and described, to develop these two features to the highest degree.

In the radial drilling machine illustrated in Fig. 1, centralized control has been achieved by the bold step of embodying all the speed changes in the saddle itself. The changes of speed are made by two levers operating steel sliding gears, a plate giving lever positions for the various rates of speed and feed being fixed to the saddle close to the speed change levers. It will be obvious that speed control is quicker and easier than on machines where the speed changes are made in a gear-box carried on the baseplate at the back of the column. The reversing gear is also carried on the saddle, and is operated by a convenient lever. Thus all speed changes can be made, and the spindle started, stopped or reversed without the operator changing his position. The fact that all transmission shafts and gears in this design run at a constant high speed, results in a greatly increased efficiency.

Another important feature bearing on the question of efficiency is the automatic lubrication of all gears, shafts, etc., in the saddle, which reduces the time and attention required for oiling to a minimum. Gear-driven feed motion is provided with changes made by lever, the friction clutch being operated by a lever which is always in the same position. An instantly adjustable automatic stop is provided. The spindle runs in phosphor-bronze bearings carried in a steel sleeve, is provided with a ball thrust bearing, and balanced by a compensated spring arrangement.

Naturally, the complete saddle is heavier than an ordinary saddle, but the rollers on which it is carried enable the

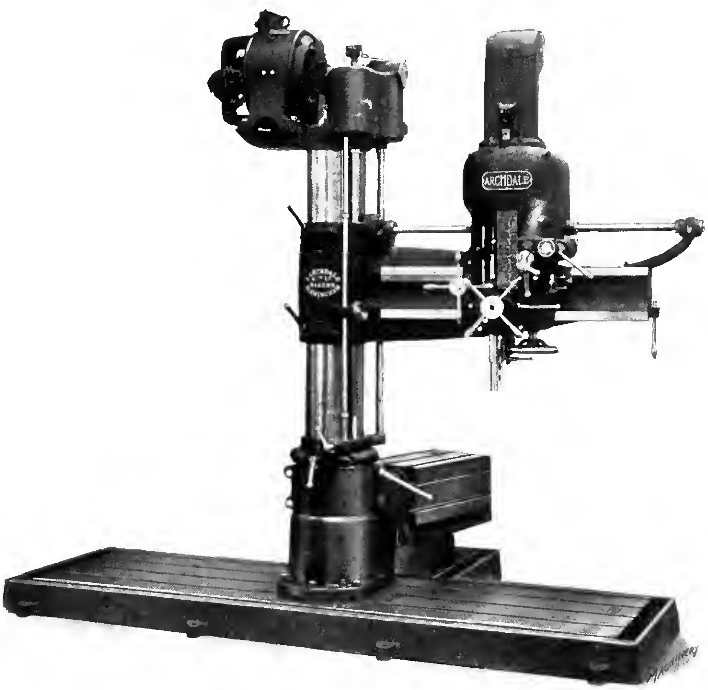


Fig. 1. Archdale Radial Drilling Machine

movement along the arm to be made with the greatest ease. The traversing wheel is shown at *F*, Fig. 2, which shows a view of the saddle mechanism with the front cover removed. The mechanism for sliding the spindle gears *A* and the back gears is clearly indicated, *J* and *H* being two levers operating the sliding gears through the helical pinions *C* and racks *B*.

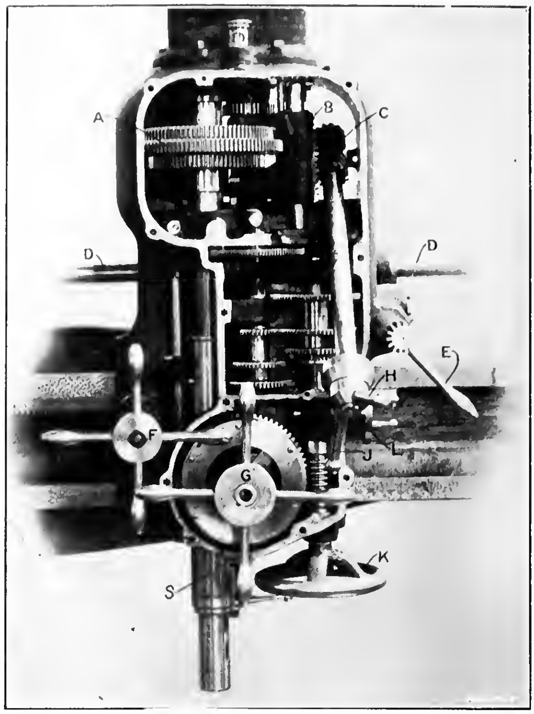


Fig. 2. View of Saddle Mechanism with Front Cover removed

The feed control is obtained at *L*. Quick and slow hand-feed motions are obtained by handwheels *G* and *K*. The reversing lever is shown at *E*.

The arm is of an oval box section, and it is claimed that this is superior to the ordinary composite section of a box with ribs top and bottom. Severe tests have shown that torsional deflection is so minute as to be practically negligible. The fixed column carries a rotating sleeve on which the arm is vertically adjustable, this sleeve being mounted on roller journal bearings and a ball thrust bearing, making the swinging of the arm extremely easy. A convenient lever is provided for rigidly clamping it to the fixed column. A friction gear-box at the top of the sleeve operated by a convenient handle controls the vertical movement of the arm, safety stops being provided to prevent over-running.

The base is double-ended and has an extension at the back. Thus, as drilling proceeds on one portion, work may be set up at either one or both of the two remaining positions. The operator, therefore, can be drilling practically the whole of the time, moving from one position to another. As setting up of work on drilling machines takes up a considerable portion of the whole time, it is clear that this is a valuable feature where a large output is required. The box table may be used in either of three positions or swung clear of the base. The motor, which rotates with the arm and sleeve, is at the top of the column, and therefore can never be an obstruction to work being set up on the baseplate. Where the work is such as requires lubricating, the pipe is taken up through the center of the column, fitted with swivel joint, and connected by flexible pipe to the saddle. The lubricant is thus available for all positions of the spindle or arm with-

out danger of fouling the pipe. The pump is, in this case, a separate unit, being connected to the machine by pipes, preferably under ground, in covered troughs.

* * *

AIR BRAKE TESTS, PENNSYLVANIA RAILROAD

Important improvements in the braking of heavy passenger cars were described in a paper read before the American Society of Mechanical Engineers at the Engineering Building, New York City, February 10, by S. W. Dudley of Pittsburg. Air brake tests were conducted jointly by the Pennsylvania R. R. and the Westinghouse Air Brake Co., and the results are considered the most important recent contribution to the subject. A train of twelve steel cars running at sixty miles per hour stores up 224,000,000 foot-pounds of energy. This is sufficient to raise the entire train 120 feet. With prevailing brake equipment such a train would be stopped by an emergency application in a distance of 1600 to 2200 feet, according to the truck rigging and brake shoe design. These tests showed that this distance has actually been reduced to 1000 feet or to within the length of the train. This was the result of improvements in the truck brake design involving the clasp brake, having two shoes per wheel, and the location of the brake shoes with reference to the horizontal center line of the wheels, in addition to improved methods of applying the air brakes quickly and simultaneously and at a high pressure. This concerns safety. These tests emphasized, as has never been done before, the possibilities of improvement in efficiency and economy in regular service operation by proper attention to design and installation in order to permit the realization of the flexibility of improved air brake apparatus. These improvements center in the electric control of the brakes, giving quick, simultaneous and responsive action. The electric control has opened the way for maximum effect in practice of improvements in practically all the factors involved in air brake apparatus, all of which were covered in the development represented by these tests. The tests constituted a progressive development of brake rigging and brake shoes in connection with the scientific study of the air brake as a whole. Fifteen years ago trains were stopped in about half the distances prevailing in the practice of today. Increased size and weight of equipment brought an entirely new brake problem. These tests showed that high-speed braking on the longest passenger trains can be accomplished with safety but at the expense of a somewhat complicated apparatus which responds to both pneumatic and electric impulses.

* * *

CLEVELAND AUTOMATIC FOR MACHINING BRASS NUTS

The Cleveland Automatic Machine Co., Cleveland, Ohio, recently installed two of its 3/4 to 1 1/4 inch model C "automatics" in the plant of the Metric Metal Works, Erie, Pa. These two machines are equipped with an air chucking device, a rotary tilting magazine, and special tools to adapt them for facing and tapping brass coupling nuts ranging from a very small size up to 2 1/2 inches in diameter. The machines have now been in operation long enough to show that they are exceptionally well adapted for nut work. The output is three times that which has ever been obtained by any other method.

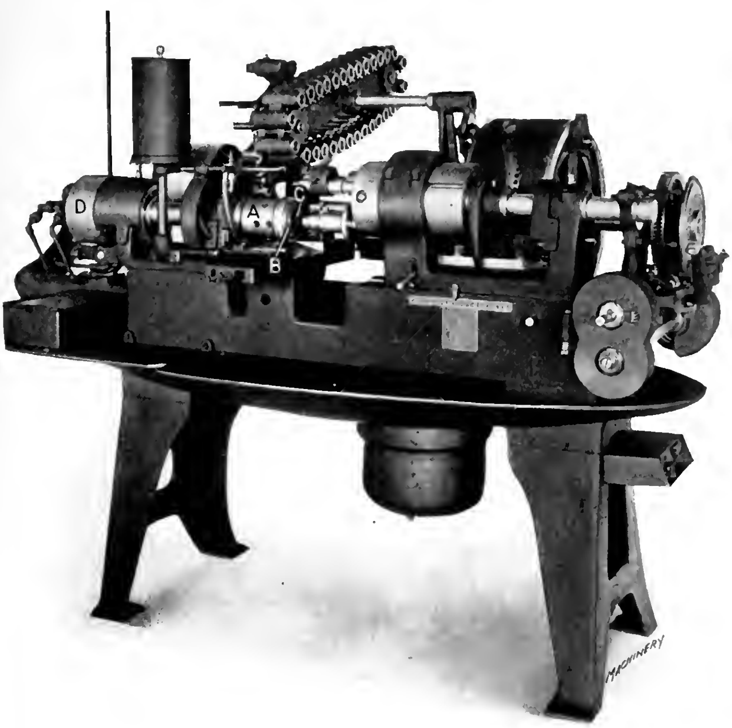


Fig. 1. Front View of Cleveland Automatic for machining Brass Nuts

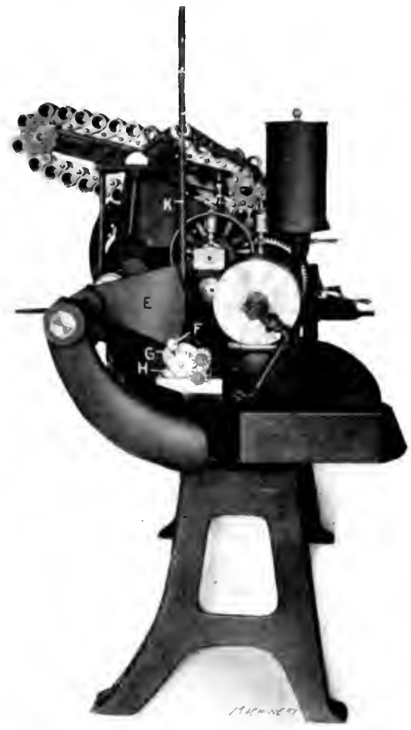


Fig. 2. End View of Machine showing Mechanism for controlling Air Chuck

The air chuck on the machine in Fig. 1 is shown at *A*. The chuck is screwed onto the spindle in place of the regular chuck hood and is fitted with three removable jaws *B* which, in turn, are provided with three pads *C* that can be shaped to suit various kinds of work. The rear end of the spindle is shortened and the air cylinder *D* is screwed onto it. A connecting-rod actuated by the piston in the cylinder *D* operates the chuck jaws *B*, the admission of air at each side of the piston opening and closing the chuck.

Fig. 2 shows an end view of the machine where the mechanism for controlling the admission of air to the cylinder *D* is clearly illustrated. The segment *E* is fitted with a roller *F* in contact with the lever *G* that operates the air valve to release the chuck. The geared lever *H* swings up as the lever *G* is carried down by the roller *F*; a second roller on the opposite side of the segment *E* then comes into contact with the lever *H* as the segment swings around and this moves the valve to its original position, closing the chuck and

at the same time exhausting the air on the opposite side of the piston. The air supply pipe K is fitted with a sight-feed lubricator (not shown) which thoroughly oils the piston and moving parts of the air valve.

The rotary tilting magazine L, Fig. 3, is equipped with a link belt M, each link being fitted with a bushing of suitable shape to hold the work. When the magazine L tilts up after the conveyor N has removed a blank, the lever P comes in contact with the pin R which indexes the link belt to bring another piece of work in line with the conveyor when the magazine swings down the next time. This rotary tilting magazine was described in detail in the February number of MACHINERY, so that further discussion of this feature of the machines which form the subject of the present article is unnecessary.

The conveyor N is fitted with a flanged sleeve S that comes in contact with a stop on the turret head (not shown) on the backward stroke of the turret after the chucking operation. Should the chuck fail to grip the work, the sleeve S strips the work off the conveyor, thus allowing the conveyor to remove another piece of work from the magazine without

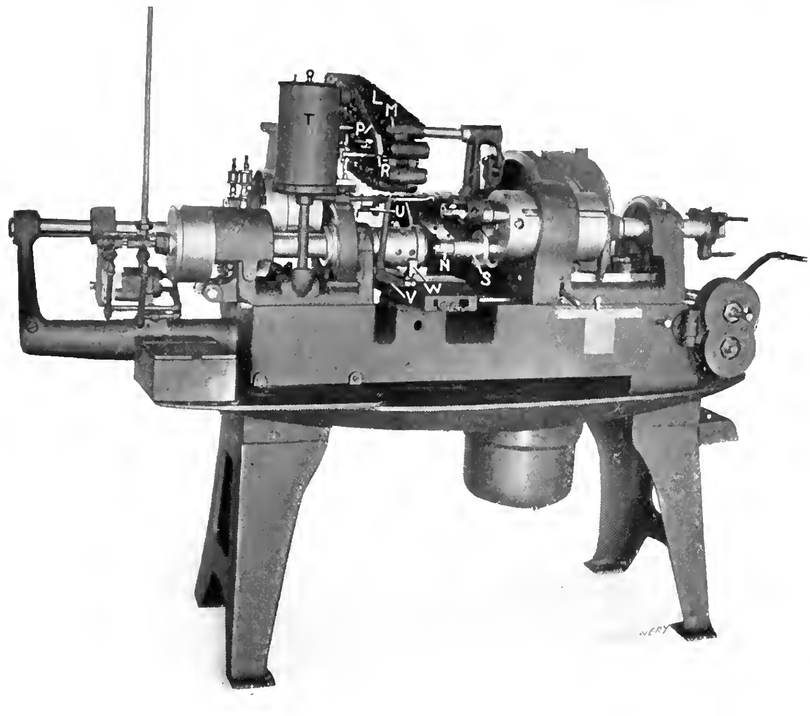


Fig. 3. Arrangement of the Magazine and Chuck Mechanisms

interference. If the finished work is not ejected from the chuck, the forward movement of the next blank carried by the conveyor comes in contact with it and compresses a spring in the shank of the conveyor N; this takes up the strain and avoids damaging the machine.

Fig. 3 also shows an oiling device used to drop oil onto the tap. This lubricating equipment consists of the tank T with suitable piping and a valve U which is operated by a lever V pivoted on the spindle head and operated by the tripping dog W on the cross-slide. As the cross-slide moves forward to allow the facing tool on the rear of the slide to operate, the tripping dog W strikes a V-block on the lever V, causing the valve U to open and drop the required amount of oil onto the tap. The amount of oil supplied may be varied from one drop to a steady stream, being under control of the operator.

It has already been stated that these machines were built to meet the special requirements of the Metric Metal Works, but "Cleveland" automatics equipped with this type of air chuck can be used for all sorts of work requiring drilling, counterboring, reaming, tapping, recessing and similar operations.

ADMINISTRATION BUILDING OF NEW DEPARTURE MFG. CO.

The New Departure Mfg. Co., Bristol, Conn., recently moved into its new Administration building, which has been in course of construction for the last twelve months. The demand for New Departure ball bearings has increased so rapidly that the company could not wait to build the required additions to its manufacturing plant, and as a result bought the factory of the Whitlock Coil Pipe Co., Hartford, Conn., which comprises 145,000 square feet of floor space. The office quarters were also inadequate and this deficiency has been met by the erection of the new Administration building, which is 62 feet wide by 220 feet long and six stories high. The building is modern in every detail of construction and is absolutely fireproof. The outer walls are of light grey brick in three shades, relieved by broad ribbons of blue and green colored tiles at the second and fifth stories. The entrance is reached by a broad flight of granite steps, and is flanked on each side by hand-carved limestone panels.

The ceiling of the main vestible of the building is decorated in Roman gold, and the side walls are panelled with marble. The floor is also of marble with a geometrical design worked out in tiles, and with the monogram of the company in green and white as a center piece. The main lobby, which is just beyond the vestibule, is 16 feet square; the floor is of Italian marble and the wainscot is relieved by ornamental capitals. The office is located on the fifth floor of the building and is reached by an electric elevator which runs from the lobby.

The private offices of the officials and heads of departments are located at the front and south side of the fifth floor. The workers in each department are directly opposite the private office of the head of that department. These offices are finished with panels of mahogany carried up to the height of the window sills. The partitions between the general offices are of plate glass above the wainscot. At the west side of the office there is a double fire- and burglar-proof vault. All equipment of this vault is steel and absolutely fire-proof. One of the features of the main office is a large leaded glass dome ceiling light 112 feet in length by 16 feet wide. In addition to the general offices there is a large foremen's conference room on this floor, which has a small kitchen attached to provide for serving luncheons.

On January 1 the following changes were made in the organization of the New Departure Mfg. Co.: Mr. Albert F. Rockwell, who was one of the founders of the company and who has taken an active part in the development of patents covering the product, has been relieved of certain managerial details, but continues as president of the company. Mr. DeWitt Page, who formerly held the positions of secretary, sales manager, purchasing agent and advertising manager, has been appointed general manager of the company. Mr. Charles T. Treadway, for some years past treasurer of the company, continues in that capacity, but also becomes chairman of the board of directors.

* * *

Tax factories and there will be fewer factories; tax trade and there will be less trade; tax machinery and there will be less machinery; but tax the value of land and of natural resources and there will not be any less land or natural resources.

A ROTARY CUTTING-OFF MACHINE

A machine which has accomplished some remarkable performances in cutting off bars and tubes has recently been built by Charles Taylor, Ltd., Birmingham, England. The cutter revolves around the bar or tube to be cut off, the work being held stationary in a vise. This avoids revolving long and heavy bar stock, and facilitates moving up and regripping the work. The cutters do not have to be stopped while the rod is being adjusted, thus reducing to a minimum the time lost in cutting off several pieces in succession.

The headstock consists of a substantial iron casting forming the main body of the machine and having massive split bearings in which runs a hollow spindle carrying the cutter-head. The cutter-head has two cutter-slides operated by a hand lever, which feeds the cutters in by means of chains passing through the spindle. These chains act in connection with an automatic balancing device to insure the cutters doing equal work. Fig. 1 shows how this is accomplished. In this illustration *A* is the cutter, *B* the slide carrying the cutter, *C* the chain which feeds the cutter in, and *D* a yoke which can oscillate on a cylindrical bearing in the piece *E*. Thus as one cutter is forced out, the yoke *D* moves on its bearing and draws the opposite cutter in until both cuts are exactly equal, and they remain so throughout the cut.

In most cutting-off machines it is highly important for both cutters to be set precisely alike to a gage, and this requires a skilled operator. In the machine under consideration, this is not of great consequence because if the cutters *A* are carelessly placed, even to the extent of 1/16 inch or more, as indicated by the dotted lines on the end of the cutters, the effect when the machine is at work is that one cutter retreats and the other advances until both cutters are working precisely alike. When this balance is obtained the cutters remain in position until they are again taken out for resharpening. An unskilled operator can handle this balancing machine.

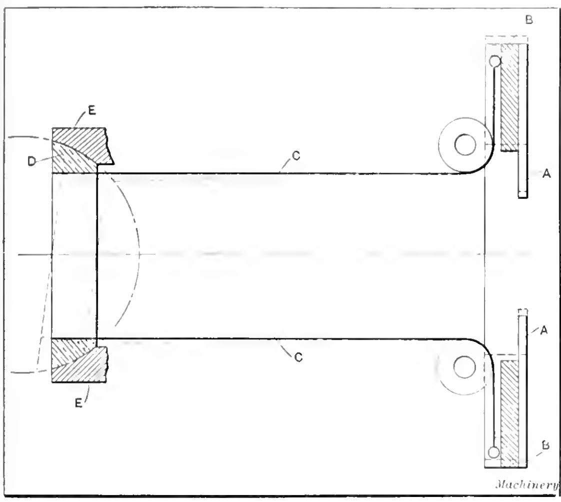


Fig. 1. Diagram illustrating Method of feeding Cutters to Work

The feed chains are protected by a steel liner running the whole length of the spindle, the spindle being driven by a balanced cast-iron pulley of 16 inches diameter, for a three-inch belt. The cutters are of plain oblong section and are rigidly supported throughout their length. As shown in Fig. 2, they are so placed as to have ample clearance at all points and require grinding on one face only. This is accomplished by having their bearings so shaped that when the cutters are clamped in place they lie in such a position that only the extreme corner of one side of each is in contact with the work, except, of course, the front cutting edge. All other parts have a liberal clearance. Moreover, the cutters are offset from each other so that each takes a cut of less width than the groove which is being cut. This allows the chips to swell, as all chips do, without binding in the groove. Also when the cutters are dull they simply yield slightly from the face of the groove and so touch without the slightest binding effect. As the cutters are of plain rectangular section set to cut their own clearance, they cannot wear narrow on the front or cutting edge and bind in the groove, which is a frequent and continuous trouble with the ordinary formed cutting-off tool. In Fig. 3, for instance, showing the usual formed tool, the points *A* and *B* break off causing the tool to bind in the groove on the sides *C* and *D* with consequent breakage.

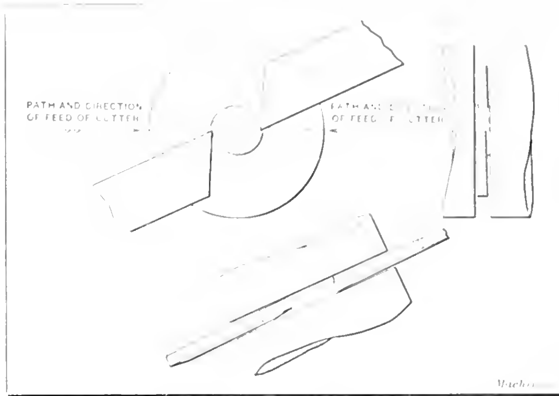


Fig. 2. Method of mounting Cutters that gives Ample Clearance

Other features of the machine include a lever stop with a spring plunger set to act in such a way that the spring is compressed as the stock is cut through, thus serving to retard the advance of the cutters at the last moment and to insure that the end of the stock is left clean. The stock is held in a self-centering vise in front of the cutters, and provision is made to support the stock which projects from the vise by means of an adjustable roller support, which facilitates the feeding of heavy stock through the vise. The cut off pieces are supported in the spindle on a long supporting member projecting into the spindle from the rear end. A two- or three-speed countershaft is provided enabling the speed to be changed, if necessary, while cutting is actually in progress.

The performance of this machine can be gaged as follows. The average time for cutting off solid bars is, for ¾-inch round mild steel, 11 seconds; 1-inch round mild steel, 12 seconds; 1½-inch square mild steel, 19 seconds; 2-inch round mild steel, 22 seconds; 3-inch round mild steel, 45 seconds; and 2-inch round cast steel, 65 seconds. In dealing with gas pipe, a 1½-inch pipe can be cut off in 5 seconds. J.

* * *

DELICACY OF THE CHEMICAL BALANCE

Those not familiar with the methods of chemical analysis have very little conception of the delicacy of the chemical balance and extreme care that must be taken when ascertaining weights to a fraction of a milligram. The balance is supported by the knife-edges only when actual weighing is in progress. When the substance to be weighed is being placed on the pan, and during all manipulations of the weighing, the rule is to raise the beam off the knife-edges by means

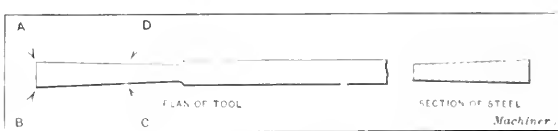
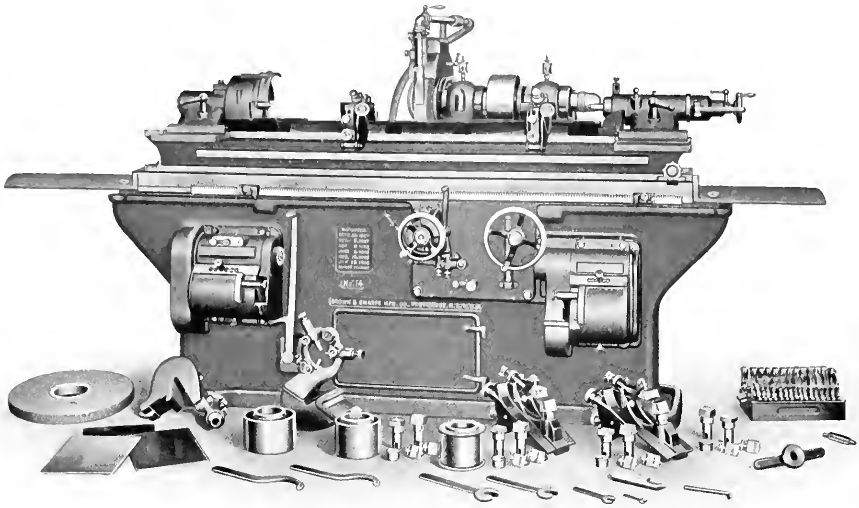


Fig. 3. Diagram illustrating Weakness of Formed Cutter

provided for the purpose. When not in use the beam is always supported by the auxiliary means provided. Extreme care must be taken to keep the knife-edges free from corrosion. A jar of unslacked lime or pure sulphuric acid is kept in the case to absorb atmospheric moisture. A warm object cannot be accurately weighed because the air currents set up a disturbing force sufficient to vitiate the accuracy of the work.

Grinding Time on This Work is



No. 14 PLAIN GRINDING MACHINE

You are probably familiar with some, if not all of the various types of machine parts represented in the case opposite.

It is the sort of work to be found in quantity in many manufacturing shops—work on which a small saving per piece means a worth while saving by the end of the day.

There are long, slender shafts requiring careful support, pieces of large diameter on which heavy cuts are taken, taper bearings on spindles, irregular shaped work as shown near top of case, etc.

We have developed the type of Plain Grinding Machine with quick change work speeds and table traverse, shown above, as particularly fitted for rapid production on such work.

BROWN & SHARPE

PROVIDENCE, R. I.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429 University Block, Syracuse, N. Y. REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, Ohio, Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore. CANADIAN: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon. FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. V. Lowener, Copenhagen, Denmark; Stockholm, Sweden; Christiania, Norway. Schuchardt & Schutte, St. Petersburg, Russia. Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain. The F. W. Horne Co., Tokio, Japan. L. A. Vail, Melbourne, Australia. F. L. Strong, Manila, P. I.

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PERSONALS

Henry Pollard recently took charge as superintendent of manufacturing of the Chicago plant of the Benjamin Electric Co.

E. E. Hendee, secretary of Joseph T. Ryerson & Son, returned to Chicago in the middle of February after a two weeks' trip to the South and Southwest.

Edward Blake, who for several years was sales manager of Wells Bros. Co., Greenfield, Mass., and for the past three years general manager of the J. T. Slocomb Co., Providence, R. I., has resigned his position with the company. Mr. Blake has made no definite plans for the future.

A. B. Hall, for the past fourteen years connected with the machinists' supply department of the Whitman & Barnes Mfg. Co., was elected a director and second vice-president of the company at the annual stockholders' meeting held January 28 at the general offices, Akron, Ohio.

William Miller has discontinued his connection as secretary of the firm of Henry Disston & Sons, of Philadelphia, after a service of thirty-seven years, and on February 1 associated himself with the Simonds Mfg. Co., Fitchburg, Mass., and Chicago, Ill. Mr. Miller is one of the most experienced and efficient men in the saw, knife and file-making business, and is well and favorably known in the hardware trade.

O. P. Wilson, of the purchasing department of the Westinghouse Electric & Mfg. Co., has resigned to take the position of assistant general manager of the Norma Company of America, 20-24 Vesey St., New York City, manufacturer and importer of high-grade ball bearings, precision instruments, etc. Mr. Wilson has been connected with the Westinghouse Electric & Mfg. Co. for fourteen years, and for the last ten years has been one of its head buyers.

C. S. Dundore, after thirteen years' service as treasurer and general manager of the American Die & Tool Co., Reading, Pa., has started in business for himself under the name of the Dundore Mfg. Co., 221 S. 9th St., Reading, Pa. The company will serve the tool and contract work trade, being equipped to make tools and dies and also to do contract work in the manufacture of machines and metal specialties. Special attention will be given to the manufacture of boiler and bridge builders' tools.

* * *

OBITUARIES

Neil W. Snow, president and general manager of the Detroit Twist Drill Co., Detroit, Mich., died January 22, aged thirty-four years.

William Colthar, proprietor and general manager of the Victor Vise Co., Springfield, Ohio, and a manufacturing machinist, died January 19, aged forty-nine years. Mr. Colthar acquired his mechanical training with the Mechanics Institute at Cincinnati, and after considerable experience in the machine tool industry in the latter city he undertook work on his own account, being the original designer of the Timken roller bearing. He did considerable work on the Paige typesetting machine, and designed many original machines. He is survived by his widow and one son.

Caleb Colvin, founder of the Caleb Colvin iron foundry, which later became the L. W. Pond Machine & Foundry Co., Worcester, Mass., died of bronchitis at his home in Worcester, February 17, aged eighty-five years. He was born in Cranston, R. I., and at the age of eighteen was apprenticed to the iron molder's trade. He went to Worcester in 1865 and established the iron foundry business, which was afterward made a partnership known as C. & J. A. Colvin. The business was incorporated in 1887 under the name of the L. W. Pond Machine & Foundry Co. Mr. Colvin retired from active business in 1905.

Erwin Starr Sperry, editor and publisher of the *Brass World and Platers' Guide*, died at Bridgeport, Saturday, January 31. Mr. Sperry was born in Ansonia, Conn., in 1866, and graduated from the Sheffield Scientific School of Yale University in 1887, where he afterward held a position as assistant instructor in chemistry under Prof. H. L. Wells. In 1891, he went to Bridgeport as chemist for the Aluminum Brass & Bronze Co., and afterward became superintendent of the Waldo Foundry. Ten years ago, he started publishing the *Brass World and Platers' Guide*. He was a member of leading scientific societies of this country and Europe. Mr. Sperry is survived by his widow.

David B. Hyde, one of the Hyde brothers who have been closely connected with the emery wheel manufacturing business since its inception, died February 14 at Riverside, Cal., of pneumonia, aged fifty-five years. He was born at Wilmington, Vt., in 1859 and at the age of thirteen was thrown upon his own resources. He and one of his brothers (mere boys at the time) showed great enterprise by placing on the market a patent inkstand, and thousands of these stands were sold in America and Europe. Mr. Hyde was one of the pioneers in the manufacture of emery wheels and grinding machinery. In 1880 he, with his four brothers and D. T. Homan, started the Springfield Glue & Emery Wheel Co. at Springfield, Mass., being the first to make emery wheels for water tool grinding in this country. In 1893 he and his brother, O. H. Hyde, and E. C. Gwynn, organized and started the Safety Emery Wheel Co. of Springfield, Ohio, and he introduced the safety collars used on emery wheels. Mr. Hyde also originated the "Champion" tool-holder now manufactured by the Western Tool & Mfg. Co. of Springfield, Ohio. He was later connected with the Pittsburg Emery Wheel Co., but on account of poor health sold out his business interests and went to California, where he was engaged in dry farming on an extensive scale at the time of his death. Mr. Hyde leaves a widow, two daughters and one son; also three brothers, E. R. Hyde of the Bridgeport Safety Emery Wheel Co. and O. H. and C. L. Hyde of the Safety Emery Wheel Co. of Springfield, Ohio.

Henry Brinton, president of the H. Brinton Co., Philadelphia, Pa., died at his home at Bala, January 30, after a brief illness with heart trouble, aged sixty-six years. He was born at Christiana, Lancaster Co., Pa., of a line of Quaker ancestry descended from William Brinton who came to America in 1684. He received a thorough training as a machinist in the shops of I. Broomell & Sons, now the Christiana Machine Co., and later spent about two and one-half years with Bement-Miles & Co., Philadelphia. From there he went to the Colt's Armory in Hartford, Conn., where he worked for a time on the Baxter engine. His next work was on the Branson knitting machine at Bellefonte, Pa. When the Branson Co. failed, Mr. Brinton went to the Lancaster Watch Co. at Lancaster, Pa., where he obtained experience in fine manufacturing methods which had a pronounced effect on his own designing later. When the Branson Co. was reorganized, Mr. Brinton went back to Bellefonte, only to meet another financial crisis. After a further experience at the Lancaster Watch Co., he joined Branson a third time in Philadelphia and was for some years the superintendent of the knitting machinery business under the Branson name. In 1888 Mr. Brinton started manufacturing knitting machines in the partnership of Brinton, Denney & Co., and five years later, Mr. Denney sold his interests to J. E. Longergan and the firm name became H. Brinton & Co. The business was incorporated in 1906 under the name H. Brinton Co. Mr. Brinton probably did more to improve and commercialize automatic cylinder knitting machines of the latch needle type than any one else. He took out patents on the knitting machine sinker mechanism with the sinker driven from below the stitch level. On ribbers, the Brinton design was revolutionary. The ribber pattern wheel mechanism built by Mr. Brinton twenty years ago, has not been surpassed or changed to this date. Splicing devices for inserting an extra thread is also of Brinton design and a ring in the dial cap for operating multiple-feed rib machines was another Brinton invention. In general, it may be said that the prime feature of Mr. Brinton's work was the beautiful simplicity of his mechanism for producing complex results. When he finally adopted a design, that design was usually as near to the perfection of mechanical simplicity as it was possible for it to be made. He was married in 1874 to Rachael Cawley, who with a daughter and two sons survive him.

COMING EVENTS

April 4-11.—First National Efficiency Exposition and Conference, Grand Central Palace, New York City. Walter H. Tallis, director, Efficiency Society, Inc., 41 Park Row, New York City.

April 29-30.—Annual meeting of the National Association of Cotton Manufacturers, Boston, Mass., in the Paul Revere Hall of the Mechanics Bldg. C. J. H. Woodbury, secretary, 45 Milk St., Boston, Mass.

May 1-October 31.—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

Copper Wire Tables. 69 pages, 7 by 10 inches Published by the Department of Commerce, Washington, D. C., as Circular 31 of the Bureau of Standards.

Standard Specifications for Incandescent Electric Lamps. 20 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular 13 of the Bureau of Standards.

United States Coast and Geodetic Survey. Annual Report of the Superintendent to the Secretary of Commerce. 100 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

High-frequency Ammeters. By J. H. Dellinger. 70 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint No. 206 from the Bulletin of the Bureau of Standards, Vol. 10.

Electrolytic Corrosion of Iron in Soils. By Burton McCollum and K. H. Logan. 69 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as No. 25 of the Technologic Papers of the Bureau of Standards.

Latent Heat of Fusion of Ice. By H. C. Dickinson, D. R. Harper and N. S. Osborne. 32 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as No. 209 of the Scientific Papers of the Bureau of Standards.

Coal Washing in Illinois. By F. C. Lincoln. 108 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 69. Price 50 cents.

A great amount of data gathered from experiments made in the mining laboratory of the university, personal visits to the various coal washeries in the state and a thorough search of the scattered literature on the subject has been compiled and tabulated in this bulletin. The bulletin also contains an article by S. W. Parr on the moisture in washed coals and is a summary of tests made at the Experiment Station on carload lots of various washed coals.

Elementary Manual of the Steam Engine. By Ernest V. Fallier. 266 pages, 5 by 7¾ inches. 102 illustrations. Published by D. Van Nostrand Co., New York City. Price $2.

This work, as indicated by the title, is intended for the instruction of students and young men studying the elements of engineering. It treats of reciprocating steam engines, governors, engine calculations, the indicator, heat, boilers, pumps, Corliss engines, pipes and fittings, rotary engines, internal combustion engines and lubrication. Wherever possible, principles are illustrated with arithmetical examples, and questions are given at the end of chapters which may be used for self-examination to the student studying at home. The work is one that should be appreciated by the class generally for whom it is intended.

Factory Organization and Administration. By Hugo Diemer. 378 pages, 6 by 9 inches. 172 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price $3.

The first edition of this work was published in 1910. In rewriting the book, the author has rearranged the material in what appears to be more logical order. The subjects treated comprise: Principles, Field and Methods of Industrial Management; Industrial Finance; Organization and Control; Typical Factory Organizations; Factory Accounts; Departmental Reports; Factory Location; The Planning of Factory Buildings and the Influence of Design on Their Productive Capacity; Employment of Labor and Labor Problems; General Office; Order Department; Bills of Material; Drafting Department; Pattern Department; Purchasing Department; Stores and Stock Department; The Production or Planning Department; Foundry Systems; The Machine Shop and Tool Department; Shipping and Receiving Departments; Time Taking; Cost Department; Aids in Taking Inventory; Inspection Methods in Modern Machine Shops; Rate Fixing and Time Studies; Wage Systems; Principles Underlying Good Management; and A Bibliography of Works Management.

Welding—Theory, Practice, Apparatus and Tests. By Richard N. Hart. 210 pages, 6 by 9 inches. 127 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price $2.50.

The first edition of this work was published in 1910. The rapid progress of the last three years in apparatus and methods of welding has made a revision necessary, especially with regard to arc welding and oxy-acetylene welding. The work deals with the characteristics of iron, platinum, gold, silver, aluminum, copper, and nickel. The electric welding processes are described, including the La Grange-Hoho process, the Zerener electric blowpipe, the Bernardos arc-welding process, the Slavianoff arc-welding process, combination Slavianoff and Bernardos processes, and the Thomson process. Part III is devoted to hot-flame welding, treating of the oxy-acetylene and oxy-hydrogen processes. The torches and apparatus in general are illustrated and described. A chapter is devoted to the thermit process, illustrating its apparatus and application to rail welding, marine repairs and other characteristic jobs for which it is especially suited. A chapter is given up to soldering and miscellaneous processes including the Lafitte welding plate, the "ferrofix" brazing process, brazing and soldering, the Blaugas process, etc. The work is one to be recommended to all desiring to become acquainted with the characteristics of the various welding processes developed within the past few years. While the treatment of the subjects is by no means exhaustive, it leaves comparatively little to be desired by those who wish to gain a general knowledge of the modern welding art.

NEW CATALOGUES AND CIRCULARS

Massachusetts Institute of Technology, Boston, Mass. Catalogue for 1913-1914.

Stevens Institute of Technology, Hoboken, N. J. Annual catalogue 1914-1915.

Technical Supply Co., Scranton, Pa. Booklet describing the Levi automatic blueprint finisher.

Polytechnic Institute, Brooklyn, N. Y. Annual catalogue of the College of Engineering, 1914-1915.

Alston Saw & Steel Co., Folcroft, Pa. Circular of the Alston process improved hacksaw blades made for all purposes.

Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio. Bulletin 22 on air compressor efficiency and the factors controlling it, with special reference to the Cincinnati air gear.

Brown Hoisting Machinery Co., Cleveland, Ohio. Pamphlet C on "Brownhoist" safety crabs and winches. Provision is made so that the handles cannot fly back and the load cannot drop.

Hannifin Mfg. Co., Chicago, Ill. Circular illustrating and describing Hannifin air-operated chucks, including master hinge air-operated collet chucks, and two- and three-jaw universal chucks.

H. A. Lowe, 1374 E. 88th St., Cleveland, Ohio. Circular of the Lowe universal test indicator weighing 1¼ ounce and magnifying 100 times. The dial is graduated to thousandths inch.

Northern Engineering Works, Detroit, Mich. Crane catalogue 26 illustrating electric traveling cranes, hand power traveling cranes, electric and pneumatic hoists, overhead track systems, bucket handling cranes and railway cranes.

Railway Roller Bearing Co., Syracuse, N. Y. Catalogue of the roller journal boxes, electric motor bearings, etc. The construction of the bearing is shown and examples of applications to electric locomotives, street cars, motors, etc., are included.

Simplex Wire & Cable Co., 201 Devonshire St., Boston, Mass. The "Simplex" manual containing, in addition to information regarding "Simplex" products, tables and data for the ready reference of electrical engineers, contractors, wiremen, etc.

Greenfield Machine Co., Greenfield, Mass. Catalogue No. 5 of the "Greenfield" universal tool and cutter grinder and its attachments. The uses of the attachments are illustrated and other matter is contained of value to users of tool grinding machines.

Mesta Machine Co., Pittsburg, Pa. Bulletin M of the Mesta improved pickling machines for pickling metal objects of any shape. The Mesta machine brings mechanical action into play to such an extent that the material is pickled with about one-half of the acid and labor required in hand pickling.

Webster & Perks Tool Co., Springfield, Ohio. Circulars of Nos. ¾ floor or bench type grinder, 1¼ "P" self oiling grinding and polishing machine, 1⅜, 1½ and 1⅝ direct-current electrically driven floor type polishing and buffing lathes, and 1¾ alternating current direct connected electrically driven type grinder.

Gould & Eberhardt, Newark, N. J. Catalogue of high duty shapers and attachments, details of construction and general specifications. The line comprises 14-inch, 16 inch, 20 inch, 24-inch and 28-inch sizes. Shapers with direct current and alternating-current motor drives are shown, and accessories for same.

Winfield Electric Welding Machine Co., Warren, Ohio. Catalogue of Winfield electric welding machines, comprising spot and butt welding machines, which are illustrated and described. The catalogue contains information on electric welding useful to manufacturers employing the electric welding process.

Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa. Catalogue "Saving the Friction Loss—'Sells' Roller Bearings," containing a description of the construction, operation and application of "Sells" roller bearings. The catalogue is illustrated with halftone and sectional views, the latter showing the design in detail.

Wood Turret Machine Co., Brazil, Ind. Catalogue of the "tilted turret" lathe, a feature of which is that the turret is so made and placed that the stock can pass clear through, thus giving unlimited capacity in length of work. The machine is made in six sizes, ranging from 1 inch to 4½ inches automatic chuck capacity.

National Lead Co., 111 Broadway, New York City. Pamphlet on electro-plating zinc alloy die-castings, giving practical methods for cleaning, polishing and electro-plating the various alloys used in die-casting. The information contained will be particularly acceptable to electro-platers who have experienced difficulty in doing this class of work.

Pawling & Harnischfeger Co., Milwaukee, Wis. Pamphlet entitled "Difficult Drilling and Boring Made Easy," illustrating work done by the Pawling & Harnischfeger drill presses in machine shops. Manufacturers having to drill large structural work, castings, etc., should find the illustrations and descriptions of these drilling machines of interest.

National Tube Co., Pittsburg, Pa. Bulletin No. 18-A entitled "National Reamed and Drifted Pipe." This bulletin contains a complete description with illustrations of this product, together with a short introduction explaining the processes of well drilling and information relative to the various accessories necessary for the drilling and pumping of wells.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Pamphlet on door safety switches for use with electric elevators. A great majority of accidents on all kinds of elevators are the result of setting the elevator machine in motion before the doors are closed and locked and the passengers clear. With the ever-increasing number of passengers the safety feature is of the utmost importance.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin 19, listing the products of the company. An idea of the extent of the products manufactured can be gained from the fact that the bulletin has eight pages, two columns to the page, filled with small type. Of "Kewanee" products, 852 are listed; of "National" pipe products, sixty-four, and of Shelby seamless steel tubing products, thirty-seven.

Niles-Bement-Pond Co., 111 Broadway, New York City. Catalogue of Niles electric traveling cranes, showing the equipment of Niles standard traveling cranes and details of construction. Grab bucket trolleys, electric wall cranes, gantry cranes, traveling hoists and hand power frames are also shown. The catalogue is beautifully illustrated with numerous views of works in which Niles bridge traveling cranes are installed.

Curtis Pneumatic Machinery Co., 1568 Kienlen Ave., St. Louis, Mo. Catalogue of air compressors, air hoists, air cranes, pneumatic and hydro-pneumatic elevators, trolleys, trolley systems and sand blasts. The company has specialized in pneumatic hoisting appliances for over twenty years and has developed the simple air cylinder into a straight-line motor with wonderful speed control and dependability, capable of the widest application to hoisting problems.

Gardner Governor Co., Quincy, Ill. Circular "The Gardner One Tool Plant," consisting of a vertical self-oiling air cooled compressor, 2 by 2½ inches, driven by ½ H. P. electric motor, mounted on a four wheel truck. A tool box is provided and a rack for hose. The machinery is enclosed in a removable cover and the outfit forms a compact, portable compressed air plant. While primarily designed for stoneworkers, monumental work, etc., it should serve in many other situations where compressed air is required.

Yale & Towne Mfg. Co., 9 East 40th St., New York City. Pamphlet entitled, "History of the Trade-mark 'Yale,'" which is a record of cases in which the company's rights have been sustained and confirmed in litigation involving a legal right in trademarks, catalogue numbers, distinctive designs and other indications of the origin of patterns. The pamphlet is one that should be read with interest by all concerned with trademarks, and it should also be found interesting by readers in general because of the matter contained on the origin of locks.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Rail Reports Bulletin No. 4 on open hearth steel. This bulletin contains a summary of chemical and physical results as reported in bulletins 1, 2, 3 and 4 on standard open hearth A rails and titanium open hearth treated A rails. It was found that the average hardness of standard rails is twenty-four per cent greater in the webs than in the heads and flanges while in the titanium treated rails, the average difference is only five per cent. The impact resistance of titanium rails averaged thirty-five per cent higher than of standard rails in the heads, four per cent in the webs and fifty per cent in the flanges. Titanium rails in the White-Souther endurance test averaged fifty per cent greater endurance than standard rails. The value of these reports on extensive rail tests is evident to all metallurgists and users of rails.

H. W. Caldwell & Son Co., Western Ave., 17th to 18th Sts., Chicago, Ill. Catalogue No. 38 on elevating, conveying, power transmitting and general machinery, containing 797 pages, 6 by 9 inches. The company makes helicoid conveyors, machine molded gears, friction clutches, ice handling machinery, specialties for flour mills, grain elevators, cotton seed oil mills, alfalfa plants, starch works, linseed oil mills, breweries, distilleries, malt houses, sugar refineries, glucose works, cement works, phosphate works, lime works, gypsum works, chemical works, tanneries, etc. The catalogue is one of the most complete in the line of power transmission elevating and conveying machinery. It is copiously illustrated, printed on high-grade paper and completely indexed. It should be in the hands of every engineer and manufacturer having use for the line of machinery and parts listed.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue of LeBlond engine lathes which are furnished in various styles, with such combinations of equipment as may be desired, as follows: regular stud lathe, 14 to 20 inches swing; regular standard engine lathe, 12 to 24 inches swing; regular quick-change engine lathe, 12 to 24 inches swing; heavy-duty manufacturers' automobile lathe, 17 to 21 inches swing; seventeen-inch rapid production lathe; heavy-duty standard engine lathe, 25 to 33 inches swing; heavy-duty quick change engine lathe, 17 to 33 inches swing; heavy-duty quick change engine lathe, 25 to 33 inches swing; heavy-duty quick change sliding bed gap lathe, 19-38, 25-50 and 30-60 inches swing; regular plain chucking lathe, 12 to 24 inches swing; heavy-duty quick change combination turret lathe, 17 to 27 inches swing; heavy-duty manufacturers' complete turret lathe, 24 to 27 inches swing—with triple gear single pulley drive, 31 inches swing; heavy-duty quick change universal turret lathe, 17 to 33 inches swing; motor-driven engine lathes of any size or type. A line of accessories is shown comprising turrets, turret toolposts, compound rests, relieving attachment, multiple automatic length stop, belt shifter, draw-in attachment and collets, translating gears for metric threads, etc.

TRADE NOTES

Warren Forge & Tool Co., Warren, Ohio, has elected James Robertson, president; M. J. Konold, vice-president and secretary; George E. Warner, treasurer; and George F. Konold, general manager.

Walcott & Wood Machine Tool Co., Jackson, Mich., has bought the patent rights, patterns and good-will of the Melling-Northrup die-sinking machine manufactured by the Melling-Northrup Co., Jackson, Mich.

Gem City Machine Co., 429 East First St., Dayton, Ohio, was destroyed by fire during the last week in January. Three days later, however, the firm was operating in other quarters, delivering orders and contracting for new work.

Buffalo Forge Co., Buffalo, N. Y., has opened offices at 176 Federal St., Boston, Mass., for its fan, ventilating and pump department. The company is represented in the New England territory by B. R. Andrews, formerly with the B. F. Sturtevant Co.

J. T. Slocomb Co., Providence, R. I., maker of machinists' micrometers, centering drills, etc., has been sold to J. H. Drury, sales manager of the Union Twist Drill Co., Athol, Mass. J. T. Slocomb, who organized the business, will remain for a short time.

Eveland Engineering & Mfg. Co., 2324-2328 Market St., Philadelphia, Pa., has been authorized by its

MACHINERY

APRIL, 1914

MANUFACTURING "AMERICAN" STEEL PULLEYS*

TOOLS AND METHODS EMPLOYED IN PRODUCING BELT PULLEYS FROM SHEET STEEL

BY FRANKLIN D. JONES†

Fig. 1. "American" All-steel Split Pulley—Arms Integral with Hub

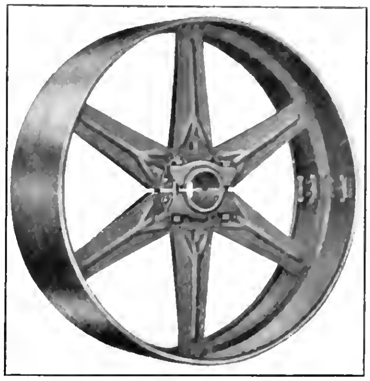


Fig. 2. "American" All-steel Split Pulley—Arms Riveted to Hub Flange

At the plant of the American Pulley Co. at Philadelphia, the normal monthly output of pressed steel pulleys of various sizes is about 22,000. To manufacture this number of pulleys from sheet steel and secure a strong, accurate, well balanced product, requires highly specialized machines and constructional methods, many of which are interesting not only from a mechanical viewpoint, but as a study in efficient means of production. In this article the principal operations connected with the manufacture of the American pulley will be described. It should be mentioned that the order and nature of some of the operations for different sizes and designs of pulleys vary somewhat, as this company makes pulleys ranging from 3 to 72 inches in diameter; most of the operations which will be referred to, however, are common to all medium and large sizes and represent the most important processes.

Two types of "American" pulleys which have been widely used are shown in Figs. 1 and 2, these designs being for medium and large sizes, respectively. The hub of a half section of the type of pulley shown in Fig. 1 is integral with the arms, whereas the arms of the pulley illustrated in Fig. 2 are securely riveted to half an annular hub ring of angle section. In each case, the outer hub is riveted to an inner hub shell. Sizes varying from 44 to 72 inches, inclusive, have eight arms instead of six and the arms are bifurcated or forked where they are riveted to the hub ring. The forked ends which overlap are also riveted together, thus forming a rigid pulley especially adapted for heavy duty. The rim sections of all the pulleys are joined at the center by flanges, to which the arms are riveted, and the rims are beaded around the outside edges to stiffen them and make a safe rounded edge.

Forming Pulley Arms and Hub

The method of forming a half spider (including half the hub and three arms) for a pulley of the type shown in Fig. 1 is illustrated in Fig. 3. First, the flat steel stock is sheared to length and is then slit, as at *A*, in a die to form the three arms. The three arms are then corrugated, as at *B*, to stiffen them, in a hydraulic press equipped with suitable dies. (This operation for some pulleys is done later.) The flat, corrugated plate is next flanged in a V-shaped die, as at *C*, which is the first step in the formation of the hub, the latter being shaped in three operations. After the plate is flanged, the three arms are spread apart and the hub roughly formed as at *D*; then this roughly formed part is placed in another die where the hub is made round and the arms are spread and convexed to the proper degree, as at *E*. The die for the spreading operations *D* is shown in Fig. 4. This die is so arranged that the central arm of the slit plate is held by block *A* while the other two arms are being spread by the action of

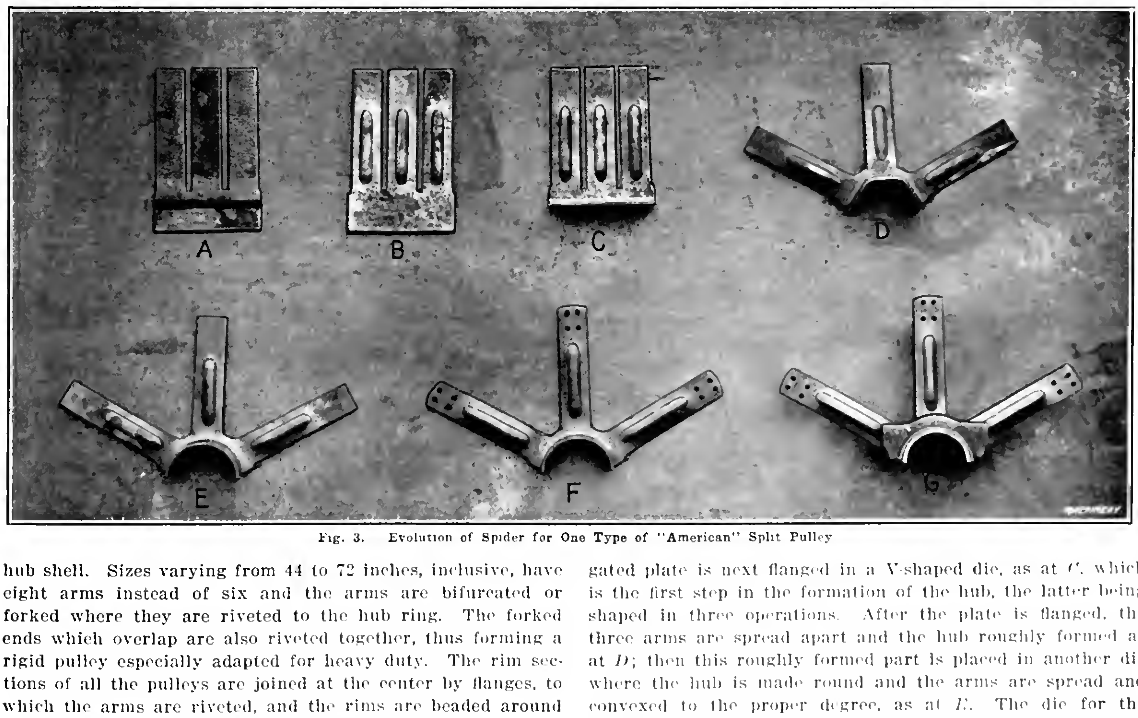


Fig. 3. Evolution of Spider for One Type of "American" Split Pulley

* For other articles on the manufacture of steel pulleys see "Making the Philips Pressed Steel Pulley in the November, 1913, number of MACHINERY.
† Associate Editor of MACHINERY.

a cylindrical shaped punch B which compresses the straight flange and roughly forms the hub.

After the hub has been formed and the arms are spread to the proper angle, the outer ends of the arms are pierced for the rim flange rivets, as at F, Fig. 3. The dies used for piercing these holes are shown in Fig. 5. The spider is clamped against locating plug A by lever B which operates a clamping slide, and the arms are located in relation to the punches by stop C. The extreme ends of the arms are next rounded in another die to approximately the curvature of the rim and are beveled on one side to avoid interference with the fillet of the rim flange. This beveling is necessary, for the ends of the arms which are milled to a uniform radius, as described later, must come in contact with the flange to insure an accurate pulley. Each arm is located for beveling by the pierced rivet holes which engage pins on the die. Holes are next drilled in the hub for the rivets which hold

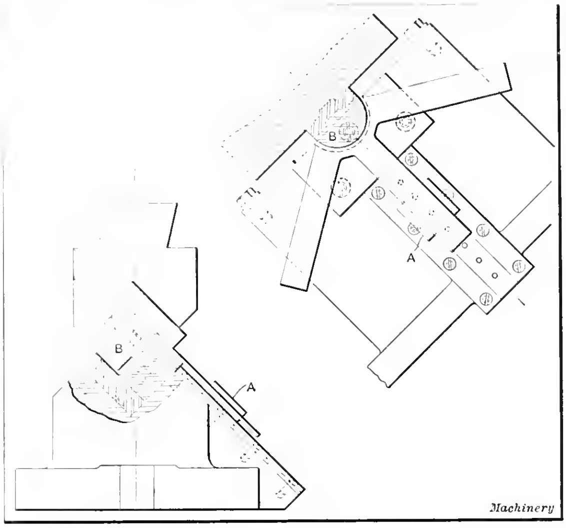


Fig. 4. Die for spreading Arms of Spider and roughly forming Hub

the inner shell. This drilling is done on the special multiple drilling machine shown in Fig. 6, the spindles of which are fed inward simultaneously, by the action of levers B operated by a cam at the rear. The work is held by three magnetized locating plugs C which engage the arms at the rear. These plugs hold the work securely enough for drilling, but it

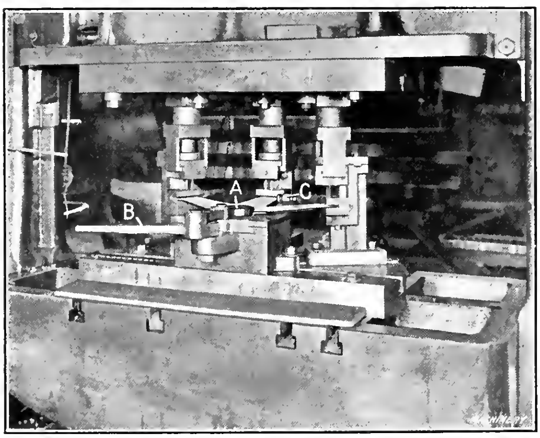


Fig. 5. Press and Dies for piercing Rivet Holes in Spider Arms

can be removed without demagnetizing the plugs. The location of the holes in the hub, relative to the arms, is controlled by pin A which engages a hole in the central arm, as shown.

The hub clamp shown attached to the hub at G, Fig. 3, is also formed of flat steel stock. This clamp, which is for the bolts that tighten the pulley hub on the shaft, is first blanked and then bent to a U-shape in a simple form of die; finally, the clamp is rounded to fit the hub and finished in the die illustrated in Fig. 7. This die has a rounded seat which conforms to the curvature required for the clamp, and a curved punch A. As the punch descends, the wedge-shaped plates B and B_1 at the sides engage plates C and C_1 which are forced inward, thus preventing the work from spreading or buckling while the forming operation takes place. As the punch

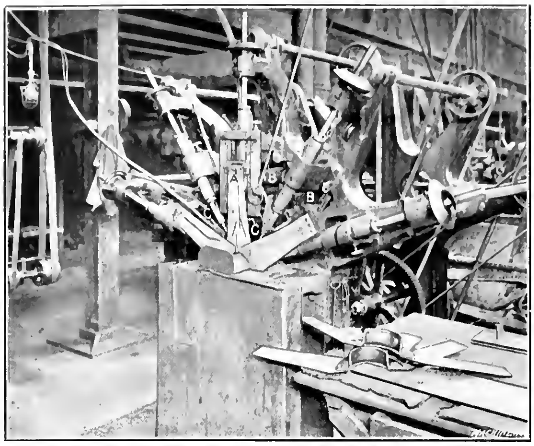


Fig. 6. Multiple Drilling Machine for drilling Rivet Holes in Hub of Spider

ascends, these plates loosen so that the work is easily ejected.

The assembling of the hub, hub clamp, and hub shell, to form the part shown at G, Fig. 3, is a riveting operation, hydraulic machines being used. The final operation on the pulley arms is shown in Fig. 8. Two half-sections or spiders are bolted around an accurately made bushing A which is not a part of the pulley but is a tool that represents the maximum shaft for which that particular pulley is adapted; this bushing is left in place until the pulley is completely assembled, riveted and tested. For the operation illustrated in Fig. 8,

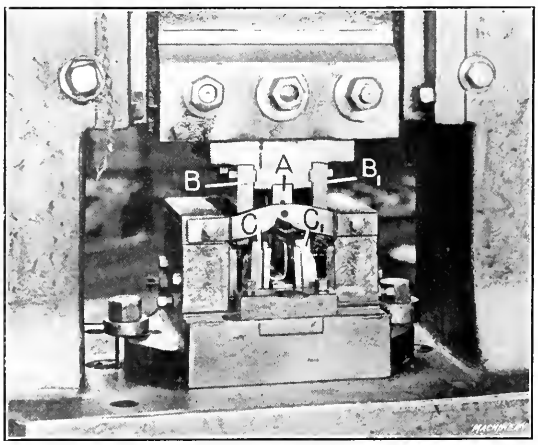


Fig. 7. Die for Final Forming Operation on Hub Clamp

which is that of milling the ends of the arms, this bushing is placed over a close-fitting plug and the arms are milled to a uniform radius by cutter B, the work being fed by simply turning it by hand. These milled surfaces insure a true pulley, as the rim sections are forced against them and are riveted in this position. Thus it will be seen that the accuracy of a pulley formed of sheet steel depends upon the design as well as upon the way in which it is manufactured.

Forming the Pulley Rim

The complete rim is composed of four sections, there being two sections in each half, joined by flanges at the center, as previously mentioned. These sections are first sheared approximately to length and then trimmed to an exact length in a die. At the same time, the corners are beveled slightly

so that the edges of the bead and flange will be radial after they have been formed, and the rim is made circular. These flat pieces are next passed through the rolls shown in Fig. 9, where they are roughly formed. The bead at the edge is partially turned over, as at *A*, and the flange is bent nearly at right angles. The last pair of rolls *B* is equipped with a crinkling device which uniformly corrugates the flange as shown at *C*, so that when the flange is pressed at right angles the bending action will be uniformly distributed and buckling prevented.

One of the large hydraulic presses used for finishing the rim sections is shown in Fig. 10. The rims are given the required shape by dies, and two sections are pressed simultaneously. This press has two large vertical plungers, one

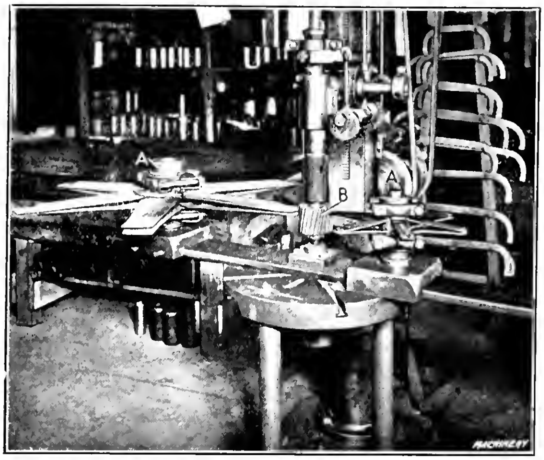


Fig. 8. Machine for milling Ends of Spider Arms to a Uniform Radius

being above the central inner die and one below it; in addition, there are four horizontal plungers located radially and 90 degrees apart. Two rough-rolled and crinkled rim sections the central die. The upper vertical plunger then descends and forces the crinkled flange down flat and at right angles, when the flange is pressed and while the rims are held se-

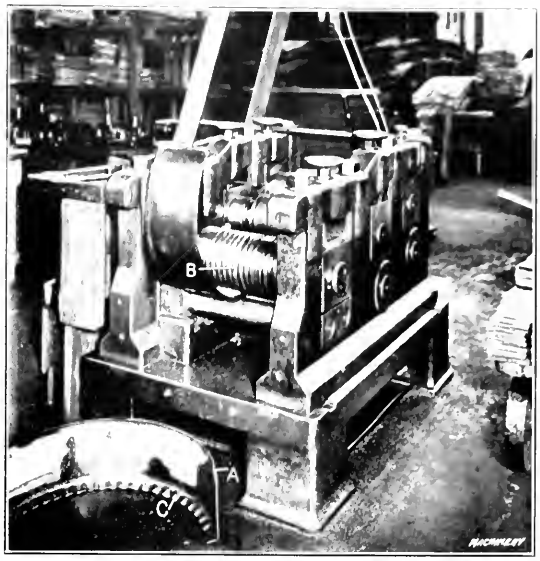


Fig. 9. Rolls for rough-forming Sections of Pulley Rim

curely, the lower plunger ascends and a curved beading die on it engages the edge of the rim (which it will be recalled was partially formed in the rolls) and rounds it, thus giving the rim a stiff outer edge. These operations are performed quite rapidly and the rims leave the press smoothly and accurately formed. The plungers are moved to and from the work by a pressure of about 150 pounds per square inch, but when the dies come into contact with the rims, the pressure is increased by an intensifier to 1000 pounds per square inch or more, in order to give the stock a permanent set. The rims

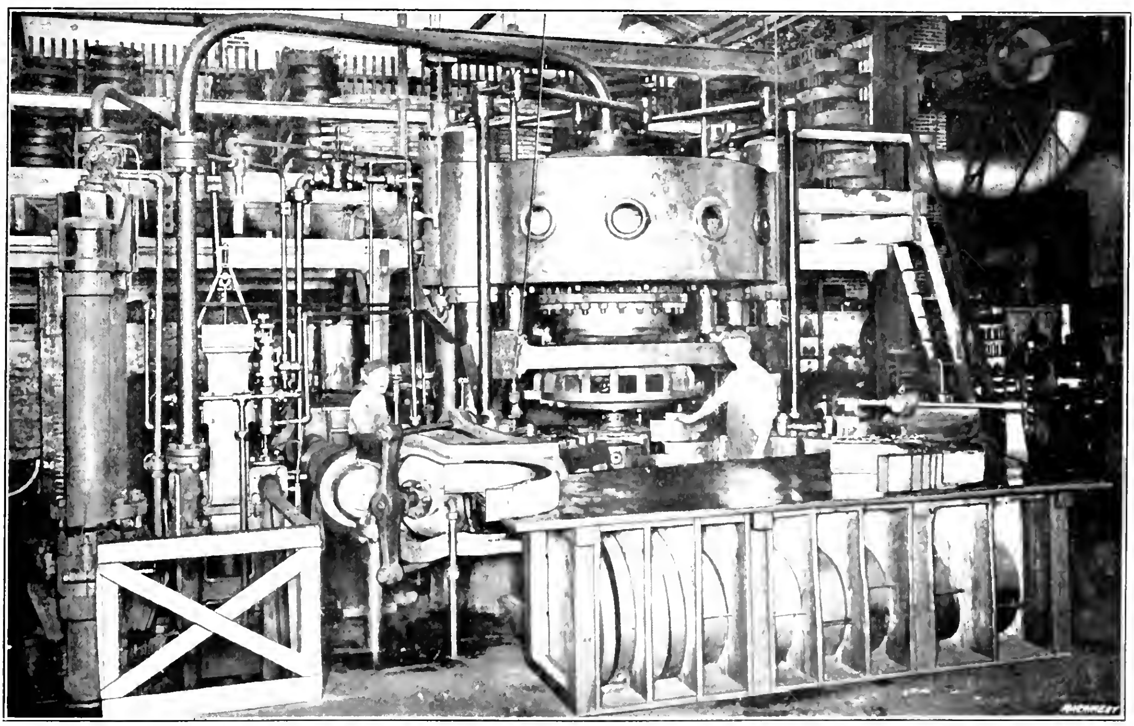


Fig. 10. Large Hydraulic Press equipped with Dies and used for finish-forming Rim Sections

are first inserted by two men standing one on each side of the press. The four radial plungers equipped with dies of the proper radius next move inward and press the rims against for pulleys larger than 18 inches in diameter are not formed in a hydraulic press with dies, but are rolled to the required size.

The rim ends and flanges are next pierced for rivet holes, which complete the rim section. The dies for piercing the central flanges are shown in Fig. 11. It will be noted that the dies for each pair of holes in the rim are independently attached to a circular faceplate or platen *B* having radial T-slots. The die bases are tongued to fit these slots which are also engaged by the clamping bolts. Each die is accurately located radially by plugs *A* which pass through it and enter holes that extend parallel with the slots. With this simple construction, one die is made to cover a wide range of sizes. The punches are, of course, also adjustable on the upper platen. The dies used for piercing the arms (illustrated in Fig. 5) are also constructed on the same principle, so that they can be adjusted for pulleys of different diameters.

Assembling the Pulleys

The pulleys are assembled on stands as indicated in Fig. 12. A spider having arms milled to a uniform radius and a tool bushing bolted in the hub, as previously mentioned, is placed over the vertical stake of an assembling stand and loose rivets are inserted through the arms, rim flanges and bolt clamps. One half of the pulley rim is accurately aligned with the other half, by short dowel pins *A* which were previ-

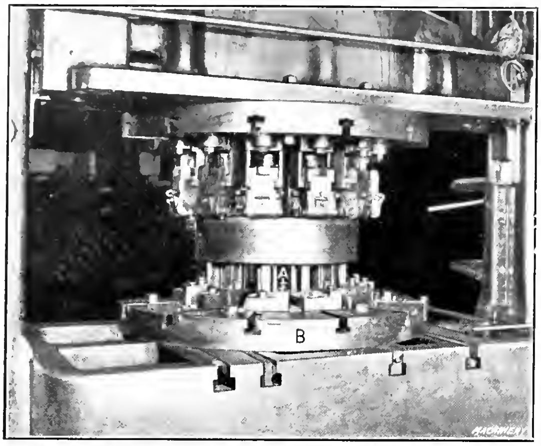


Fig. 11. Press and Dies for piercing Rivet Holes in Central Flange of Rim Section

ously inserted in the beaded edges. The assembled pulley is now taken to one of the hydraulic riveters (see Fig. 13) where the rivets are set. Before the riveting begins, the rim is firmly held against the ends of the milled arms by segments *A* which are forced in radially by an outer cam-ring *B*. This machine is used for setting rivets in the flange and arms. The rivets for the bolt clamps at the rim joint are set in the

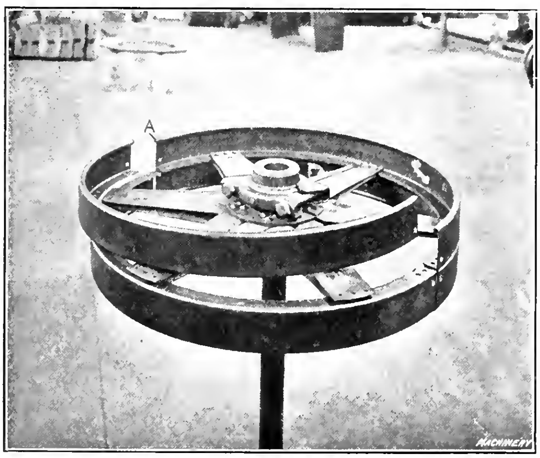


Fig. 12. Spider and Rim Sections being assembled prior to Riveting

special hydraulic riveter shown in Fig. 14. A heavy bar *A* passes through the pulley and provides a backing for the riveting dies *B* which receive the thrust of the lower plunger and dies *C*. When the rivets are set, the pulley is removed by simply pushing the bar back through bearing *D*.

Testing, Balancing and Inspecting

All finished pulleys are subjected to careful tests for accuracy and balance. The test for accuracy is made by the use

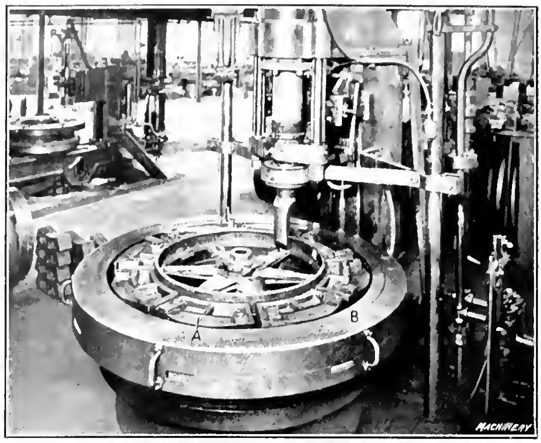


Fig. 13. Hydraulic Riveter equipped with Special Clamping Fixture for holding Rim against Milled Ends of Arms

of stands similar to that shown in Fig. 15. The spindle on which the pulley is mounted is revolved by a belt, as shown, and the stationary pointers *A* show whether the rims are circular and concentric or not. Screws *B* and B_1 at the sides show the accuracy in a lateral direction and are also used to force the pulley one way or the other, as may be required. Any slight local distortion of the rim is corrected by the

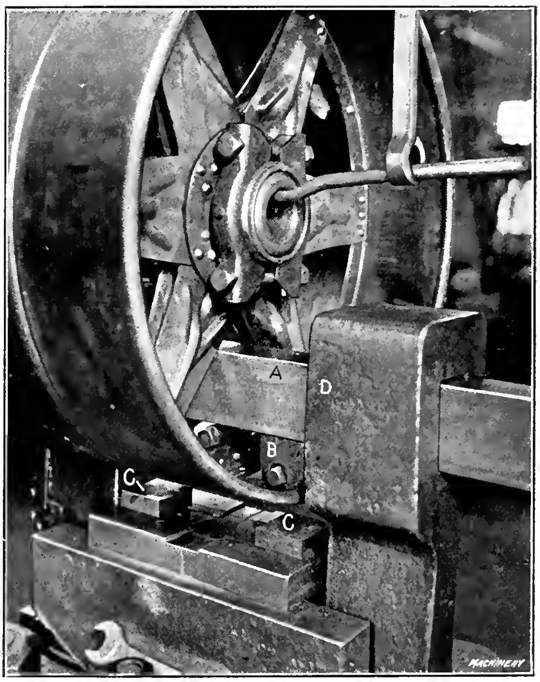


Fig. 14. Special Hydraulic Riveter for setting Rivets in Bolt Clamps at Rim Joint

special clamp tongs shown on the floor just in front of the stand. Most pulleys are very accurate, considering that the rim is not machined and that all the forming operations are effected by the use of dies.

After the accuracy test, the pulleys are tested for balance. In making this test, the pulley is mounted on an arbor and the latter is placed upon thin disk rollers of the testing stand shown in Fig. 16. These disks are free to revolve so that any unbalanced or heavy part of the pulley will turn to the

bottom. This balance test is very sensitive as a slight irregularity in the distribution of the weight will cause the pulley to turn. As the pulley rim is of uniform section, the balance is, in most cases, very accurate and the use of counterweights is unnecessary.

Crowning Pulley Rims

"American" pulleys are made with either straight, cylindrical rims or with "crowned" rims which slope away from the center. The crowning is done on sizes above 48 inches, after the pulley is assembled and riveted together. The hydraulic press for doing this work is shown in Fig. 17. This press is equipped with sectional dies *A* which fit into a tapering seat in the outer ring *B* which is attached to the lower platen *C*

Fig. 15. Stand for testing Accuracy of Finished Pulley

of the press. The dies are also tapered on the inside to conform to the crown or taper required for the pulley rim. The pulley *D* to be crowned is first drawn up against the top platen of the press and is held there by a wire cable *E* operated by an overhead electric hoist. The lower platen or plunger then moves upward and the crowning dies are forced

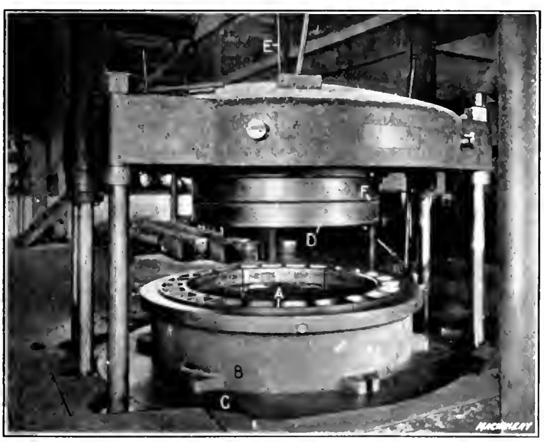


Fig. 17. Large Hydraulic Press and Dies used for crowning Pulley Rims

over the pulley, thus tapering one-half the rim. The platen is then lowered and the pulley is released by raising the sectional dies in their tapering seat. The opposite half is then crowned in the same way, the position of the pulley being reversed. Crowned rims are recommended for pulleys carrying non-shifting belts, and straight, cylindrical rims for belts that must be shifted.

The weight of one of these steel pulleys is about 45 per cent of the weight of a cast-iron pulley, and it is claimed that the strength is sufficient for any duty not so severe as to demand a special pulley. The annular groove *F* (Fig. 17) around the center of the rim face, formed by the curvature of the inner rim flanges, is said to greatly increase the efficiency of the pulley as a transmitter of power, owing to the fact that the air which is trapped between a rapidly moving belt and the pulley rim can escape through this groove, thus giving better belt contact.

* * *

CATALOGUE WASTE IN CENTRAL AMERICA

Special agent Garrard Harris writes that the waste of catalogues, trade circulars and form letters addressed to

Fig. 16. Stand for testing Balance of Pulley

merchants and business men of Central America, as well as other countries of Latin America, is enormous. Mails are loaded with beautiful catalogues that are works of art in every respect, exhibiting the most experienced thought and ability of experts. Most of the publications are illustrated and in the United States would prove valuable and effective

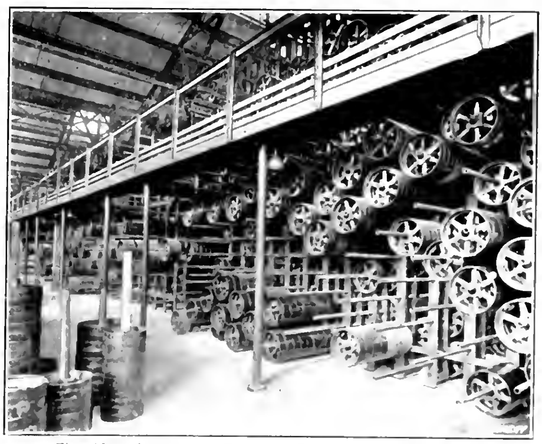


Fig. 18. View in Store-room of American Pulley Co.—Note Arrangement of Pulley Racks

trade getters. Yet in the Latin-American countries they are ineffective. Trade circular letters so prepared that a trained observer could hardly detect the mark of the mimeograph or the fact that each one was not an original personal letter also go to the waste basket. One reason is that all this trade literature is in English. Another is that Latin-American merchants prefer to do business with traveling men. Catalogues printed in Spanish, however, may be used effectively to introduce goods to the notice of possible buyers

THE CLEVELAND AUTOMATIC SCREW MACHINE—1*

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON†

The Cleveland Automatic Machine Co., Cleveland, Ohio, made the first model of the Cleveland automatic screw machine in 1891. This machine is constructed on the single spindle principle and incorporates many interesting features in design, construction and operation. One feature which

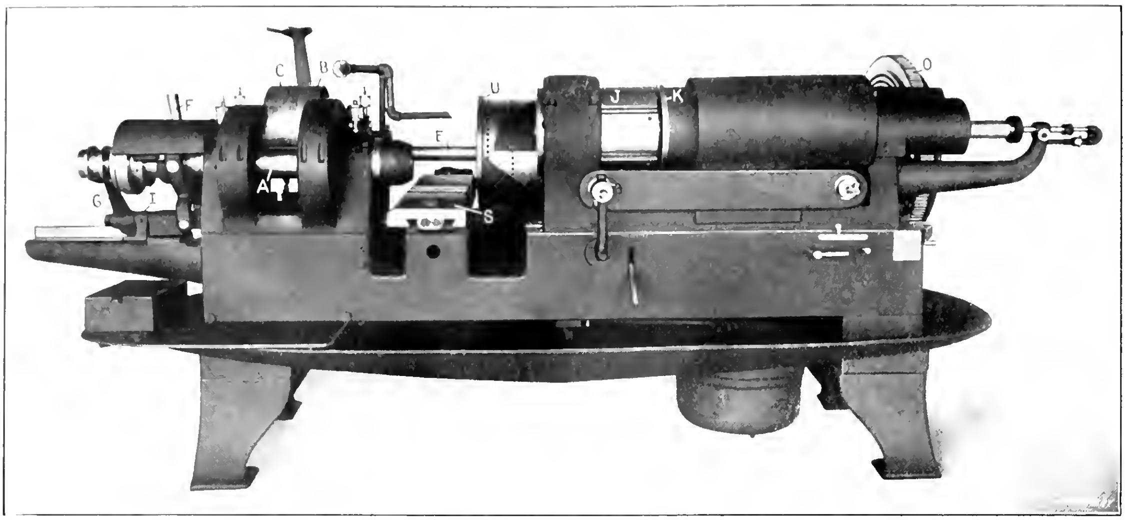


Fig. 1. Front View of $3\frac{1}{4}$-inch Cleveland Full Automatic Screw Machine

characterizes it is the method of obtaining the variation in the feed of the turret and cross-slide tools. A regulating drum on which adjustable strip cams are held is used for this purpose; these cams operate a bell-crank lever which shifts the position of a roll located between two driving friction disks and thus changes the speed of the driving shaft operating the turret through spur gears, an epicyclic train and a worm and worm-wheel. This mechanism provides for a wide

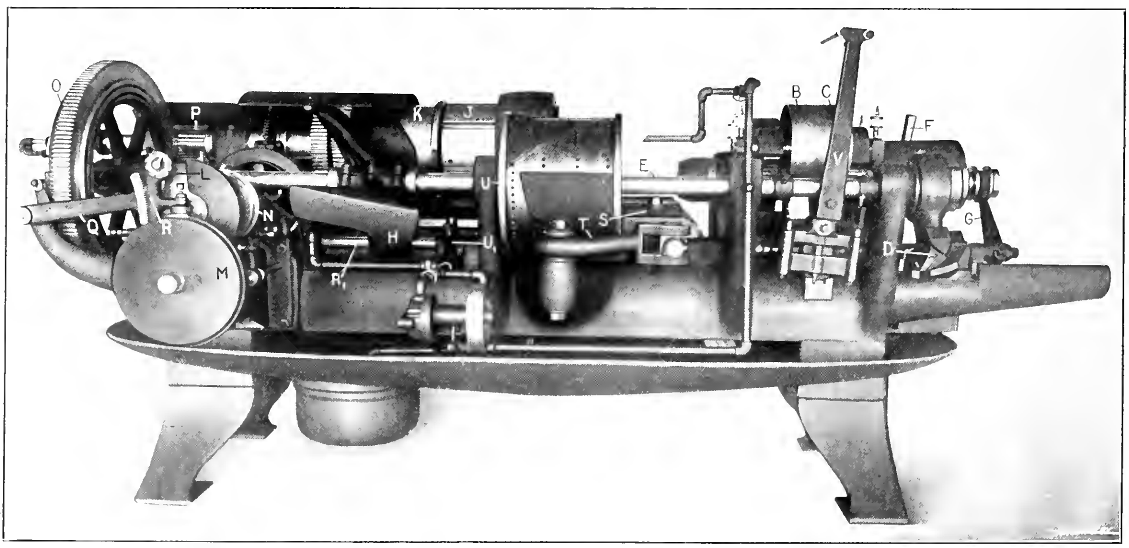


Fig. 2. Rear View of the Cleveland Full Automatic Screw Machine

range of feeds to the individual turret and cross-slide tools and can be regulated while the machine is in operation. The latest improved model of the Cleveland automatic screw machine is shown in Figs. 1, 2, 3 and 4, which present front, rear and end views, respectively, of the $3\frac{1}{4}$-inch full automatic turret type of machine.

Types of Cleveland Automatic Screw Machines

In addition to the full automatic type of machine shown in Figs. 1, 2, 3 and 4, which is known as model A and is built in sizes ranging in chuck capacities from $\frac{3}{8}$ inch to $7\frac{3}{4}$ inches, the Cleveland automatic is also built in several other types adapting it to a large range of work and variety of purposes. The full automatic machine is provided with a turret having five holes on sizes from $\frac{3}{8}$ inch to $2\frac{1}{4}$ inches inclusive, and six holes on the machines of greater capacities.

The next type of machine is the plain automatic known as model B. This machine has no turret but is provided with one tool spindle which can be used for holding a box-tool, drill or tools of a similar character. The range of this machine, however, can be greatly increased by the addition of simple attachments on the cross-slides and tool spindle. The model C machine is of the full automatic type and is half-way between models A and B. It is provided with only three holes in the turret and resembles model B in construction.

* For information on automatic screw machine practice previously published in MACHINERY see "Examples of Screw Machine 'Set-ups,'" November, 1913, and articles there referred to.

† Associate Editor of MACHINERY.

The type of machine known as model D is similar to model A, but is built to handle castings, forgings, etc., and hence is semi-automatic in its operation. The turret of this machine is provided with four holes and both the turret and spindle heads are adjustable along the bed. A modification of the plain machine is the double-spindle plain automatic which is provided with two opposing work-spindles located in a parallel line and with the chuck mechanism of both heads acting simultaneously. This machine is particularly adapted for finishing both ends of a piece of work, thus obviating the necessity of a second operation to complete the part.

Principles of Design and Operation

Before proceeding with the description of the construction of the Cleveland automatic screw machine, the general principles of operation will be briefly outlined. The following description given pertains particularly to the full automatic type of machine known as model A, as this machine incorporates all the principal points of design and operation common to this make of automatic screw machine. The work-spindle A, Fig. 1, is driven from the overhead countershaft through two pulleys B and C and three pinions (one being intermediate) and gears, two pinions being carried on the same shaft as the pulleys, one on an intermediate shaft, and the gears on the work-spindle. Pulleys B and C are separated by a loose pulley so that when the belt is thrown onto it no power is transmitted to the spindle. Pulleys B and C can be rotated both forward giving two speeds, or one forward and one reverse for threading. The chuck which is of the push type is operated by a sleeve that passes through the spindle and is actuated by adjustable cams held on the arm D, Fig. 2, located on the rear shaft E. Lever F is provided for opening and closing the chuck when setting up.

The feeding of the stock is accomplished by a feeding finger and tube passing through the work-spindle and operated by an arm G, see Figs. 2 and 3, which receives power through a rod R_1 actuated by the cam H. Variation in length of feed is accomplished by shifting the position of roll carrier U_1 along rod R_1. The turret J, which is of the drum type and is provided with holes for carrying six end-working tools, is mounted on a horizontal shaft located parallel with the spindle. It is operated back and forth by cams held on a separate drum K, which is rotated by spur gears, a worm and worm-wheel, epicyclic train and friction disks L and M; this mechanism receives power from a pulley N driven by a belt from the overhead works. The turret is indexed by a rod passing through the drum K which, when the turret moves back, comes in contact with pins held in its rear face, thus transmitting a rotary movement to the turret after the locking pin is withdrawn from the slots in its periphery by a cam held on drum K.

The feed given to the tools in the turret and on the cross-slides is governed by adjustable strip cams held on the regulating drum O, see Fig. 4, which is mounted on shaft E and rotated by a gear P held on the turret shaft. The cams on this drum operate a friction roll running between disks L and M through the medium of a bell-crank lever Q and rack arm R. The indexing of the turret is accomplished at a much higher speed than that used when cutting and this is effected by dogs carried on the regulating drum O which operate a tooth clutch, changing the drive direct to the pulley N instead of through the epicyclic train of gears mentioned.

The cross-slide which is a single casting S, carrying both the front and rear forming and cutting-off tools, is operated by a lever T. This lever receives its motion from cams held on drum U mounted on the rear shaft E. On the Cleveland automatic, as ordinarily equipped, the front and rear cutting tools cannot be operated independently, that is, they cannot be brought to work on the bar at the same time. However, for work which can be better handled in this way, a double cross-slide can be furnished as will be described later.

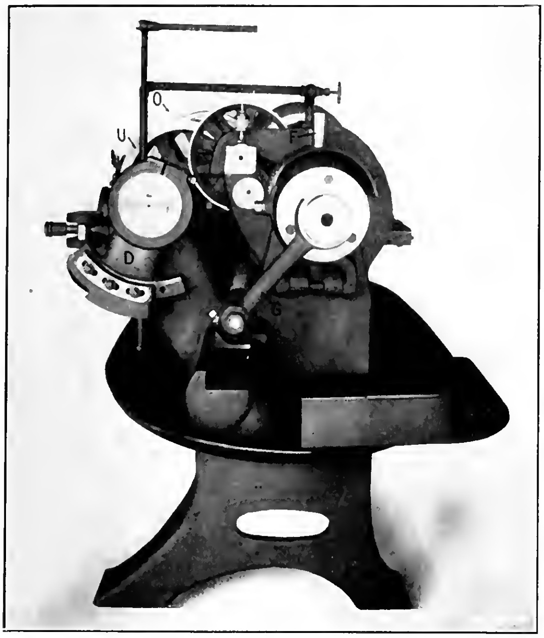


Fig. 3. End View of Cleveland Automatic showing Chuck Closing and Stock Feeding Mechanism

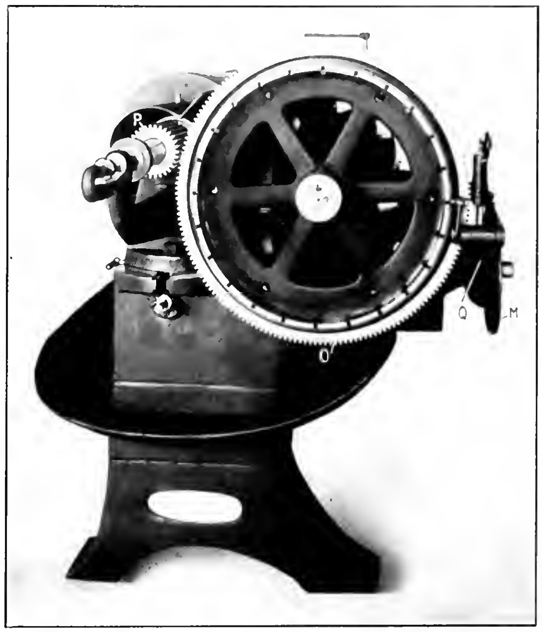
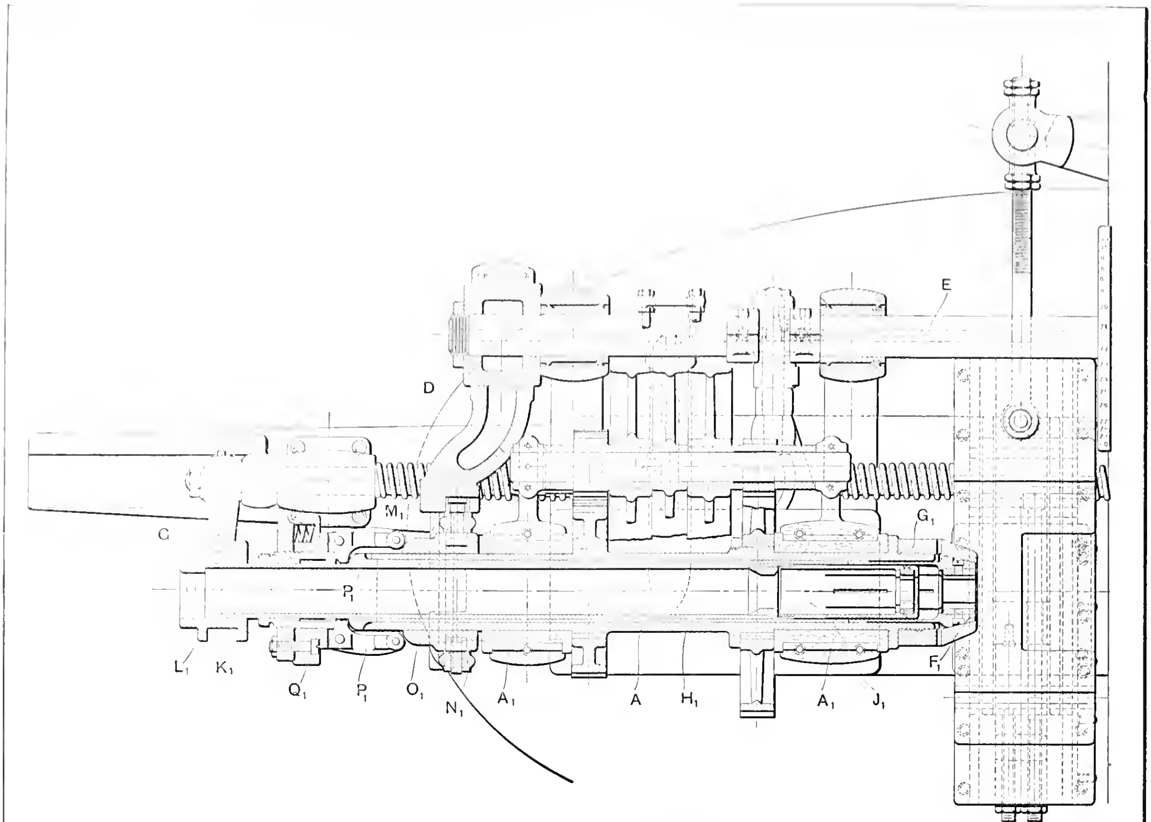


Fig. 4. End View of Cleveland Automatic showing Regulating Drum and Auxiliary Mechanism for changing Feed of Tools

Construction and Operation of the Work-spindle

The work-spindle A is a 0.40 per cent carbon steel forging that rotates in special journal metal bearings A_1, see Figs. 5 and 6. With the standard type of drive the spindle is rotated forward by pulley B through a pinion B_1 and gear C_1. It is revolved backward by pulley C through pinion D_1, an intermediate pinion and gear E_1. There are several other types of drives employed for special purposes, as will be described in a subsequent article.

The shifting of the driving belt from one pulley to the other is accomplished by an ingenious positive-acting belt shifting device V, which is shown in detail in Fig. 7. This device consists primarily of a bracket a fastened to a boss on the machine and carrying a swinging member b fulcrumed on a pin carried in the bracket. The device is operated to shift the belt to the different pulleys by means of cam fingers I_1, see Fig. 8, which are carried on the rear shaft E and are adjustable. The fingers, as the shaft rotates, come in contact alternately with spring operated plungers c and d, depressing them, and through the medium of levers e withdraw the wedge f from the slots in plate g. When the wedge f is withdrawn from one slot in the plate, the shifter is thrown instantane-



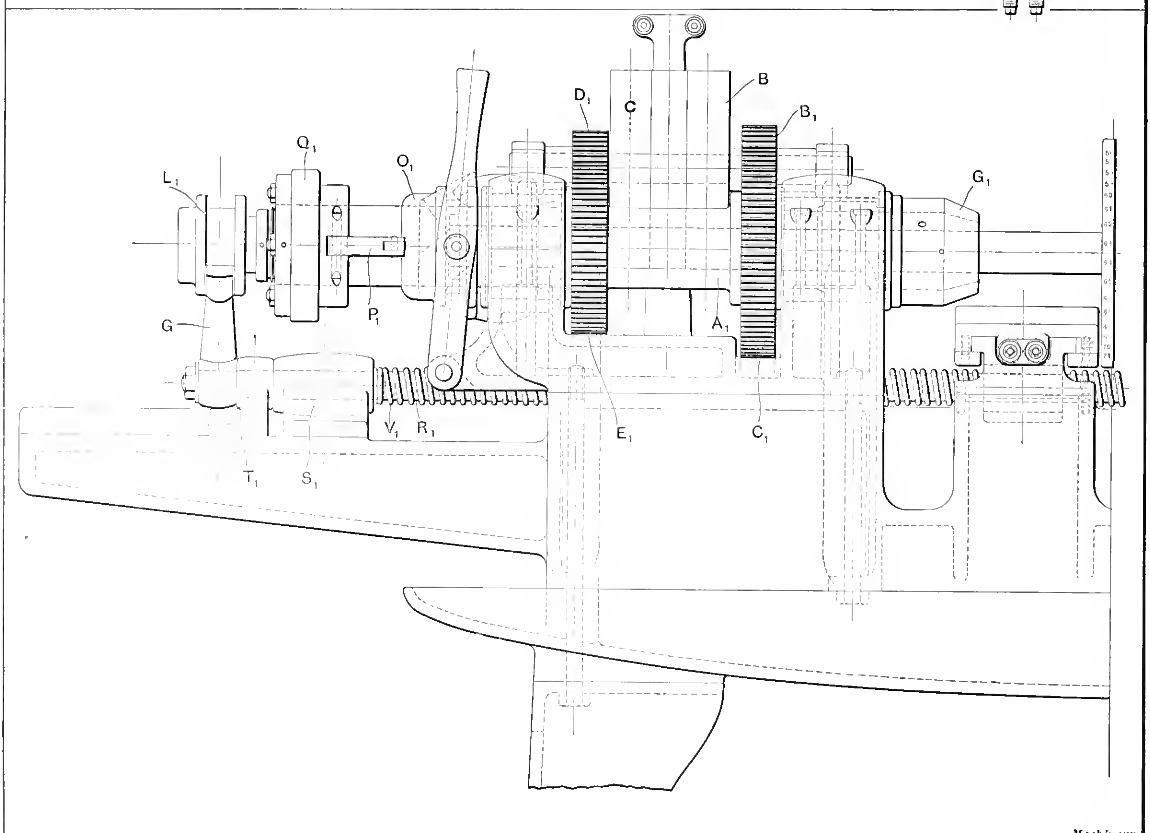


Fig. 5. Sectional Plan View showing Construction of Spindle, Spindle Driving Mechanism, Chuck Closing, Stock Feeding and Auxiliary Mechanism
Fig. 6. Front Elevation of Work-spindle End of Machine

ously into the next slot and thus shifts the belt or belts by means of the arm *h*. There are different combinations of these arms for the various types of belt drives and they can be easily changed by taking out the screw *i*. In Fig. 7, *h* is the arm and finger for the third speed drive, *j* for the double belt drive and *k* for the single belt drive.

Chuck Closing and Stock Feeding Mechanism

The chuck F_1, Fig. 5, which has a tapered nose, is of the push type and is held in the cap G_1 screwed onto the nose of the work-spindle. It is operated by a sleeve H_1 that receives power from the arm *D*. A detail of this arm is shown in Fig. 10, which illustrates its adjustable features. In addition to being split, enabling it to be clamped in any position on the shaft, this arm is provided with adjustable cams *m*, *n* and *o*. Here *m* is the chuck opening cam, *n* the safety cam and *o* the chuck closing cam which is cast integral with the arm *D*. Cams *m* and *n* comprise the same casting and are adjustable on the arm *D*, being held in the desired position by three clamping screws fitting in elongated slots. There are also additional tapped holes in the arm allowing for further adjustment.

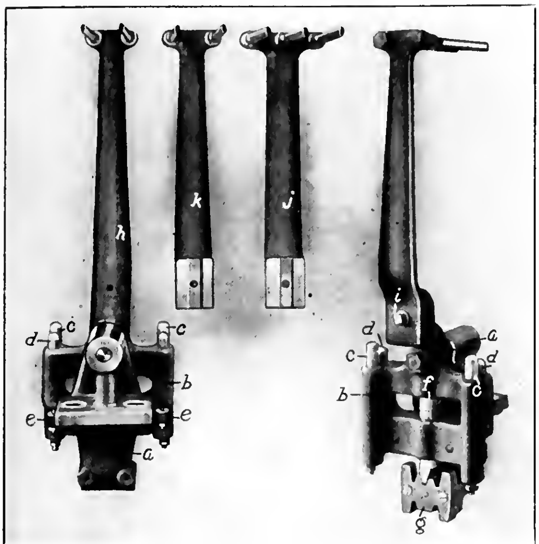


Fig. 7. Details of Positive-acting Belt Shifting Device

When smooth stock is being held in the chuck the adjustable cams *m* and *n* are set tightly up against cam *o*, thus giving a quick closing and opening action to the chuck and allowing a short space of time for feeding the stock. When rough bar stock is being handled, and for magazine work, it is necessary to keep the chuck open much longer; for this action the cams *m* and *n* are separated from cam *o* in order to allow sufficient time to handle the work successfully.

Fig. 10. Detail of Adjustable Cam Chuck Closing Segment

The action of closing the chuck is simple and is accomplished in the following manner: As arm *D* rotates, cam *m* comes in contact with a roll M_1, Fig. 5, held on the fulcrumed yoke N_1. This yoke, in turn, carries two rolls that work in a circular groove cut in sleeve O_1. As the cam forces this sleeve in a direction away from the chuck it acts upon two fingers P_1 provided with rolls at their outer ends, the rear ends of the fingers bearing against the rear end of the chuck closing sleeve H_1. This action forces the split chuck into the hood closing it on the work. As cam *o*, Fig. 10, comes into action, it reverses the operation of yoke O_1 and removes the pressure from the sleeve H_1, allowing the chuck to open, due to spring tension. Pressure bushing Q_1 acts as a medium for holding the fingers P_1 up on the collar O_1.

The bar stock is fed through the spindle by a spring finger J_1 screwed into the front end of the tube K_1, the rear end of which is provided with a grooved collar L_1. Fitting in this grooved collar is a forked lever *G* which is carried on the rod supported in brackets S_1 and T_1, the former being fastened to and the latter sliding on the base or extended bracket on

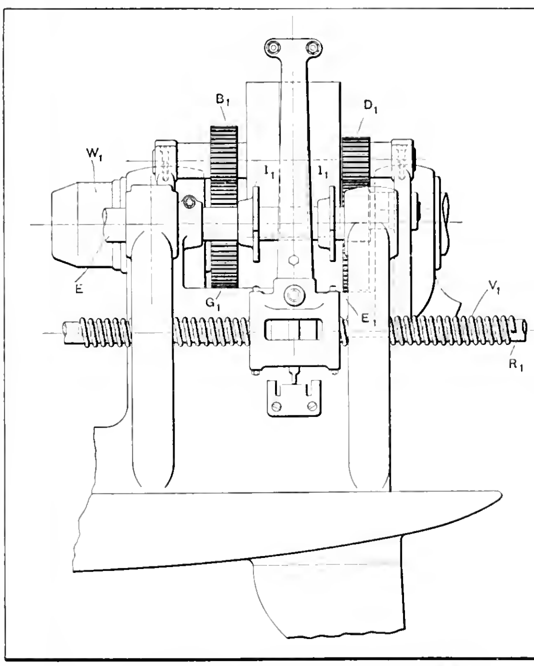


Fig. 8. Rear Elevation of Work-spindle End of Machine showing Drive and Belt Shifting Arrangement

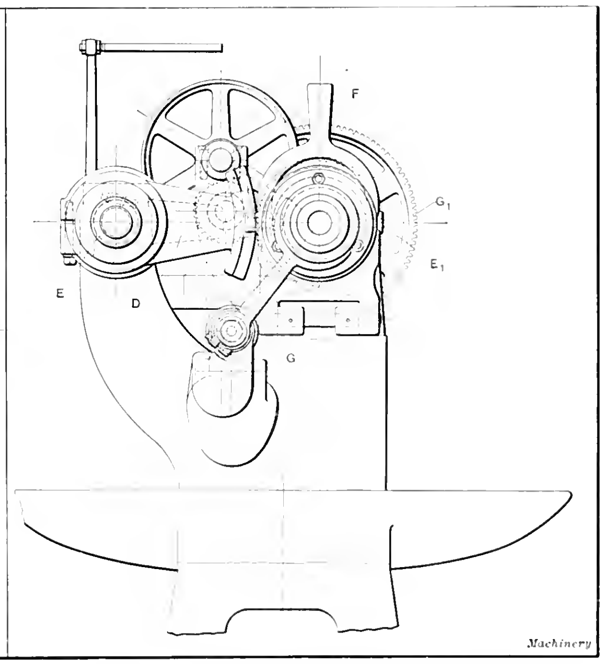


Fig. 9. End Elevation showing Chuck Closing and Stock Feeding Mechanism

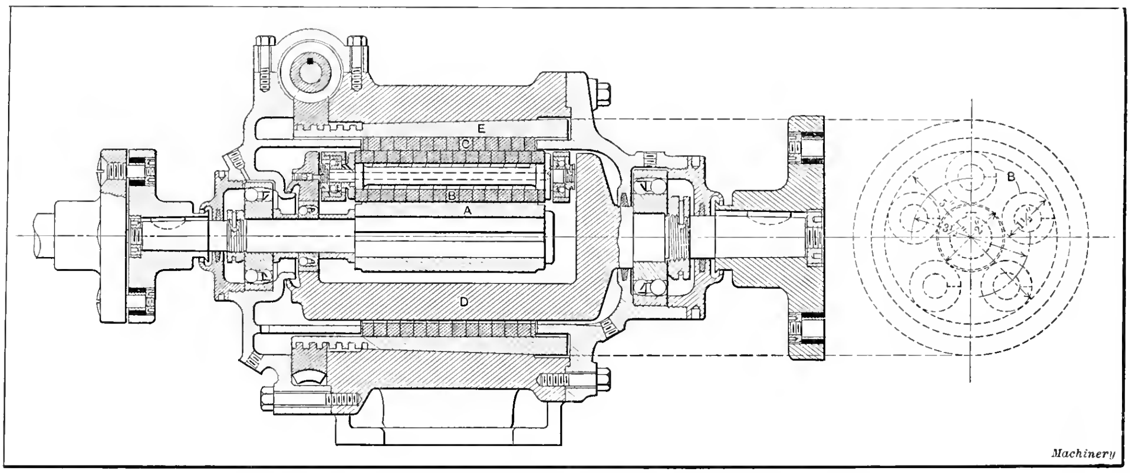
the machine. The movement of forked lever G is controlled by a cam H, Fig. 2, which contacts with a roll held on bracket U_1, clamped to rod R_1. Adjustment for length of feed is controlled by shifting the position of the bracket U_1 along rod R_1, and the timing is effected by shifting the cam H around the shaft E. An open wound coil spring V_1, Fig. 6, serves to keep the forked arm G and sliding bracket T_1 up against the stationary bracket S_1, when the rod R_1 is not acted upon by the cam. For double feeding, a drum is provided carrying two cams, allowing for feeding the stock twice for every revolution of the cam-shaft.

* * *

"FAST" SPEED REDUCING MECHANISM

The accompanying illustration shows a new type of high-speed "transformer" or speed reducing mechanism invented by Mr. Gustav Fast. As will be seen, this device is an application of the friction gear principle. The motion is transmitted from the cylindrical sleeve A on the high-speed shaft, to five rolls B (see end view) which are carried by housing D connected with the low-speed shaft.

The novel feature of this mechanism is that the frictional rolls B are flexible, being made in the form of a helical spring in order to insure an even contact between the inner and outer members A and C against which they bear as they revolve. The outer part C is also made in the form of a helical spring and it is enclosed by a sleeve E that is tapering on the outside. When this sleeve is drawn in by means of the threaded end and worm gearing shown, the diameter of the flexible track for the rollers is reduced. This construction is said to insure a perfectly cylindrical surface even when this flexible lining is contracted to its limit, which equals a reduction in diameter of 1/16 inch. By means of the adjusting worm gear, sufficient pressure can easily be obtained for any load within the capacity of the mechanism.



Sectional View of Speed-reducing Mechanism equipped with Flexible Frictional Rollers

The speed reduction of the particular design illustrated is in the ratio of 3½ to 1, but this type of speed reducer can be designed for ratios varying from 2½ to 1 up to 10 to 1. It is claimed that the transformer runs very smoothly and quietly at speeds even as high as 6000 revolutions per minute and that it makes considerably less noise than a steam turbine or an electric motor running at the same speed. The total weight of the machine is 218 pounds. The maximum power that a speed reducer of the type here shown is capable of transmitting at various speeds is as follows:

Speed of "High-speed" Shaft, R. P. M.	Horsepower Transmitted	Speed of "High-speed" Shaft, R. P. M.	Horsepower Transmitted
1000	11	4000	34
2000	21	5000	38
3000	28	6000	40

In the construction of this speed reducer, heat-treated vanadium steel proved to be an important factor in making the device efficient and practicable. The high wearing qualities of chrome-vanadium steel tires led the inventor to use vanadium steel in this transformer for the driving roller, the friction rollers and the flexible track or casing. After using the transformer six months, the parts showed practically no wear and the surfaces were very hard and smooth. The vanadium steel used was made by the Halcomb Steel Co., and it is the type D, 0.50 carbon chrome-vanadium steel.

The heat-treatment given these parts is as follows: All of them were quenched in oil at 1650 degrees F.; the driving roller was then drawn at 650 degrees F.; the friction rollers at 450 degrees F.; and the flexible track at 800 degrees F. It is claimed that the efficiency obtained with this mechanism has been as high as 99 per cent and that it has never dropped below 97 per cent for any kind of a load. The mechanism has been loaded to 100 per cent above its capacity for a continuous run of three hours without being injured.

* * *

NEW DEPARTURE IN ENGINEERING EDUCATION

An interesting educational experiment will be made this year at the College of Mechanical and Electrical Engineering of the State University of Kentucky, where the thesis of the students of the senior class will consist of a complete design with specifications for a 15,000 kilowatt power plant, not worked out individually by each student, but by the students as a group of engineers. A location will be definitely decided upon and the young men will visit the spot, making an actual preliminary survey and boring a few test holes. They will also investigate the water supply and the climatic conditions where the plant is to be located. After the preliminary work has been done, the class will be organized into an engineering body working in a class drafting-room like in a modern engineering establishment, with a regular eight-hour working day. It is stated that even a time clock will be installed and that regular attendance to duties will be enforced. One of the professors will act as chief draftsman, the man being selected to act in such capacity having had experience in the office of a large power plant designing firm.

This new departure in engineering education is worthy of commendation. It seems to place the engineering college on more practical ground and to make the transition stage between school and practical engineering work easier than has been the case in the past, when many graduates have entered practical work with little or no knowledge of actual engineering conditions.

* * *

According to the *London Times*, a bill will shortly be introduced in the French Chamber of Deputies making legal the division of the quadrant of a circle into 100 parts, or grades, each divided into 100 centesimal minutes, each of these, in turn, consisting of 100 centesimal seconds. According to this division a complete circle will have 400 grades, 40,000 minutes, or 4,000,000 seconds.

ELECTROPLATING ZINC ALLOY DIE CASTINGS

Difficulty has sometimes been experienced in electroplating zinc alloy die castings, although they can be electroplated as easily as iron or steel if the proper methods are followed. The following, which is from a booklet on this subject issued by the National Lead Co., New York City, contains some practical methods whereby die castings can be cleaned, polished and electroplated.

Cleaning and Polishing

Die castings that are to have a polished surface should be "cut down" with the usual buff wheels and tripoli composition. The finishing should be done with white compositions of Vienna lime. After the parts have been polished, the excess of polishing material should be removed by the aid of benzine or gasoline, and they should be dried in maple sawdust. If the benzine or gasoline is dispensed with, hot alkaline solutions should be used for cleansing. The strong alkalies of caustic soda or potassium should never be used in cleansing zinc, as they have a reducing action upon the metal and produce oxides, thus destroying the polished surface.

The solution should be maintained at a temperature of 160 to 180 degrees F. Soda ash may also be used for the purpose, one pound of this material and one-quarter ounce of cyanide of potassium being used per gallon of water.

The articles should remain in the cleansing bath for a few minutes and then the excess polishing material brushed away, using an oval painter's sash brush for the purpose; the rubber-set variety is the most economical. After cleansing, immerse in clean, cold water and then into a cyanide dip. This dip should consist of 6 ounces of cyanide of potassium or sodium to each gallon of water and should be used cold. After re-washing the articles in clean, cold water they are ready for the plating bath.

Articles to be unfinished are cleansed in the same manner, if somewhat corroded due to the formation of oxide of zinc on the surface by contact with moisture. Immerse for a few seconds in a pickle consisting of one part of hydrochloric acid and four parts of water (this will dissolve the oxide); then rinse the die castings in cold water, immerse in the cleaning solution for a few seconds, re-wash in cold water and scratch-brush to bring up the color of the metal. Repeat the cleaning operations, using only the cleaning solution and the cyanide dip; the casting is now ready for plating. If the articles are to have a polished finish, the scratch-brushing may be dispensed with.

Copper-plating Die Castings

The solution for copper-plating should have the following proportions:

Water	1 gallon
Cyanide of copper	3 ounces
Carbonate of potash	1 ounce
Cyanide of potassium or sodium	4 ounces

To prepare the solution, the potash and copper should be dissolved in half the amount of hot water, the cyanide in the balance of lukewarm water; then mix thoroughly together. Use the solution at a temperature of 150 degrees F. and at 2 to 2½ volts pressure. Cast copper anodes give the best results, but the electrolytic variety may be used.

Brass-plating Die Castings

Prepare a solution exactly the same as for the copper bath; then dissolve equal parts of cyanide of zinc and cyanide of potassium in warm water. An addition of 1 ounce of zinc carbonate and the same proportions of cyanide should be added to the copper bath per gallon; then add ½ ounce of sal ammoniac per gallon of solution. If the color should be too deep a yellow, a little more zinc should be added to the bath to obtain the required shade. This bath should be used at a temperature of 120 degrees F. and at 2 to 3 volts pressure. The cleansing of the articles should be done as previously stated.

Nickel-plating Die Castings

Much trouble has been experienced in nickel-plating die castings with the ordinary solution, due to black streaks appearing in the deposit caused by local action of the ordinary solution upon the metal. The following formulas will give satisfactory results without the difficulties mentioned:

Nickel sulphate	10½ ounces
Potassium citrate	7 ounces
Ammonium chloride	10½ ounces
Water	2½ gallons

To prepare this bath, dissolve the nickel sulphate and ammonium chloride in half the amount of hot water prescribed; then dissolve the potassium citrate in the balance of the water and mix thoroughly. The voltage should be 2½ to 3 volts. This bath should always be kept neutral to avoid black streaks. For this purpose pure caustic potash dissolved in water should be added to the bath so that the solution is neutral to the test of red or blue litmus paper.

The following bath is used extensively in plating articles made from zinc and gives excellent results:

Double nickel salts	8 ounces
Chloride of sodium	1 ounce
Magnesium sulphate	2 to 4 ounces
Water	1 gallon

To prepare the bath, dissolve the nickel salts in half of the water at a temperature of 180 degrees, and dissolve the other salts in the balance of cold water; then mix thoroughly together. Use this solution cold, with anodes of cast nickel. The voltage should be 2½ to 3½ volts. The articles to be nickel-plated may be plated direct or be lightly coated in the copper or brass baths prior to nickel-plating. The time of immersion in either of the nickel baths should be according to the thickness of the deposit required, although thirty minutes gives a fairly good deposit in either case.

Silver-plating Die Castings

Cyanide of silver	3 ounces
Cyanide of potassium	4 ounces
Water	1 gallon

Use anodes of pure silver at about 1 volt pressure. Die castings for silver-plating should be previously copper-plated for a short time then amalgamated in a mercury dip consisting of the following proportions:

Water	1 gallon
Oxide of mercury	½ ounce
Cyanide of potassium	6 ounces

After copper-plating and washing in water, the articles are immersed in the dip for a second or two, or until uniformly coated with mercury. They should then be re-washed and immersed in the silver bath. The articles may also be nickel-plated in one or the other of the nickel baths and then quickly coated in the silver striking solution, after which they should be directly immersed in the silver bath without rinsing.

The silver strike should be as follows:

Cyanide of silver	½ ounce
Cyanide of potassium	6 ounces
Water	1 gallon

Use silver anodes with 3 to 4 volts pressure. The nickel surface must be immediately coated over for successful silver deposits.

Gilding Die Castings

In gilding die castings the articles must be previously coated with brass or copper and have a bright luster. The following formula will give excellent results:

Phosphate of soda	8 ounces
Sulphate of soda	1½ ounce
Cyanide of sodium	6 pennyweights
Chloride of gold	6 pennyweights
Water	1 gallon

To prepare the solution dissolve the cyanide and chloride of gold in part of the hot water and the sodium salts in the balance; then mix together thoroughly. Anodes of gold, platinum or carbon may be used, and the bath should be kept at a temperature of 180 degrees F. at 2 volts pressure. If the articles are previously coated in the copper bath they should afterward be flashed in the brass bath to save an excess of gold.

The usual lacquers should be applied to brass, copper, silver or gold finishes. In plating die castings or articles of zinc, it is a distinct advantage to use as little free cyanide as possible. If this is reduced to a minimum, very little difficulty will be experienced in the blistering of the deposit. In nickel-plating, the baths should be maintained at the neutral point, as previously mentioned.

WORM HOBBING ATTACHMENT FOR AUTOMATIC SCREW MACHINES

DETAILS OF THE DESIGN OF THE ATTACHMENT AND METHOD OF MAKING THE HOB

BY B. F. ALEXANDER*

The Warner Instrument Co., Beloit, Wis., now incorporated under the name of the Stewart-Warner Speedometer Corporation, was the first to use an attachment on a National-Acme automatic screw machine for hobbing worm and spiral gears from blanks formed from bar stock on this machine. The first idea of making such an attachment is credited to Mr. A. B. Cadman, superintendent of the Beloit factory of the Stewart-Warner Speedometer Corporation, and formerly of the Warner Instrument Co. It has since been developed into many different types, the latest of which is the one described in this article. To show that these attachments are quite practical and not in any sense experimental, I might add that the first attachment that was made is still in actual service, having been used over a period of four years. During this period it has hobbed thousands of spiral gears.

The following describes a drop feed attachment—the first of its kind to be made—and a glance at Fig. 1 will give the reader an idea of the worm. It will readily be seen that the design of this worm is such that it could not be handled by

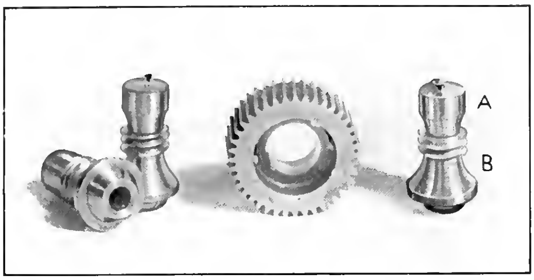


Fig. 1. Worm to be hobbed and the Hob

a circular hob fed longitudinally, and that is the reason a drop feed is used. By calculation, it was found that forty teeth would give a hob of the diameter that would clear the two high points on the worm blank, marked *A* and *B* in Fig. 1, and this number of teeth on the hob determines the entire gearing of the attachment. The worm being of the single threaded type, and the hob used to produce it having forty teeth, it follows that the worm must make forty revolutions to one revolution of the hob. Now then, the chucking spindle holding the worm blank must make forty revolutions to one revolution of the hob, which is driven by an extra shaft geared to the center spindle of the machine at the back or pulley end. Having the ratio given between the speed of the chucking spindle and the center spindle, which in this case is 29 to 36, the shaft *B* in Fig. 3 must revolve at the same speed as the chucking spindle. The 40 to 1 reduction is obtained through the worm on this shaft and the worm-wheel on the hob spindle. In Fig. 3, *D* shows the worm-wheel and *C* the worm keyed on the shaft *B*. On the No. 53 machine fitted up for this job, a 29-tooth pinion on the center spindle drives a 36-tooth gear on each chucking spindle. Therefore a 29-tooth pinion *A* is keyed on the center spindle on the back end of the machine and drives a 36-tooth gear *C* on the shaft *B* as shown in Fig. 4, with any idler *D* that conveniently meshes with the two gears *A* and *C*.

The Feed

The attachment is so designed that the hob starts hobbing the worm as soon as the forming tool begins to form the blank. Since the worm *C* and the worm-wheel *D*, Fig. 3, drive the hob at the required speed, and as their relative positions cannot be changed without altering the speed of the hob, it is evident that the center of the worm *C* must be the center about which the hob spindle oscillates. The worm can drive the worm-wheel *D* keyed on the hob spindle at the same speed in any position of the hob. The hob spindle is carried in bearings on an independent plate *H* which swings back and forth about the center of *C*, Figs. 3 and 5, on the surface of the casting *I* that is bolted down on the screw machine head. A cam *E* is mounted on the forming tool cross-slide to raise and lower the hob. An arm on the casting *H* has a roll *F* that fits in the cam *E*, and thus the raising of roll *F* by cam *E* lowers the hob and *vice versa.*

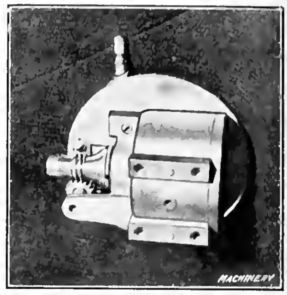


Fig. 2. Worm in Position on Case of Auto-meter

Fig. 6 shows the cam *E* more clearly. From *B* to *A*, the cam lets the hob drop quickly down to the surface of the worm, and this drop occurs when the cross-slide of the machine moves in quickly until the forming tool starts to cut. This action of the cross-slide reduces the time required to feed in by sliding in quickly to the point where the forming tool begins to cut. The tool then has more time to feed in and do the forming at a slower feed, thus producing a more perfectly finished blank. For this reason the cross-slide was selected to feed the hob on this attachment, and obtain the same action for the feed of the hob as for the feed of the forming tool. When the roller *F* has passed up the sharp incline *B*, Fig. 6, the cross-slide is just beginning to feed in slowly and the hob is just touching the blank; then the roller starts up the incline *A* at a slow speed, thus feeding the hob down into the blank to the required depth at a very slow feed. No spring or weight is required to lift the hob out of the hobbed worm, as the cam *C* performs this function by lifting the hob high enough to clear the machine's chucking spindle carrying the hobbed worm, allowing it to swing around a quarter of a revolution to its next position for the drilling operation.

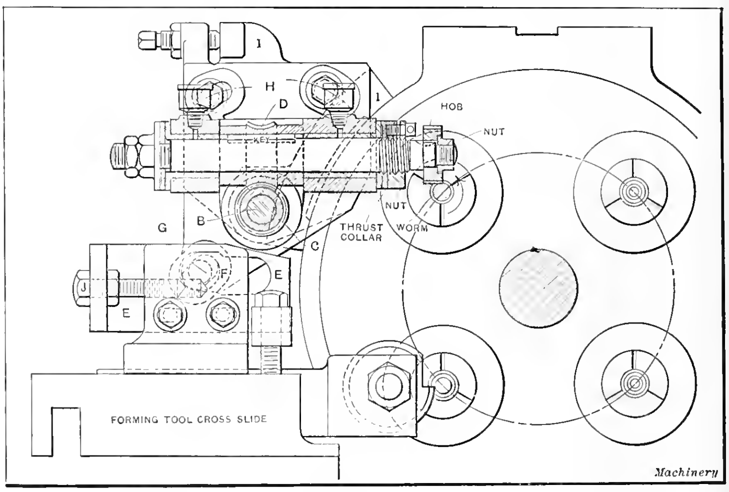


Fig. 3. Arrangement of Worm Hobbing Attachment on Automatic Screw Machine

Not being certain of the accuracy of the scaled dimensions of positions of the machine's parts and the outside diameter of the worm being subject to a change, the cam *E* was made adjustable. By sliding it in or out by the screw *J*, Fig. 3, various diameters of a 0.098-inch lead single threaded worm may be hobbed, providing that the variation does not amount to enough to change the spiral angle sufficiently to interfere

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with the angle the teeth in the hob are cut on. However, considerable variation in the diameter of the worms to be hobbed can be taken care of. The face of the hob being flat and tangent to the worm, there is considerable clearance between the sides of the teeth on the hob and the sides of the threads on the worm in back of the cutting surface of the hob. This clearance increases as the curvature of the worm gets farther from the toothed face of the hob. This is evident, in that the teeth get narrower at the top, and the space between becomes wider.

The hob spindle is made adjustable to compensate for the regrinding of the hob. By loosening the nuts on the back end of the spindle from the steel thrust collar, the clearance may be taken up by tightening the lock-nut on the hob end, thus pulling the spindle forward. The key for the worm-

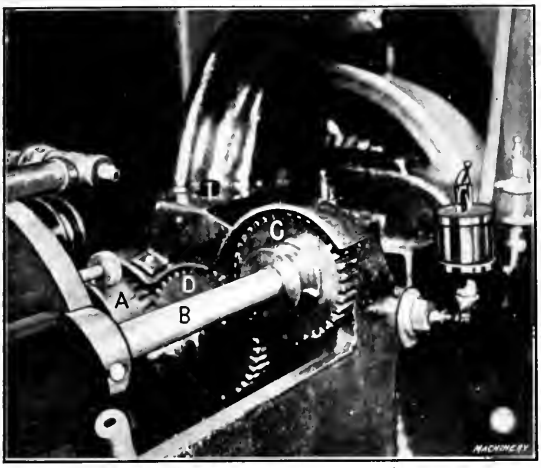

Fig. 4. Arrangement of the Gearing

wheel is solid in the spindle and has ample room between the bearings to allow it to slide in the worm-wheel either way. The spindle runs in hardened steel bushings, the back bushing being clamped in the casting *H* while the front bushing is pressed in. The back bushing is clamped in place because in changing the spindle or taking it down for repairs, this bushing must be readily withdrawn to permit the key in the spindle to be drawn through the bearing boss.

The Making of the Hob

To make the generating hob another hob is required to cut the teeth with, this hob being similar to the one used in hobbing a worm-wheel. In fact, the relation between these two hobs is the same as between a worm and worm-

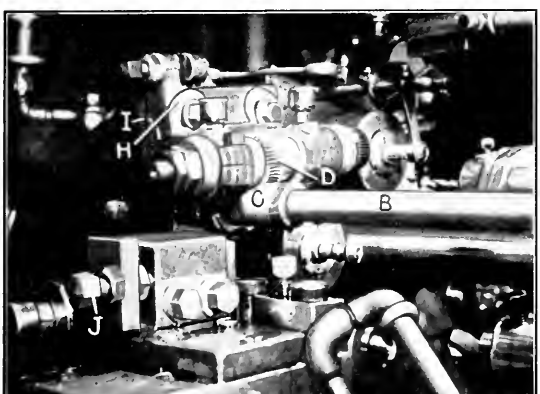

Fig. 5. Hobbing Attachment in Place on Automatic Screw Machine

wheel. This hob for producing the teeth in the generating hob used on the fixture is made to the same dimensions as the worm to be hobbed. It is thus evident that the generating hob will reproduce a worm of the same form of thread as that of the hob that produced the teeth in it. We have, however, a slight exception in this case, in that the hob takes a drop cut in the worm blank, thereby leaving a curve on the threaded length of worm with a radius equal to half the diameter of the hob—in other words, producing a worm somewhat of the Hindley form. No advantage in this shape of worm is gained, however, as the worm-wheel driven by the worm is much smaller in diameter than the generating hob.

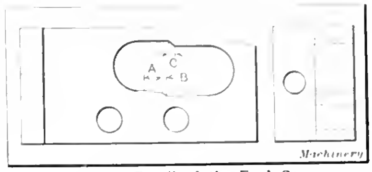

Fig. 6. Detail of the Feed Cam

Fig. 9 shows the worm shaped hob for producing the teeth in the generating hob. It is made up with a standard taper shank to fit the milling machine spindle, and is very substantial at the hob-end to prevent any vibration or spring, although the center may be used when the tool is in operation, thus eliminating all chance of chatter. The threaded length of the hob must be the same as for a hob used for hobbing a worm-wheel of the same dimensions as the generating hob. In other words, if the threaded length of the hob were shorter than the length engaged by the teeth in the generating hob, good results would not be obtained. The thread was cut in a lathe with a 29-degree formed tool, the lead of the thread being 0.098 inch and the depth 0.068 inch. The thread is single, the same as the finished worm. After the thread was cut, the hob was fluted and the top of the teeth and the bottom of the spaces relieved by hand. It was then hardened and tempered. The next step was to make a gashing cutter to gash the generating hob blanks with. This cutter is circular and is of the 29-degree form—

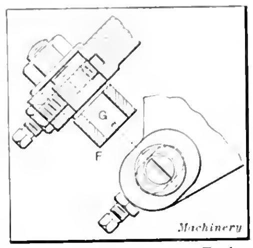

Fig. 7. Detail of the Feed Roller and Arm

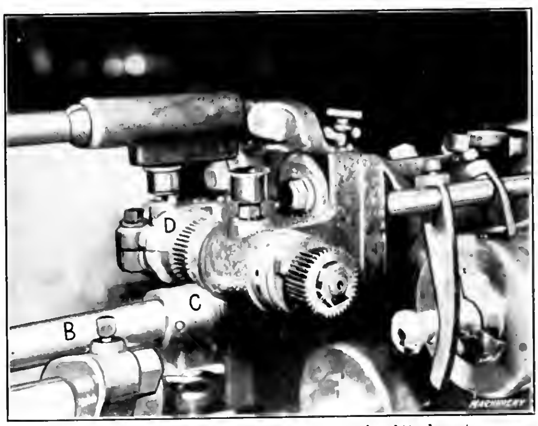

Fig. 8. View of the Hob in place on the Attachment

14 degrees, 30 minutes on a side—with the calculated width of face. Teeth were cut and relieved in it and the cutter was then hardened and tempered ready to gash the blank.

Having the hob and gashing cutter made, we may go ahead and make the generating hob blank. The finished piece is to have forty teeth and the circular pitch is the same as the lead of the worm. The pitch diameter can be found by calculation, but the outside diameter cannot be determined by the calculation used in finding the throat diameter of a worm-wheel of 40 teeth and 0.098 inch circular pitch. This is due to the fact that the dedendum of the worm must be added twice to the pitch diameter of the hob to obtain the outside diameter. In brief, the dedendum of the worm is the addendum of the hob. The hob is designed to stand considerable regrinding. It will therefore "stand up" comparatively long and hob thousands of worms before it must be discarded. Stock is left on to grind by, making the toothed face wider than the length of the spindle bearing

through the center. The difference of the two widths equals the amount that may be ground off before the hob must be discarded. In this case 3/16 inch was left on the flat face to be ground. The toothed face is 9/16 inch wide and the length of the spindle bearing in the center ⅜ inch, thus leaving a counterbore 3/16 inch deep and large enough in diameter to clear the flanged nut that holds the hob on the spindle.

The grinding of the hob after the edges of the teeth have become dull is a very simple matter. Simply lay the hob flat on a magnetic chuck on a surface grinder, with the cutting side up, and grind across the surface. About 0.002 to 0.005 inch is generally sufficient stock to grind off; this will sharpen the cutting edges of the teeth and the hob will be as efficient as ever. A good feature of this method of grinding is that the two faces of the hob are always parallel after grinding; consequently the cutting edge runs true with the spindle. It must be clearly understood that the toothed face has no clearance, being made parallel with the spindle hole in the center. Otherwise the grinding would be a detriment, as the hob would be smaller in diameter after each grinding, and would, therefore, require readjustment of the hobbing fixture. Clearance on the face would also complicate the cutting of the teeth of the hob with the equipment of an ordinary tool-room. I doubt if it could be done successfully. However, it is not necessary, and not enough advantage would be obtained to balance the extra expense and trouble in making a hob of this type. I might add that the Stewart-Warner Speedometer Corporation grinds all hobs of this type on magnetic chucks and has not yet experienced any serious trouble from the hobs becoming magnetized from the chucks.

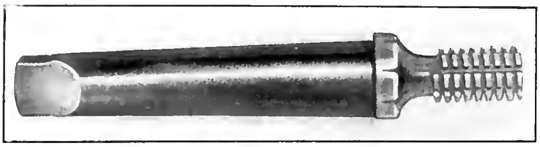

Fig. 9. Worm-shaped Hob for producing the Teeth in the Generating Hob

The gashing of the blank can be done by the usual method employed for gashing worm-wheels with flat faces. This consists of moving the table of the milling machine around to the required gashing angle and feeding the blank across the gashing cutter. When greater accuracy is required, this company employs a different method, as given in the following: Put a plate under the index head, leaving the table set at zero, and swing the plate with the index head around to the required angle. This arrangement allows the table to be fed across in the same plane as the gashing cutter. If the gashing is done by swinging the table around, the blank is fed against the cutter on an angle, thereby getting a gash that is not of the same form as that of the gashing cutter. It must be understood that the face of this hob is flat and not concave, and that it has to be gashed across the entire face at the same depth.

After the blank has been gashed, the index head is set back on the table in its usual position, and the gashed blank placed on an arbor and set up between centers so it can turn freely without any end-play. Put the hob for cutting the teeth in the spindle, raise the blank up to it and enter for the full depth of teeth; then feed across the hob. It is understood, of course, that the worm-hob carries the gashed blank around, similarly to the way a worm carries a worm-wheel around. A mark should be scratched on the blank, so that every time the blank has made one revolution the table can be fed in about 0.020 inch. This method gives a tooth of uniform shape across the entire face. All that is now left to be done is to harden the hob and temper it. It is then ground on the flat cutting surface, ready for use.

* * *

It is stated that liquid air can be produced at the rate of from 3 to 8.5 cubic inches per horsepower hour, according to the apparatus and arrangements employed.

SLIDING ACTION IN BALL BEARINGS

BY M. TERRY*

The popular impression regarding ball bearings is that in order to secure rolling contact, the contact points of the balls on the races should be points on a cone of rotation, the apex of which lies in the center line of the shaft, or that they should be points on the surface of an imaginary cylinder, the elements of which are parallel to the center line of the shaft. These purely geometrical considerations constitute a very elementary analysis, and when our theory is extended to embrace a few laws of mechanics and elasticity of materials, it becomes apparent that there is, perhaps, no such thing as pure rolling action, but only an approach to it; and—other things being equal—the degree of approach to the true rolling action determines the quality of the bearing.

Cup and Cone Bearing

Fig. 1 shows a cup and cone type of bearing with points of contact a satisfying the geometrical requirements. A point may be considered as an area of a circle of an infinitesimal diameter. If the load be applied and the points of contact are to remain mere points we shall have the condition of a measurable load distributed over an infinitesimal area which would result in an infinite stress per square inch. Such a condition is, of course, impossible, and deformation of balls and races will take place with the points of contact gradually widening into measurable areas of contact—probably circular or elliptical in shape.

In Fig. 1, b and c are the limiting points of contact, and whether the line bac be a straight line or a curve, the symmetry of the design suggests that points b and c are equally distant from the axis of rotation of the ball. The ball has a motion similar to that of the earth, *i. e.*, it revolves in an orbit determined by the inner and outer races and at the same time it rotates about its own axis. Assuming that in completing one revolution about the axis of the shaft the ball makes N rotations about its own axis $x—x$ and that there is absolutely no sliding, we can write the following equations:

$$2\pi rN = 2\pi R_1; \text{ and } 2\pi rN = 2\pi R_2.$$

Therefore R_1 should be equal to R_2, which in this type of bearing is a constructive impossibility, and hence sliding proportional to the difference between R_1 and R_2 must take place. Similar sliding action also occurs on the inner race.

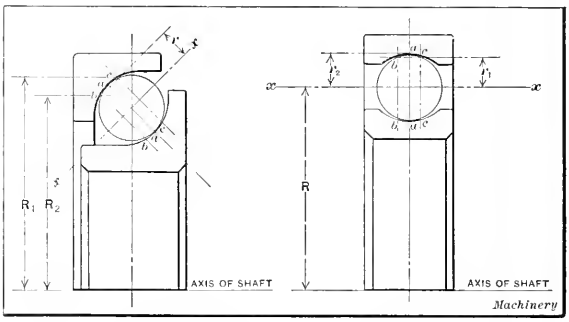

Fig. 1. Cone and Cup Bearing   Fig. 2. Radial Bearing

Radial Bearing

Fig. 2 shows a radial bearing under load. If the lines of contact bac were straight lines, pure rolling action would be possible, but as a rule lines bac are curves the radius of curvature of which increases with the size of the ball. The amount of sliding in this type of bearing depends largely on the ratio $\frac{r_1}{r_2}$; the closer this ratio approaches the value of unity, the less is the sliding action. Let N, as before, represent the number of rotations made by the ball about its own axis while revolving once about the axis of the shaft. Then, from Fig. 2 and assuming pure rolling of points b and a on the outer race, we have:

$$2\pi r_1 N = 2\pi\,(R + r_1) \quad (1)$$

and

$$2\pi r_2 N = 2\pi\,(R + r_2) \quad (2)$$

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Dividing (1) by (2) we obtain:

$$\frac{r_1}{r_2} = \frac{R + r_1}{R + r_2} \qquad (3)$$

This condition of equality can occur only when either $R = 0$ or $r_1 = r_2$. The first is a practical impossibility; the second can be only approached by a good design, fine workmanship, careful selection of materials and their proper treatment. It should be observed that

$$\frac{r_1}{r_2} < 1, \text{ and } \frac{R + r_1}{R + r_2} \text{ is also less than unity.}$$

Applying the same analysis to the inner race we find that for true rolling action

$$\frac{r_1}{r_2} = \frac{R - r_1}{R - r_2} \qquad (4)$$

Since r_1 is less than r_2, we have in practice:

$$\frac{r_1}{r_2} < 1, \text{ but } \frac{R - r_1}{R - r_2} > 1.$$

Thus the greatest amount of sliding occurs on the inner race. In practice r_1 approaches r_2 so closely as to make the amount of sliding almost nil.

Now, to compare the bearings illustrated in Figs. 1 and 2, let us assume workmanship, materials, etc., equally good in both bearings. Then, for the same amount of distortion of the ball the sliding action in Fig. 1 is proportional to $R_1 - R_2$, which is a fairly appreciable quantity, whereas in Fig. 2 it is proportional to $(R + r_2) - (R + r_1)$ or $r_2 - r_1$, which is almost negligible in amount. Thus, so far as sliding action is concerned, the radial type of bearing possesses a great inherent advantage over the cup and cone type, due entirely to the location of the points of contact, whereas a simple geometrical analysis would place the two bearings on a par. There are, of course, other points of difference between the two bearings, but they have nothing to do with either rolling or sliding.

* * *

EXPERIMENTS ON ROPE DRIVING

Very extensive experiments have recently been conducted under the auspices of the Society of German Engineers at the Charlottenburg laboratory. These researches cover a wide field, and of especial interest are those which relate to the influence of velocity. The efficiency in per cent is given under various tensions, showing a considerable decline at low loads. With a tension of 286 pounds in a rope of two-inch diameter, which is somewhat below the tension of 200 pounds per square inch commonly employed in calculations, the efficiency is 98 per cent at 2540 feet per minute and 96 per cent at velocities of 7680 feet per minute. These experiments conform so nearly with discoveries which were made many years ago as to make it fairly certain that with a properly designed installation and with a good grade of cotton rope the high point of efficiency, which by many tables is indicated to be at from 4500 to 4800 feet per minute, may be moved a considerable distance beyond these figures. They also indicate that rope drives can be used to advantage at much higher speeds. Another matter definitely established by the Charlottenburg tests is that idler or jockey pulleys produce a marked loss in efficiency.

The evidence from actual experience, as well as from tests, indicates that it is safe to use proper installations of rope drives up to 7000 feet per minute, and that the power up to this speed will be approximately in direct ratio to the increase in speed. As an example, it may be mentioned that nine ropes of two-inch diameter are regularly conveying a normal load of 880 horsepower at 7200 feet per minute in a large steel works in Germany. This is double the amount allowed by many tables in which too much allowance was made for centrifugal force by the compilers. It therefore would appear that the high speed permissible with rope drives is not limited so much by the rope efficiency and endurance, as by the material in the pulleys being able to resist the centrifugal stresses.

AUTOGENOUS WELDING OR AUTOGENOUS SOLDERING

In a paper read before a recent meeting of the Engineers and Shipbuilders of Scotland Mr. C. B. Desch compared the process of autogenous welding with that of other processes for joining metals. The following paragraphs contain a summary of the remarks made by Mr. Desch. As will be noted, an interesting distinction is made between welding and autogenous soldering, the latter name being preferred by the author of the paper. The term "welding," it was stated, is now somewhat loosely applied. It meant originally the union of two pieces of metal within their plastic range, but below their melting-point, as in an ordinary blacksmith's forge weld. It is now applied, in the term "autogenous welding," to denote a process of union by fusion, either of a part of the metal to be united or of a separate piece of metal used as a solder. Such a process is really autogenous soldering, not welding.

The ideal condition to be reached in a weld is that in which the crystals are continuous from one side of the weld to the other, with no change in the average dimensions of the crystal grains in passing through the weld. This condition requires the complete absence of intervening layers of impurities, especially of oxides, and also the absence of a zone of overheated metal. In true welding, which can take place at as low a temperature as 1150 degrees F., but which, of course, proceeds with much more rapidity and certainty at higher temperatures, there is mutual interpenetration, and, if oxidation is completely prevented, there is no reason why the weld should be weaker than the remainder of the metal. In practice, the weakness so frequently observed is due to incomplete union, readily seen under the microscope. The conditions are somewhat different when any of the high-temperature methods of autogenous soldering are applied. In electric resistance welds, the presence of oxide may be clearly traced along the plane of union, and a zone of very coarse crystallization is obtained.

The process of autogenous soldering with a blow-pipe flame introduces new conditions. Should the flame contain an excess of oxygen, oxide films are produced; with acetylene in excess, a carburized layer may be formed. In either case the joint is bordered by a zone of coarse, over-heated metal. In welding by a carbon arc, local carbonization is still more likely to take place, and the union is often extremely local. There remains the process of thermit welding, in which the two pieces of steel are united by a layer of almost pure molten iron, which alloys perfectly with the adjoining metal. Here, also recrystallization goes on in the immediate neighborhood of the joint, but to a less extent.

The evil effect of overheating may be largely overcome by hammering or forging the weld, followed by a short annealing process. Annealing alone is not usually successful. Imperfect union through the presence of gas cavities or inclusions of slag or oxide, and heterogeneity due to a highly carburized zone, are defects which are not removed by subsequent treatment.

It is not the intention to suggest that autogenous soldering is a process to be condemned. On the contrary, it has a wide field of usefulness, and is, in fact, a necessity for certain classes of work. It must be admitted, however, that a joint made in this way has not the same qualities as the original steel. It is not sufficient to show that fracture does not commonly take place in the plane of union when a mechanical test is made. It is not the weld, but the zone immediately near it, which is injured. Neither are tensile tests conclusive on this point, as the injury to the steel does not always affect the tensile breaking strength, but is revealed when the welded steel is subjected to shock or fatigue. Accounts have been published of boilers which have cracked in places in the course of use, after being repaired by autogenous soldering. When it is intended to use the same pressure as before, and to regard the plates as retaining their original strength, such a practice seems very undesirable. A systematic series of fatigue tests on such repaired plates would be interesting and valuable.

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APRIL, 1914

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THE "FIVE BROTHERS"

Typhoid fever increases the weight of a patient, if he recovers from that malady; and a somewhat similar effect may be produced on the business of this country by the flood of legislation which has been recently enacted. A considerable number of these laws are good and should work out beneficially for the country. The trusts and big corporations have been curbed, which most of them needed; but we have reached the time when working people, among whom may be classed a good many machinery manufacturers, are anxious to saw wood again. Probably only a small number of the readers of MACHINERY are familiar with the legislation known as the "Five Brothers," kin in name only to the "Seven Sisters," a series of bills passed by the New Jersey legislature while President Wilson was governor of that state.

Some of the "Five Brothers" will accomplish desired reforms, and others will interfere with legitimate business, including the machinery business; although recent reports from Washington indicate that several objectionable features will be omitted or changed. One, which at this writing still stands, would prevent a manufacturer from giving his exclusive agency to a dealer and protecting that dealer in his territory so that he can educate his men on the mechanical and selling points of a machine and safely assume the expense of working up a sale. Another clause requires a manufacturer to sell his product at the same price (allowing for freight) in all parts of the country, making him liable if a dealer or agent should grant any concession from the price, such as taking a second-hand tool in part payment. A law of this character might be welcomed by manufacturers if they were allowed to make an agreement for the maintenance of prices with each other and with their agents; but such an agreement would throw them into the clutches of the Sherman law, which expressly prohibits it. These provisions were doubtless intended to prevent discrimination against competitors by trusts and powerful combinations, but some other way should be discovered to accomplish this object that will not harass legitimate manufacturers.

* * *

THE SPIRAL BEVEL GEAR

The development of the spiral bevel gear generating machine primarily for automobile manufacture will probably lead to the use of this type of gearing in other machinery. The spiral bevel gear has the same characteristic as the spiral spur gear as regards smoothness of action. The double spiral or herringbone gear is being used extensively now in machine construction, because of its efficiency and noiselessness. Improved machinery that produces this type in one piece has reduced the cost so that its use is feasible where once it was out of the question.

The spiral bevel gear made by the generating process is nearly noiseless, and when designed for drive in one direction only can be made highly efficient. This high efficiency is partly due to the spiral form of tooth, the inward thrust of which balances the outward thrust because of the pressure angle and angle of face.

The spiral bevel gear may be used in preference to ordinary spiral or helical gears for right angle drives, first because the shafts are in the same plane, and second because of the practical absence of thrust. Whether they will show as high efficiency as the best worm-gears of the same velocity ratio remains to be seen, but probably they will. The matter of lubrication is not so important as with worm-gears, and when there is doubt of the ability to lubricate properly, the spiral bevel type will be at a decided advantage.

* * *

THE STATUS OF GEAR GRINDING

The improvements in automobile design and construction have led to demands for gear durability and accuracy far exceeding anything that had been previously required of gear makers. They soon found that gears made by old-time methods from the ordinary grades of steel would not meet the close limits of accuracy and the physical tests imposed. When it was found that gears hardened by the time-honored methods were sprung out of shape, the natural remedy was to grind the teeth after hardening and thus restore them to true shape. Several gear-grinding machines were built and put into use, but with varying degrees of success.

While the grinding of spur gears is being done, the grinding of bevel gears for rear axle drives is now believed to be unnecessary. The improvements made in steel and in the design of bevel ring gears have produced a practically non-changing shape when hardened in machines provided for holding the gears between plates when dipped. The saving of time and labor is so great and the results are so uniformly satisfactory that the grinding of bevel gears has been abandoned by at least one large concern which had designed and built a machine for the purpose at heavy cost.

There is, however, a field for gear-grinding machines of some importance outside of the automobile industry. Cast spur and bevel gears can be made true and smooth by grinding at small cost, and in the case of cast steel gears used on electric railway motors, the cost is well repaid.

* * *

SPECIALIZED MACHINE TOOL BUILDING

The demands of the large automobile builders for special machine tools will apparently have a marked effect on the trend of American machine tool design within the next few years. Machine tools will be graded in three general classes: First, there will be the adaptable machine tool used in jobbing shops for all kinds of repair work and machine building. These tools will comprise the present types of engine lathes, planers, drilling machines, shapers, milling machines, gear-cutting machines, grinding machines and slotting machines. Second, there will be the more specialized machines, adaptable, it is true, but better suited for manufacturing than jobbing work which may give a dozen different kinds of work to a machine in a week. These machines will comprise the automatic screw machines, semi-automatic chucking lathes, automatic gear-cutters, bevel gear generators, hobbing machines, multiple-spindle drilling machines and broaching machines. Third, there will be purely specialized machines designed and built solely for the rapid production of machine parts of a given size, shape and material. These machines will be built around the past, as it were. The designer will study the part, and design a machine to produce it at the least possible cost of time and labor. Drilling machines that drill forty or fifty holes in four motor cylinders *en bloc* in several directions simultaneously are examples.

ETHICS OF CONTRIBUTING

The position of the editor of a technical journal like MACHINERY as regards publicity of methods, tools and processes is difficult to fill with satisfaction to all classes of readers. The ambitious mechanic wants to learn all about the methods and tools used in the most up-to-date manufacturing plants. The manufacturers, on the other hand, in some cases believe that it is distinctly to their disadvantage to have descriptions of up-to-date methods published. To steer a course that will avoid the objections of the manufacturers on the one hand without disregarding the wants of the ambitious readers on the other, is not always easy.

A letter was recently received from a prominent manufacturer referring to a contribution describing an improved trimming and shaving die. This contribution appeared to the editor to be only one of many good articles published describing improved punch and die equipment, but to the manufacturer whose practice was shown, the publication was a serious, if not a vital matter. He wrote as follows:

> We call your attention to an article by —— ————. This man was formerly employed by us as a toolmaker and had nothing whatever to do with designing the dies which he described. On the contrary, he simply worked to drawings made by our designers, and under the supervision of experts in our tool department. You will therefore understand how this article has been published without our consent, and that the drawings, which are the property of this company, have without doubt been copied and carried away by the writer of the article. You are doubtless aware of the fact that manufacturing methods and the designs of tools and fixtures are very often the result of long study and particular investigation, involving a large expenditure of time and money, and that information of this character must therefore be considered as a valuable asset and as such be carefully guarded and given out only through the proper channels. While we do not wish to imply that you would publish articles of this character were you aware of all the facts, nevertheless, you must agree with us that great injustice might be done to the rightful owners of designs, tools and fixtures if they were given publicity through the medium of trade journals. To our minds this raises a serious question and we shall be pleased to have you advise us whether you do not feel that careful inquiry should be made when an article is offered to you for publication to determine whether your correspondent has a right to use the information which forms the subject of the article.

To one familiar with the editing and publication of a technical journal it would be obviously impracticable for the editor to inquire closely into the antecedents of all contributors and contributions. We must rely on the honesty and good intentions of our contributors in general. MACHINERY is not a market for "stolen goods"; and most, if not all, contributors realize it. But what constitutes stolen goods in toolmaking practice? A toolmaker surely has the right to carry away with him from any plant where he has been employed good ideas in toolmaking, etc. His new employers have a right to expect that years of experience have given him knowledge of the best practice. How is it better for such a toolmaker to give to a competitor the best ideas he has gleaned from his experience than to publish them in a trade journal? In the case under discussion, the contributor probably did not consider that the design was in any sense proprietary, but only a development of punch and die practice right up to the minute. A history of this particular tool would undoubtedly show that hundreds of workmen and various plants had contributed ideas and resources which made its ultimate development possible. This seems to us to be a case where the editor must absolutely depend on the good faith of the contributor for the proper protection of "vested rights."

* * *

The Supreme Court handed down a decision February 27, giving the Wright Co. the exclusive control of ailerons or wing warping devices for aeroplanes. This decision apparently means that the company will absolutely control the aviation field and that none of the builders of heavier-than-air machines can build machines hereafter without a license from the Wright Co. The Wright Co. plans to collect royalties amounting to $1000 for each machine, taxing each machine about twenty per cent of its cost.

BEARING PRESSURES DUE TO THE ACTION OF BEVEL GEARS UNDER LOAD

BY RALPH E. FLANDERS*

The action of a pair of bevel gears under load produces a radial pressure on the bearings due to the tendency of the driver to climb onto the driven gear. The pressure angle of the involute teeth also produces a force tending to push the gears out of engagement. This angular thrust may be resolved into a radial bearing pressure and a direct end thrust on the shaft. The amount of radial bearing pressure and end thrust due to a given load on a given gear may be calculated by rules and formulas presented herewith. We must have the following data: The pitch diameter, with width of face, and the edge angle of the gear, which is the same as the pitch cone angle. These dimensions are shown in Fig. 1. It is also necessary to know the horsepower and revolutions per minute, or the torque in inch-pounds to which the gear will be subjected. The pressure angle of the teeth, *i. e.*, whether they are 11½ degree standard teeth, or whether they are 20 degree or other shape, must be known. It makes no difference whether the teeth are of standard length or of the "stub tooth" variety.

We will evidently get different driving pressures on the teeth, depending on whether we use the pitch diameter at the

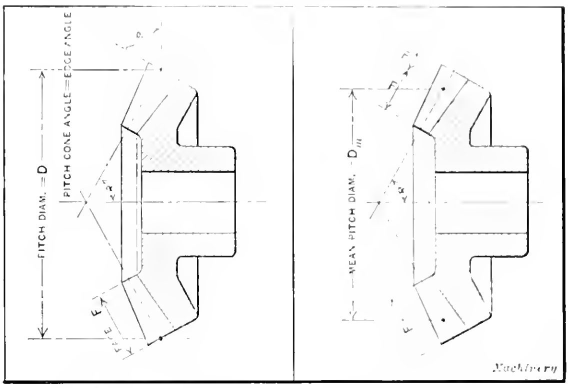


Fig. 1. Gear Dimensions required to determine Radial Pressure and End Thrust

Fig. 2. Mean Pitch Diameter defined for Purposes of Calculation

large end or at the small end of the teeth for our calculations. We should evidently use a diameter somewhere between to get correct results. An accurate calculation would require consideration of the elasticity of the tooth, which would be somewhat complicated. It will be well enough to locate our mean pitch circle at one-third the width of face from the large end of the tooth. The diameter thus located, as shown in Fig. 2, may be considered the mean pitch diameter for the purposes of this calculation. This mean pitch diameter may be obtained either by measuring an accurate drawing or by the following calculation:

RULE 1. *To find the mean pitch diameter multiply two-thirds the width of face by the sine of the edge angle, and subtract the product from the pitch diameter.*

RULE 2. *To find the tangential tooth pressure (which equals the direct radial pressure on the bearing) divide the torque in inch-pounds by one-half the mean pitch diameter.*

RULE 3. *The result obtained by* RULE 2 *can also be obtained by multiplying the horsepower transmitted by 126,050, and dividing by the product of the revolutions per minute and the mean pitch diameter.*

The next step is to find the thrust, due to the tooth pressure and the angularity of the gear, in the direction x x in Fig. 3. This may be done by the regular parallelogram of forces or by calculation as follows:

RULE 4. *To find the angular thrust of the gear, multiply the tangential tooth pressure by the tangent of the pressure angle of the tooth.* (Note: For a 14½-degree tooth the tangent is 0.2586; for 15 degrees, 0.2680; for 20 degrees, 0.3640; for 22½ degrees 0.4142.)

* Address: Jones & Lamson Machine Co., Springfield, Vt.

This angular thrust, as shown in Fig. 3, may be resolved into two components: one, the direct thrust on the shaft (which may be taken care of by a thrust bearing); and the other, an additional radial pressure on the bearing. These quantities may be derived by the parallelogram of forces or by the following calculation:

Rule 5. *To find the direct thrust on the shaft, multiply the angular thrust by the sine of the edge angle.*

Rule 6. *To find the additional bearing pressure due to the angular thrust, multiply the angular thrust by the cosine of the edge angle.*

It is evident from Fig. 4 that the bearing pressure due to the angularity of the teeth is at right angles to that due to the tangential tooth pressure carrying the load. The re-

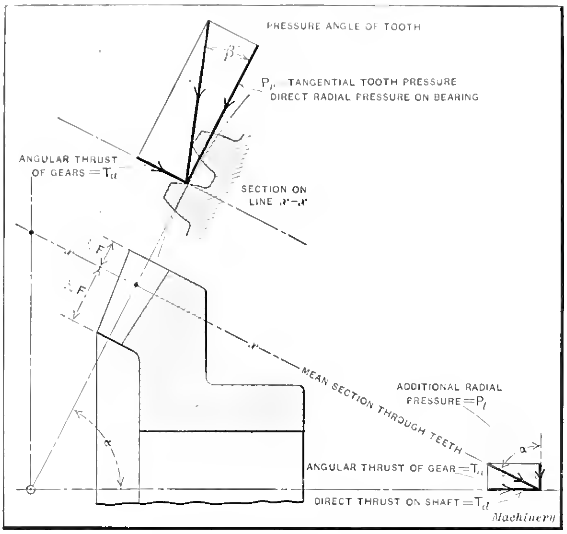


Fig. 3. Determination of Direct Thrust and Additional Radial Bearing Pressure

sultant total pressure on the bearings may be obtained by the parallelogram of forces or by calculation as follows:

Rule 7. *To find the total radial pressure on the bearings, add the squares of the tangential tooth pressure and the additional radial thrust on the bearing due to the angular thrust, and extract the square root.*

The foregoing rules may be expressed in the formulas:

$$D_m = D - 2/3\,F \times \sin\alpha \qquad (1)$$

$$P_r = \frac{2\,M}{D_m} \qquad (2)$$

$$P_r = \frac{126{,}050\,H}{R\,D_m} \qquad (3)$$

$$T_a = P_r \times \tan\beta \qquad (4)$$

$$T_d = T_a \times \sin\alpha \qquad (5)$$

$$P_t = T_a \times \cos\alpha \qquad (6)$$

$$P_b = \sqrt{P_r^2 + P_t^2} \qquad (7)$$

in which

D = pitch diameter;
F = width of face;
α = edge angle (same as pitch cone angle);
D_m = mean pitch diameter;
M = torque or turning moment in inch-pounds;
H = horsepower transmitted;
R = revolutions per minute;
P_r = radial bearing pressure = tangential tooth pressure;
β = pressure angle of involute tooth;
T_a = angular thrust of gears;
T_d = direct thrust on shaft due to angular thrust of gears;
P_t = additional radial pressure on bearings due to angular thrust;
P_b = total radial pressure on bearings.

As an example, take the case of the gear shown in Figs. 3 and 4, whose dimensions are as follows: pitch diameter = 6 inches; face = 1¼ inch; edge angle = 63 degrees 26 minutes; horsepower = 19 or torque = 1500 inch-pounds; pressure angle of tooth = 20 degrees. The radial pressure and thrust on the bearing are found by calculation from the above rules and formulas, as shown below. Graphical calculations giving the same results by the parallelogram of forces are indicated in Figs. 3 and 4.

$$D_m = 6 - \tfrac{3}{4} \times 0.8940 = 5.330 \text{ inches.} \qquad (1)$$

$$P_r = \frac{3000}{5.33} = 562 \text{ pounds.} \qquad (2)$$

$$P_r = \frac{126{,}050 \times 19}{800 \times 5.33} = 560 \text{ pounds (approximately).} \qquad (3)$$

$$T_a = 560 \times 0.3640 = 204 \text{ pounds.} \qquad (4)$$

$$T_d = 204 \times 0.8940 = 182 \text{ pounds.} \qquad (5)$$

$$P_t = 204 \times 0.4470 = 91 \text{ pounds.} \qquad (6)$$

$$P_b = \sqrt{560^2 + 91^2} = 567 \text{ pounds.} \qquad (7)$$

It will be seen from calculation No. 7 that the pressure angle of the tooth has a practically negligible effect in increasing the radial bearing pressure. In the case of spur gears, this effect is so small that the angular pressure need not be reckoned with; and in bevel gears the effect is even smaller, since a good share of the angular pressure is transmitted into thrust. It is, therefore, not necessary in practice to carry the calculations beyond the fifth rule or formula. The total radial bearing pressure thus found is, of course, distributed between the bearings of the shaft, usually two in number, in accordance with the principle of moments (see Machinery's Handbook, pages 338 and 339). The pressure on each bearing resulting from the gear action, as previously calculated, must be combined by the parallelogram of forces in the same way as shown in Fig. 4 with any other pressures arising in these bearings from other gears, belts, pulleys, brakes, or similar loads on the same shaft.

* * *

The first mention of platinum by name was made by Antonio de Ulloa in 1748. The great Ural fields of platinum were discovered in 1803 and then platinum became recognized as a metal of interest and use. Since then the interest and use have been increased by leaps and bounds so that within the last five years the price has increased from $20 to $46 per ounce. The United States now imports $4,000,000 or $5,000,000 worth a year. Platinum is an extremely useful

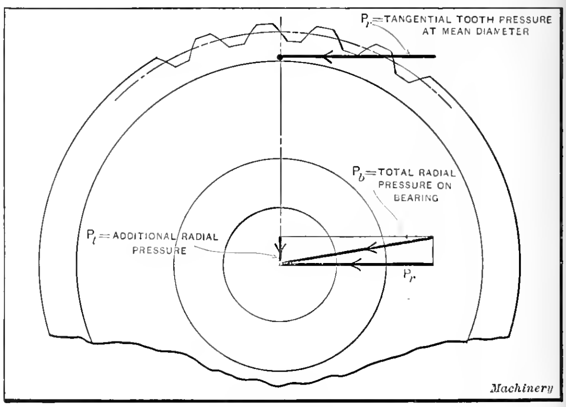


Fig. 4. Determination of Total Radial Pressure on Bearing

metal in the arts and chemists would be helpless without it. Liebig said, not many years ago, that without platinum the composition of most minerals would have remained unknown because the acids that will dissolve the minerals will also dissolve glass or porcelain and the heat required would melt gold or silver. Platinum is melted in a lime crucible, using an oxy-hydrogen blow-pipe. Its specific gravity varies. The higher the specific gravity, the more lasting the polish. Ordinary re-melted platinum has a specific gravity of about 20.3 and a cubic inch weighs 0.72 pound, but the best platinum has a density of 22.669 and the weight of a cubic inch is 0.798 or approximately four-fifths of a pound. Platinum is hardened with iridium, but as iridium costs nearly double as much as platinum, or $85 per ounce, it is used sparingly.

MAKING SPITZER BULLETS*

MACHINES, DIES, TOOLS AND METHODS USED BY THE FRANKFORD ARSENAL

BY DOUGLAS T. HAMILTON†

The methods used in the manufacture of Spitzer bullets or 0.30 caliber cartridges are of an unusually interesting nature. The point of the bullet must be absolutely concentric with the body if good results are to be obtained. If the point is slightly eccentric, the bullet is erratic in its flight and cannot be depended upon to shoot accurately. It is therefore not only necessary to exercise the greatest care in the final operations on the bullet, but the same exactness and careful attention must be followed from the initial operation through to the finished product. The cup, in fact, has to be started just right. The walls must be of equal thickness and drawn straight, as any difference in the length of the cup means, as a rule, a variation in the thickness of the wall. This variation in the thickness of the wall will be apparent in the finished jacket and is somewhat exaggerated in each successive operation, so that the care that must be exercised in drawing makes this work rather unusual in its character.

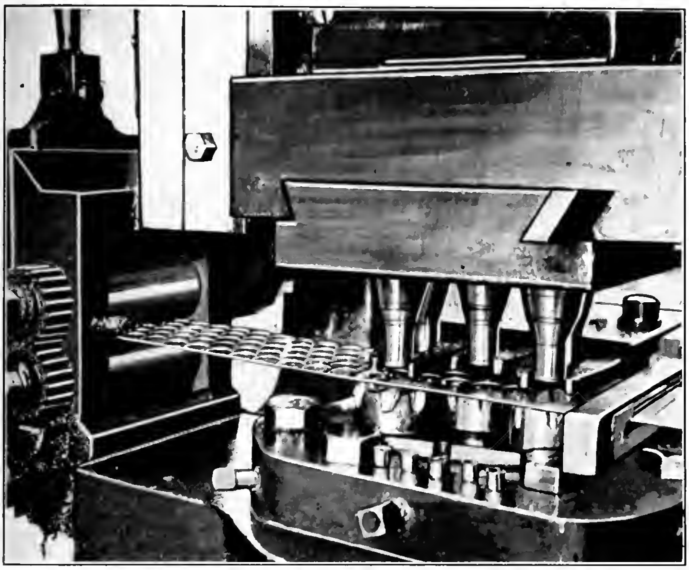


Fig. 1. Blanking, cupping and drawing the Nickel Case for Spitzer Bullets at the Rate of 470 per Minute, using Five Combination Punches and Dies

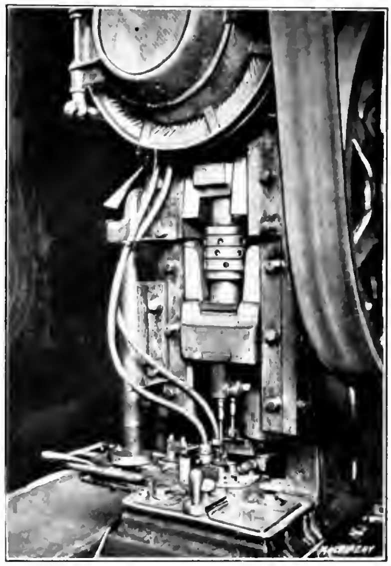


Fig. 2. Type of Drawing Press used for redrawing Nickel Jacket Cases for Spitzer Bullets using Two Punches and Dies

Making Cups for Spitzer Bullets

The cups from which Spitzer bullet jackets are made are produced from stock composed of 85 per cent copper and 15 per cent nickel. This material is purchased in sheet form and comes in rolls about 12 or 14 inches in diameter. In operation, the roll is held on a stand, as was described in connection with the making of the brass cartridge case in the March number, and is fed into a double-action press. When making the cups for the Spitzer bullet, five combination punches and dies, as shown in Fig. 1, are used. These are of the same shape and type as those shown in Fig. 10 of the article referred to, and the press is operated at a speed of ninety-four revolutions per minute, giving a production of 470 cups in this time. In addition to blanking out and cupping, this machine also performs the first drawing operation on the nickel cup. Before any further operations are performed, the cups are annealed, washed and dried and are then ready for the redrawing operation.

Redrawing Nickel Jacket Cases for Spitzer Bullets

The redrawing operations on the nickel jacket cases for Spitzer bullets are accomplished in a drawing press of the type shown in Fig. 2. This machine carries two punches and two dies as illustrated. The punches are carried in a head operated by a crankshaft, and the feeding mechanism is actuated by a cam, receiving power from the crankshaft through a pair of bevel gears and the vertical shaft shown. The cups are placed in a hopper located at the top of the machine in which a wheel carrying pins rotates. These pins pick up the cups and carry them to a receiving chute, from which they pass down through brass tubes made from close-wound brass springs, which carry the cups down to the feeding mechanism of the machine. The feeding mechanism consists of a slide in which fingers are held that grip the cups and carry them forward to the punches, which as the ram descends force the cups out of the fingers and through the redrawing dies. There are three redrawing operations on the nickel jacket case as shown by *A*, *B* and *C* in Fig. 3; this illustration also presents the three redrawing punches and dies used. The redrawing operations are accomplished in a press of the type shown in Fig. 2, which operates at 112 strokes per minute and turns out 224 cups in this time.

Making Lead Fillings or Slugs for Spitzer Bullets

The lead fillings or slugs for Spitzer bullets are made from wire which is produced in the hydraulic press shown in Fig. 4. This lead wire is made from large billets of a composition metal consisting of 30 parts lead and 1 part tin. A group of these billets just as they come from the mold may be seen in the foreground of the illustration. These are cast in an iron mold and are $1\frac{3}{4}$ inches in diameter by $13\frac{3}{4}$ inches long. The machine in which the billets are placed is operated on the hydraulic principle, water being used as a medium for obtaining the desired pressure, and is capable of exerting a pressure of 1000 tons per square inch.

In operating this machine the lead billet is placed on the stand *A*, and as the plunger of the machine ascends after forcing out the metal, this stand also rises until the billet comes almost level with the chute *B*. The operator then disaligns the plunger, as will be described later, dumps the lead billet off the chute, dropping it down into the die of the machine, aligns the plunger, starts up the machine, and as the plunger again descends, it forces the metal out through sizing dies. The metal, in passing out from the large die or billet container of the machine, passes through sizing dies

* For additional information on cartridge making, see "Drawing Cartridge Cases" in the March, 1914, number of MACHINERY and articles there referred to.
† Associate Editor of MACHINERY.

which form the wire to the correct diameter, in this case, 0.280 inch. When the machine first starts to force the lead wire out, the gage indicates a pressure of 600 tons, which gradually drops down to 550 tons as the metal begins to heat up and become softer.

As the lead wire is squirted out of the dies, it passes over a roll *C* and thence through a box *D* filled with constantly running water. This serves to cool the wire and harden it to some extent. From the box of water the wire passes over another roll and up through an adjustable mechanism which is used for winding the wire on the spool *E*. The mechanism for locating the wire on the spool is controlled by a double-pitch worm cut right- and left-hand which guides the arm of the feeding or winding attachment. As the wire in being wound up travels over to one side of the spool, the direction of the feeding or winding arm is changed by a dog which throws the nut into the groove in the worm running in the opposite direction. The worm is driven by gears from the pulley *F*, and the spool is driven from the same pulley through a friction clutch.

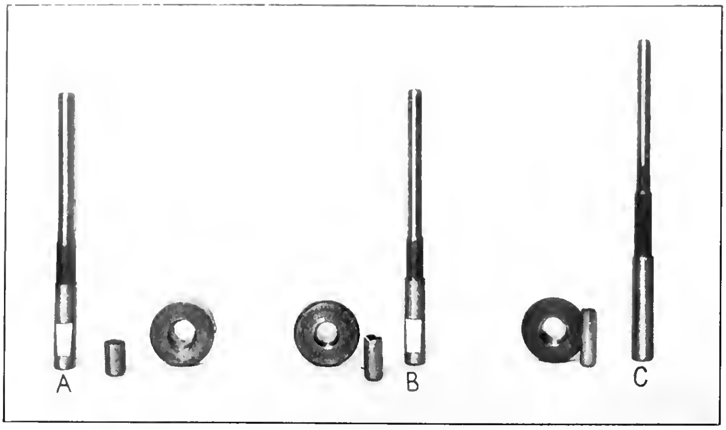


Fig. 3. Sequence of Three Drawing Operations for Nickel Jacket Case for Spitzer Bullets; also Dies and Punches used

To insert the lead billet in the central die of the machine it is necessary to throw the punch out of line with the die so that the billet can enter. This is done in order to decrease the amount of punch travel that would otherwise be necessary, and allows the machine to be operated much more quickly. The mechanism for disaligning the punch is of very simple construction, but is fool-proof. The plunger *G* is thrown out of line by operating the handle *H* and is brought back into line by operating the handle *I*. By looking carefully at this illustration, it will be seen that handle *I* is connected with the mechanism operating the valve of the hydraulic pump, and hence it is impossible to start the plunger on its downward stroke until it is in perfect alignment with the die. This attachment prevents any accident which might happen should the operator fail to align the punch accurately with the die and then start the machine.

Swaging Lead Slugs for Spitzer Bullets

The lead wire produced in the hydraulic machine shown in Fig. 4, after it has been wound on the spool, is taken to the swaging machine shown in Fig. 5, the spool being placed on a stand as illustrated at *A*. The wire passes from this roll down over a number of other small guiding rolls and is forced up by a feeding device located under the machine. This feeding device lifts the wire at each stroke an amount sufficient to produce two slugs. The machine is provided with two dials *B* and *C*, one over the other. The dies in these dials are not used for forming the slugs, of course, but merely act as feeding, or in other words, carrying members. One die in each of the dials *B* and *C* is successively in perfect alignment with the corresponding one in the other dial when the machine is indexing properly. The top dial, which is geared to the lower one, is one-half the size and carries one-half as many dies as the lower one. The lower dial indexes two positions for one index of the upper dial, the latter serving to feed each second successive hole in the lower dial.

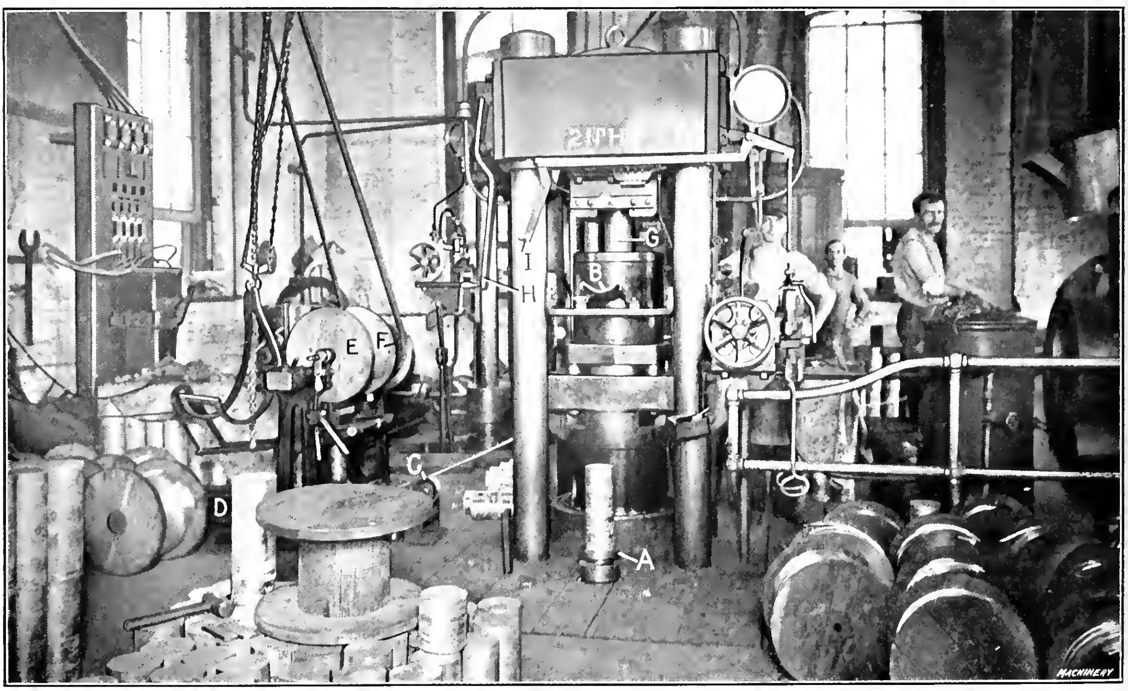


Fig. 4. Hydraulic Press for making Lead Wire, which is used as Filling for Spitzer Bullets

The lower dial, which makes two indexes for every one made by the upper dial, is used for carrying the slugs to the various punches and dies that are used for forming them to the proper shape. There are two sets of punches and dies; the first two punches *D* are used for forming the slugs, the second punches *E* force the formed slug out of the dies,

while the two punches *F* are used as a means of safety. The punch *G* is attached to the knock-off and stops the machine should the wire be feeding short. The last punch *H* knocks out any scrap that may remain in the top dial, and keeps the dies clear. The dies held in the lower dial are used in conjunction with bushings in the machine for cutting off the wire as it is fed up; then the amount of wire fed at each stroke is again subdivided by the dies held in the top and lower dial that work against each other as they rotate. This machine works entirely automatically and when properly set up produces slugs at a rapid rate.

Finish-forming Spitzer Bullets

The most difficult operation in the production of Spitzer bullets is finish-forming them, which consists in pointing the nickel case and making the point absolutely concentric with the body. The type of machine used for this purpose is shown in Fig. 6, where the sequence of operations on the bullet is

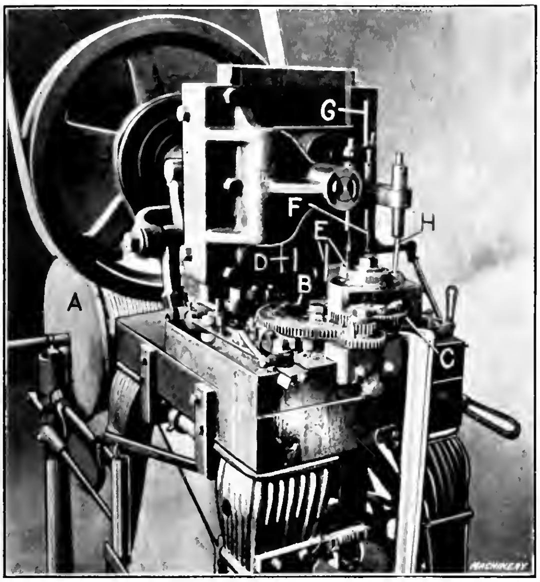


Fig. 5. Swaging Press used for making Lead Fillings for Spitzer Bullets

clearly shown by the samples on the dial. This machine is of the ratchet dial feed type. The nickel cases are located in bushings held in the dial *A* by the operator and are carried around by this medium. The slugs which are held in a hopper at the back of the machine are fed down to the second dial *B*, through a close-wound spring tube. Dial *B* is indexed in a similar manner and in unison with dial *A* and the slugs which are carried in it are forced out and located in the nickel case in the lower dial by means of punch *C* held in the ram of the machine.

Fig. 7 shows the sequence of operations followed in the production of the Spitzer bullet, and also the dies, punches and knock-out pins used. The dies in this case have been sectioned so that their shape can be clearly seen. Fig. 8 shows diagrammatically the operations performed on the

Fig. 6. Machine used for forming the Nickel Cases of Spitzer Bullets and assembling the Lead Fillings in them

Spitzer bullet. Here the relations of the forming punches and knock-out pins to the dies are clearly illustrated. By referring to this illustration, the sequence of operations on the Spitzer bullet will be clearly understood. At *A* the shell is partly reduced in diameter at the point. At *B* the point of the shell is still further reduced and the rounding of the body is commenced. At *C* this operation is carried still further, while at *D* the case is completely formed. In all the operations up to this point, the shell is formed to the shape shown by the punch and die working in conjunction with each other; that is to say, the punch is the same shape as the die, but is smaller in diameter an amount equal to twice the thickness of the walls of the case. At *D* the punch is relieved and only fits the case at the lower or curved portion; however, it follows the case right to the point and is used in connection with the die for forming the point concentric with the body.

At *E* the lead slug is inserted in the nickel jacket case, and it will be noted that the punch cannot pass down into

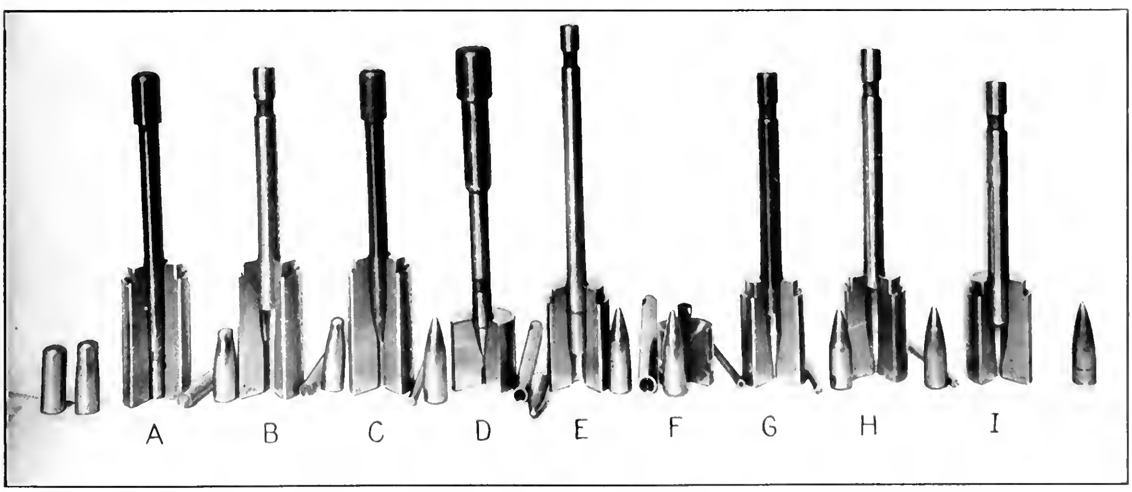


Fig. 7. Illustration showing the Type of Dies and Tools used in the Machine shown in Fig. 6 for making Spitzer Bullets

the shell, but merely rests on top of the lead slug. At *F* the operation accomplished is known as "coning." This is one of the most important operations, as it is intended to make the point of the bullet perfectly concentric with the

body. The die *a* which is used for this purpose only forms the extreme point of the bullet, and does not bear at all on the curved part of the body. These pointing dies are only allowed 0.002 inch float in the holder and must be perfectly in line with the punches. The punches and dies shown from *G* to *I* are used for forming the base of the bullet. These operations consist in turning over the top edge of the nickel case and flattening it down on the lead slug—*J* and *K* show the condition of the nickel case before and after pointing, whereas *L* shows the lead slug and *M* the finished bullet.

The proper setting up of the machine shown in Fig. 6 is an operation that requires some skill. The punches which are held in the ram of the machine must be in absolute alignment with the dies. The pointing dies are only allowed 0.002 inch float in the holders in which they are retained and are set as exact as it is possible to get them. After the machine has been set up, a number of trial bullets are run through; these are then taken out and tested in a special type of high-speed lathe in which the bullet is held true. When put under this test the point of the bullet must run perfectly concentric with the body before the machine can be started on a "run." This test of the bullet is also made

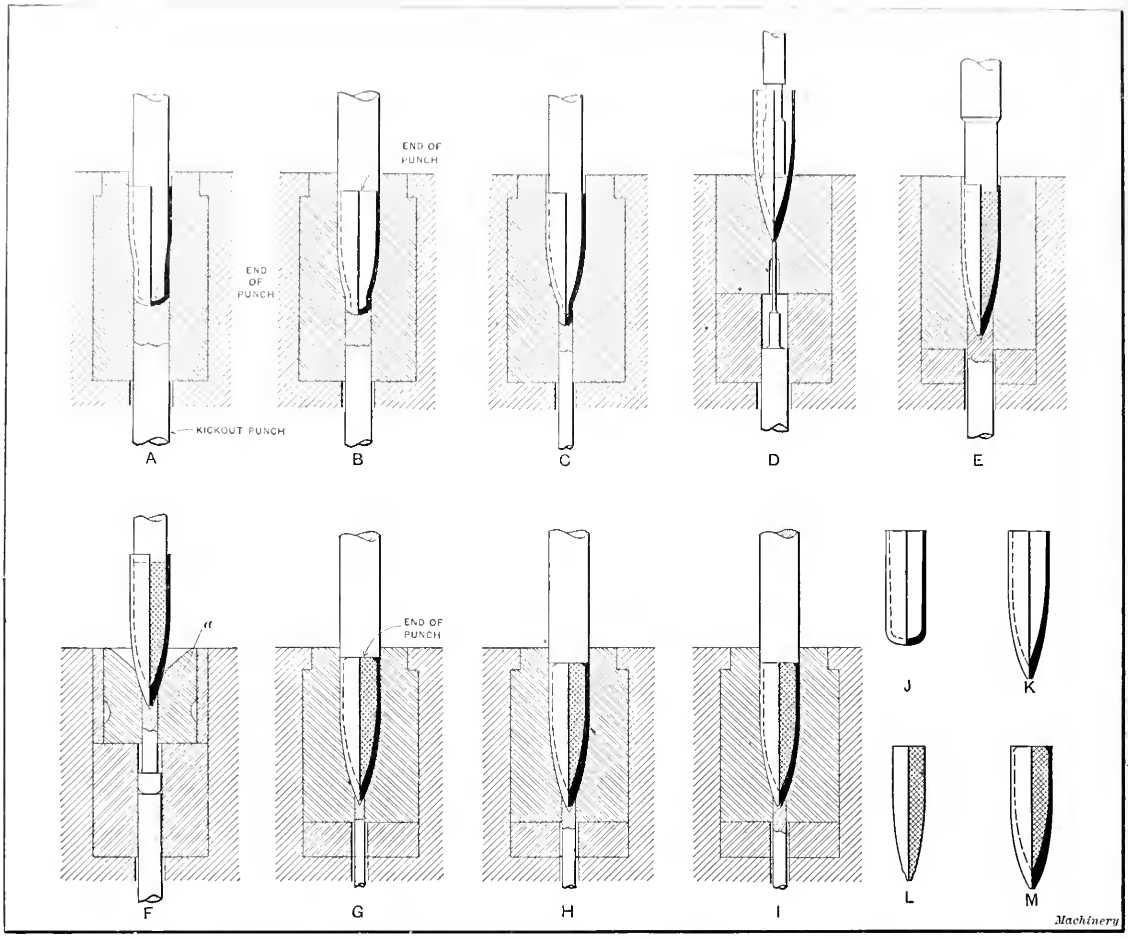


Fig. 8. Diagrammatical View showing the Sequence of Operations in the Production of Spitzer Bullets, and how the Various Tools act in Relation to each other

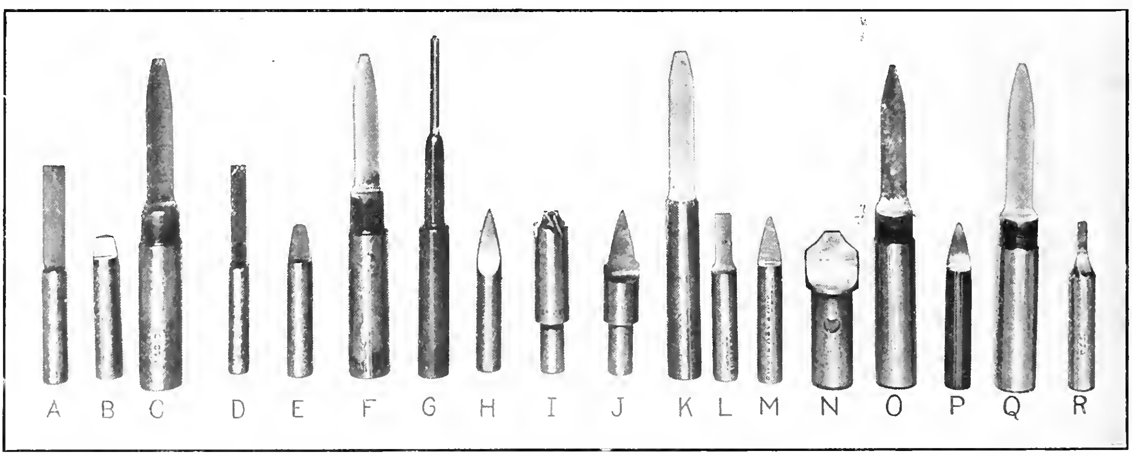


Fig. 9. Type of Tools used for making the Dies for producing Spitzer Bullets, these Dies being used in the Machine shown in Fig. 6

from time to time so that any variation in the setting of the dies will be detected before many scrap bullets have been run through. The making of the dies for bullets of the Spitzer type is considered by cartridge makers to be one of the most difficult propositions in cartridge making. It requires the most excellent tool work and also special care in using the tools, setting them up in the machine and keeping the machine in absolute alignment and perfect running order.

Canneluring and Sizing Spitzer Bullets

In order to provide a means for holding the Spitzer bullet in its proper position in the cartridge case, the bullet is provided with a knurled groove around its periphery near

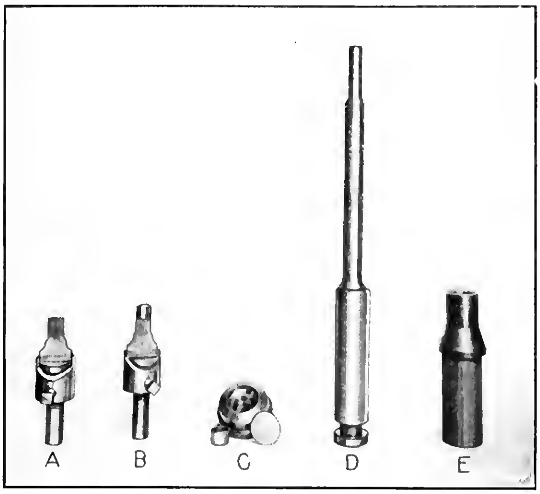


Fig. 10. Combination Blanking Punches and Dies used for making the Nickel Jacket Cups and Tools used for making the Die

the base. This operation is known as canneluring, and is accomplished in the machine shown in Fig. 12. The bullets are dumped into the hopper *A* from which they are conveyed by means of a tapered conveyor screw *B*. Conveyor *B* is rotated by means of a belt *C* running over the pulleys illustrated. The conveyor carries the bullets up to the entrance of the chute *D* which is a close-wound spring, connected with the small hopper forming an auxiliary to the six-hole turret *E* located above the canneluring dial *F*. Turret *E* in which the bullets are dropped rotates and carries the bullets around so that they can be inserted in the dial *F* by means of punches. Dial *F* is also rotated and carries the bullets past

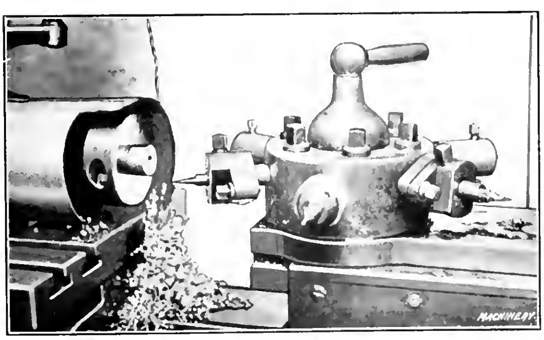


Fig. 11. Making the Pointing Die for a Spitzer Bullet in a Hand Screw Machine

a knurling segment, which produces the small groove in the circumference. As the bullets are cannelured they are forced out of the top dial *F*, pass down through a tube and are located in the lower dial *G*. This lower dial carries the sizing dies, which resize the bullets, this operation being necessary owing to the slight distortion produced during the canneluring operation. The punches for forcing the bullets through the dies held in dial *G* are carried in the slide *H* which is operated by crankshafts *I*. The dial *G* is rotated by a ratchet mechanism receiving power from a fulcrumed lever *J* which carries a roll working in and receiving motion from a groove in cam *K*.

Making Combination Blanking, Cupping and Drawing Dies for Spitzer Bullets

The type of tools used for making combination blanking, cupping and drawing dies for Spitzer bullets is shown in Fig. 10. These tools are of a similar type to those illustrated in a former article. Here *C* is the combination blanking, cupping and drawing die, *E* the blanking punch, and *D* the combination cupping and drawing punch, while *A* and *B* are the roughing and the finishing reamers, respectively, for the die. The information given in regard to the dies for making the brass case also applies to these dies.

Tools used for Making Pointing Dies for Spitzer Bullets

Fig. 11 shows how the pointing dies for Spitzer bullets are made. Sanderson hammered steel is used for making these dies because of its "shock resistance" and also the great hardness that can be obtained without danger of cracking or breaking. The operations in the making of this die which are shown at *D*, Figs. 7 and 8, are as follows: Drill large portion of hole; drill small portion of hole with a No. 68 drill, and insert roughing and finishing pointing reamers.

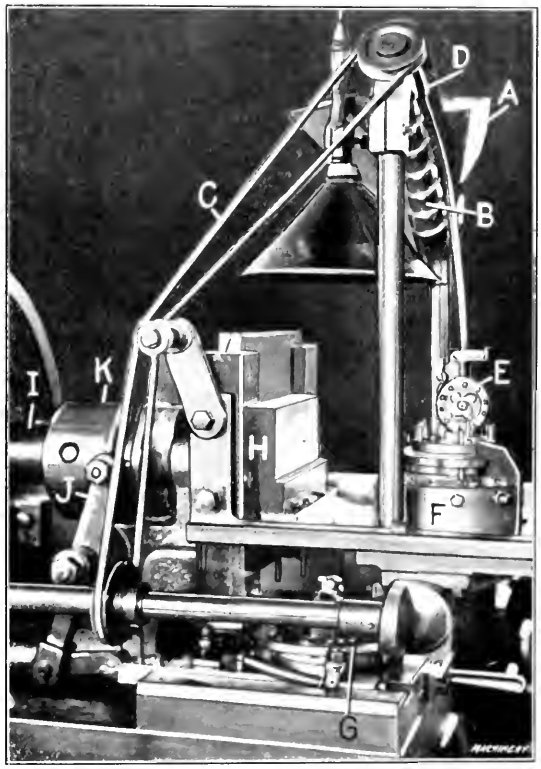


Fig. 12. Machine used for canneluring Spitzer Bullets; also for sizing them

The making of this die represents an excellent example of tool work, as the holes must be in absolute alignment with each other, and the entire curved portion of the hole perfectly concentric throughout.

Fig. 9 shows all the reamers that are used for making the pointing dies shown in Figs. 7 and 8. The names of these are as follows: *A* is the reamer for the first die; *B* is the first and second operation stem reamer; *C* is the reamer for the first and second die shown at *A* and *B* in Fig. 7; *D* is the second operation die reamer; *E* is the second operation stem reamer; *F* is the third operation die reamer, *G* is the reamer for the small hole in the third operation die; *H* is the first pointing die reamer; *I* is the countersink for the mouth of the pointing die; *J* is the pointing die finishing reamer; *K* is the "slug die" reamer; *L* is the slug die stem reamer; *M* is the coning die stem reamer; *N* is the coning die reamer; *O* is the hump die reamer; *P* is the hump and base

stem reamer; *Q* is the base die reamer; and *R* is the base die stem reamer. It will be noticed by referring to this illustration that practically all the reamers are of the "spoon" variety. This type presents only one cutting edge to the work, but is easily made and can be gaged with less difficulty than a fluted reamer. It is also readily sharpened, being stoned only on the top flat face.

* * *

COMBINATION HEAT-TREATING FURNACE

BY ALLOY

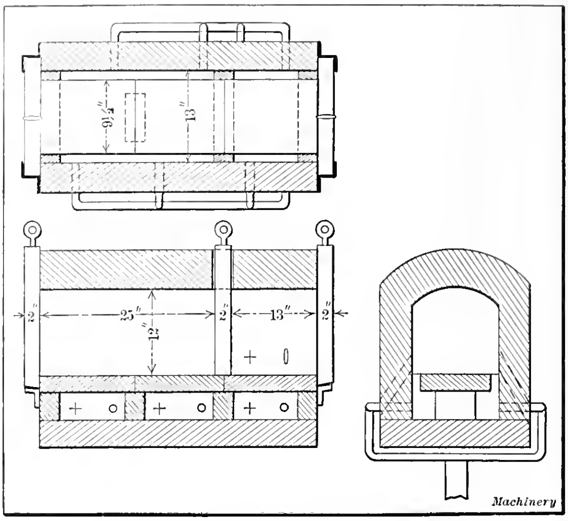
The company by which the writer is employed went to considerable trouble in looking over standard types of heat-treating furnaces in the hope of finding an equipment which would meet existing requirements. We were badly in need of space, and as the range of our work to be heat-treated is quite extensive it appeared that two furnaces were really necessary. At the same time, we were trying to find one furnace which would meet all requirements. The conditions will be better understood when it is known that the range of work to be handled includes milling cutters $6\frac{3}{4}$ inches in diameter by $1\frac{1}{4}$ inch face width and arbors 30 inches in length as well as the general small jobbing work usually encountered in repair shops. The cutters to be hardened are of high-speed steel, while the arbors are to be carbonized.

We considered the case from various angles. It appeared possible to meet the requirements with two standard furnaces, using a casehardening furnace for pre-heating the high-speed steel cutters, and having a second furnace for the high temperatures required for hardening. We also considered the possibility of saving space by eliminating the pre-heating process and using a single furnace for all the work. Allowing for the use of carbonizing boxes, it would require a furnace 40 inches long to handle the arbors, and it soon became evident that this idea was useless because of the excessive cost of fuel when treating small work and of maintaining a furnace of this size under the wear and tear of the high temperatures for hardening high-speed steels.

Interviews with furnace men were far from encouraging. They all derided the idea of getting one furnace that would handle our range of work, and ridiculed any suggestion about making a special furnace for the purpose. As it became evident that we could not buy a suitable furnace, the writer finally set out to build one to meet the requirements of the special work to be heat-treated. The furnace finally produced is shown in the accompanying illustration, from which it will be seen that there are two compartments separated by a partition 2 inches thick. When this partition is lowered there are two independent furnaces, one of which is 13 inches long and the other 25 inches long. The small compartment is provided with extra burners to give the high temperature required for hardening high-speed steel. There are also six burners—three on each side of the furnace—each of which has an independent valve so that each burner can be regulated irrespective of the other five. To obtain an even temperature all through the furnace, all of the valves are thrown wide open, and the regulating is done by the main gas and air valves. When the larger compartment is not in use, the four valves for heating this compartment are shut. The air and gas are mixed before entering the main pipe which leads to the burners, and in this way an even mixture can be obtained.

It will be seen that there is a door at each end of the furnace so that the two compartments may be used independently; this does away with the necessity for raising the partitions except when it is desired to move work from one compartment to the other or to handle work which requires the entire size of the furnace. The doors and partitions are raised and lowered by means of cables which connect with counterweights. This type of door has been criticised by some people because in the event of an explosion there is no outlet for the pressure. With a hinged door, the pressure resulting from an explosion will blow the door open, thus allowing the pressure to expend itself. In the present case, however, the correct mixture of gas and air is insured before the doors are lowered. So far, no trouble has been experienced, and it may be mentioned in favor of this type of door that it is found extremely useful when it is required to heat-treat the ends of pieces that are too long to go into the furnace. In such a case, the work is pushed into the furnace and the door lowered on it. This keeps free air away from the heated part of the work and does away with the danger of damage from oxidation.

A hinged iron leaf is provided at each end of the furnace which can be swung out of the way when it is not required. When the leaf is in position it comes flush with the top of the bed of the furnace. When removing the work from the furnace these leaves are found very helpful, particularly when heavy carbonizing boxes are being handled. The box can be dragged out of the furnace onto the leaf, where it is more convenient to obtain a good grip on it. Men who have experienced trouble in getting hold of work while it is still in the furnace will readily appreciate the value of this attachment. The bed of the furnace is made in three equal sections and we usually keep two or three extra sections in stock. The small compartment is used for work requiring extremely high temperatures, and this end is also used for a variety of odd jobs. As a natural result, the bed at this end of the furnace gives way before the opposite end is worn out. The worn bed can be easily taken out and replaced whenever necessary.



Combination Heat-treating Furnace for Carbonizing and Hardening Operations

The end view of the furnace shows the positions of the extra burners for heating the small compartment. The horizontal burner on each side is one of the six regular ones which heat the furnace. The inclined burners are the two extra ones which are used to raise the temperature of this compartment sufficiently for hardening high-speed steel. These extra burners throw their heat above the bed at such an angle that the flame does not strike the work, but strikes the top of the furnace, from which it is deflected in a way to give the best possible results. In handling the large high-speed steel cutters referred to in a previous paragraph, the work is laid in the large compartment and uniformly pre-heated to a temperature of about 1800 degrees F. The partition is then raised and the cutters drawn through to the small compartment, in which the temperature of the work is quickly raised to 2200 degrees F. The work is then taken out and plunged into an agitated oil bath. From the pre-heating to the final compartment, the work does not come in contact with the air, so that there is no possibility of damage from oxidation. For small work, it has been found very handy to use two sizes of boxes for carbonizing, one $9\frac{1}{2}$ inches round and the other 12 by 9 inches. For a small odd job, one of the boxes will go into the small end of the furnace. When there is enough small work to fill two boxes, the large end is used.

PATENTS—SOME ESSENTIAL FACTS FOR THE ENGINEER*†

INFRINGEMENT—PATENT OFFICE PRACTICE—VALUE OF PATENT—SCOPE OF PATENT

Most engineers, designers and mechanics will find it of great practical advantage to know something about patents and the elements of patent law. Such men are engaged in all sorts of industries and simply cannot afford not to know something about these subjects, because our factories are making patented articles on patented machines to a great extent, and the men working in or for those factories are trying to increase production or get more business, or at least to make sure to keep their own jobs and get better ones, perhaps.

Now, as a designer or experimenter, you may make something new, and the question will come up whether you or the company you work for ought to try to protect it by a patent. Or it may be found that a competitor has patents covering his articles, or makes the same thing you do more cheaply or better through the use of a patented process; and in either case it may be up to you to improve your own product or process to compete successfully. You will have to consider how to get around his patent and, if possible, make something better or at least different from his, with good talking points of its own to help the sales force. Maybe what you do will amount to invention and deserve patenting. You may be called on as the engineer or executive of a plant to determine the value of a patent which someone wishes to sell you, or give you a license under; or you may have to appraise the assets of a company, which are made up in part of good will, patent rights, and the like. Possibly you may have an opportunity to act as an expert witness in a patent infringement suit. In all of these relations you will probably have the aid of a patent lawyer, but nevertheless a clear general understanding of the subject should be of considerable value.

The making of inventions and the American patent system, which has encouraged inventing more than that of any other country, have been tremendous factors in our industrial success. Patented improvements are constantly making many things better and cheaper. For example, the price of sulphuric acid is about fifteen times less than it was in 1807, and about one-half of what it was in 1870. And there would not be many inventions if patents were not granted, since few people work hard on new things except when they are stimulated by the hope of substantial reward. Under our present system, Americans are always willing to try out new ideas, to see if they will work. That reminds me of the small boy who had the investigating spirit. He came home from Sunday school and went right upstairs, and presently his mother heard an awful splashing. So she went up, and there he was standing in the bath tub with all his clothes on, and water all over the floor. "For goodness sake, Willie, what are you doing?" she said. "Why, mother," he replied, "they told us in Sunday school about the Lord walking on the water, and take it from me, it's some stunt." Of course, he didn't mean to be sacrilegious.

What an Engineer Ought to Know about Patents

In considering what an engineer ought to know about patents, the subject opens up roughly, under these heads: (1) What a patent is, how it is obtained, and what it purports to give you; (2) how to determine the scope or value of a patent; (3) when it is worth while to make an invention and secure a patent on it; and (4) how in a general way to make use of a patent to get value out of it.

First, then, a patent is a grant in the nature of a contract between the United States and the inventor. The government gives the inventor the exclusive right, for seventeen years, to make, to use, and to sell, whatever it is that is covered by the patent. No one else can make it, or use it, or sell it, without his permission. If they do, they are infringing the patent, and he can bring suit to stop them, *i. e.*, get an injunction against the continuance of their infringing operations. He can also collect three-fold damages for what they have done, or the profits which they have made by the infringement. The inventor, in return for this monopoly, makes his invention public, by clearly describing it in his patent, so that the public are taught how to practice it; and at the end of seventeen years the patent runs out, and then every one is free to practice it. The inventor might have kept his discovery a secret. That is why the United States gives a monopoly for seventeen years in return for his disclosure of the invention to the world, by means of the patent.

In order to be patentable a thing must be novel and useful; and the exercise of the inventive faculties must be involved in the production of it, as distinguished from simple mechanical skill. No general rule can be laid down to define when the making of a new thing involves invention, although there are many rules as to when it is not invention. But the distinction from an older thing must be more than mere excellence in workmanship, or the improvement which would naturally occur to a skilled engineer or workman in that line. For instance, the patent which covered the first circular saw mill adapted to sawing logs was declared invalid by the supreme court, as not amounting to invention, since they found the patentee had merely made a larger machine like earlier ones which were adapted for sawing laths.

As to the form of a patent, it is made up of a specification, or a describing part; and at the end there is a claim, or usually a number of claims, which state in a very concise way exactly what it is that is protected by the patent. For example, a claim for a new chemical product: "As a composition of matter; a phenol-methylene condensation product containing a halogenated phenolic substance incorporated therewith, substantially as described." You will notice that this describes what the invention actually is, instead of enumerating its advantages, which are stated in the body of the specification.

Patents may be taken out for new inventive compositions of matter, like the above; for apparatus or machines; for articles of manufacture, such as a new kind of phonograph record having a different kind of record groove formed on it; and for new processes. Not all processes are patentable. For instance, the mere statement of a law of nature is not. In the patent of S. F. B. Morse for the telegraph, the eighth claim was held void by the supreme court, as being merely for the use of an electric current for marking intelligible signs at a distance. He did not discover the electric current, and claiming just one principle of nature, as he did in that claim, was held unpatentable. If his process, as claimed, had been for the use of several laws of nature, in an orderly manner, to produce a new result, it would have been patentable. The use of a series of steps involving chemistry, light, electricity, or other natural sciences; or of a series of steps, all working to the same end, and which may be performed by hand or by different mechanisms, may be patentable as processes. A case in point is the art of weaving, when it was new. Claims for a machine cover a number of parts which work together to produce a new result. It doesn't matter if all or some of the elements of the combination are old by themselves, so long as the combination of them is new, and makes a new result, which is not obvious. But if the elements of the claim do not cooperate together, the claim is an aggregation, and unpatentable. For instance, the man who first put a rubber on the end of a lead pencil had his patent knocked out, since the court said both the pencil and the eraser were old, separately, and they acted separately, whether they were joined together or not.

What Constitutes an Infringement

The claims show what is protected by the patent. It is infringed by any device which one of the claims describes. If the claim has some elements described which are left out of the other device, it is not infringed by it. For instance, a claim for a machine might include a part that had to be

* For additional information on the subject of patents and kindred matters see "Filing Your Own Patent," by Ford W. Harris, published in the February, 1914, number of MACHINERY, and other articles there referred to.
† Address by Dyer Smith presented to the students of Lehigh University, South Bethlehem, Pa., January 9, 1914.

moved periodically, and a spring for moving it. That would not be infringed by a machine that left out the spring, and depended on gravity. But it would be infringed if a weight was substituted for the spring, in most cases, as that would be the recognized equivalent of the spring. If the patent stated that it didn't matter whether the part was moved by a weight or a spring, or by the positive actuation of another part which was clearly described, and then the claim included broadly "means" for moving the part, it would be infringed by any of these devices.

To get a patent, the application is prepared and filed in the patent office together with a filing fee of $15. The application consists of a petition; an appointment of an attorney to represent the applicant, unless he wishes to prosecute the application himself, as he has the right to do; the specification, describing the invention clearly and fully in connection with drawings if it is such an invention as can be illustrated by drawings, and having at the end a number of claims, as previously described; and an oath. A patent is a highly technical instrument, and its value depends chiefly on the skill with which it is written and prosecuted before the patent office, and particularly on the way the claims are worded when the patent is finally allowed. Therefore, it usually does not pay to attempt to do without an attorney, or to employ an attorney of doubtful standing or ability.

The patent is to be applied for by the real inventor, alone, if he made the invention by himself; and by two or more persons, jointly, if they made the invention jointly. If one man makes the invention and another puts up the money, they must *not* apply for the patent jointly, since, if it can be proved later that it was not the joint invention of both of them, the patent will be invalidated. So, also, the application must not be made in the name of the employer or superior of the inventor. But the employer is the real inventor if he conceived the invention, gave it to the employe to work out, and told him what to do; and the employe, in putting it into practical form, did no more than any good mechanic or chemical worker would do under the circumstances, in employing common knowledge. In this case, the employe may exercise invention in improving on the conception of his chief; and then two applications might be filed: one, on the broad idea, in the name of the chief and the other, on the improvement, in the name of the employe.

Similarly, if the invention is really the joint effort of two or more persons, the patent should be applied for in the name of all, since if it can ever be shown that the patent was taken out by less than all the inventors who jointly made it, it is invalidated. An invention is made jointly by two or more people when its conception and working out is the result of their joint effort. One suggests some features and the other, other features; and these different features cooperate in the operation of the complete machine or invention, and both men work out these features together.

I may say here, in passing, that many large corporations employ regular staffs of experimenters and inventors; and most of these concerns have contracts with these employes, which provide that the latter are to assign to the company all inventions made by them in the regular course of their employment. If the employe makes an invention at home, or away from the company's plant and out of hours, or on something not connected with his regular employment with the company, it belongs to him, unless, perhaps, he has contracted absolutely to assign to them everything he invents for a certain period. If there is no contract at all and you make an invention in the line of your regular work, for a person or corporation, the title to the invention remains in you and you cannot be compelled to assign it to your employer. In this case, however, your employer has a shop-right to the invention, or a license to make, use or sell the invention without paying you royalty. On the other hand, if you have taken out a patent, he cannot prevent you from licensing other parties to make, use and sell the patented device, or from selling the patent outright, subject to your employer's license, or from making, using and selling the device yourself. Of course, if you were employed by some concerns, and did these things, you might lose your job, which is a point to be considered.

Another point to be noticed is that if you have no written contract to assign your inventions to the company, but you always have done so and it is expected of you, there may be an implied contract so that they could force you to do so.

The Practice of the Patent Office

To return to the matter of securing the patent, we will assume that the application papers and drawings, with the filing fee of $15, are filed in the patent office. There are forty-odd different examining divisions in the patent office, in each of which are examiners who examine only certain particular classes of invention, and your application goes to one of these. For instance, if your invention is in wireless telegraphy, it is placed on the desk of a man who spends all his time in acting on wireless telegraph applications. In a month or more, or maybe less, he reaches your case, reads it, notes certain objections or criticisms, and proceeds to study the claims. He compares these, separately, with his knowledge of what has been done before, and searches the files of patents relating to wireless to find an anticipation for the invention expressed in each claim. He has at his command all the wireless patents of both the United States and foreign countries, and all the technical magazine articles and books of the world, relating to wireless, all classified according to the different subdivisions of the subject.

After his search, the examiner writes a letter, in which he probably rejects some of the claims, in view of certain earlier patents. The inventor, then, through his attorney, studies this action and amends the application, canceling some of the claims, perhaps, changing others somewhat, adding new ones, and arguing that others are all right as they stand. In course of time the examiner answers this, either by allowing the case or by again rejecting certain claims; the attorney answers again, and this process is kept up until either the case is allowed or finally rejected. If this latter happens, the inventor has several appeals permitted him to the Board of Examiners in Chief, then to the Commissioner of Patents, and then to the Court of Appeals of the District of Columbia.

It may happen that the application which you have filed covers the same invention, in whole or part, as other applications of other inventors which are pending before the patent office at the same time. For example, Alexander Graham Bell filed his first application for a patent for a telephone in February of 1876, on the very day that Elisha Gray filed a caveat covering the same general idea.

When two or more patent applications are pending before the patent office at the same time, the office determines to which one the patent should be issued by means of a proceeding known as an interference. This is started by the examiner arranging for a claim or claims in the same language to be adopted in all the interfering applications. In due course of time, if the interference is contested, testimony will probably have to be taken to determine who is the real inventor. It is not simply a question of which man files his application first in the patent office because if the opposing inventor had, for example, actually built the machine and tested it, or otherwise practiced the invention at an earlier date, he would be likely to win. It may be quite a complicated matter, but the main dates involved are, first, when you conceived the invention in your mind; and second, when you reduced it to practice by actually making and testing it successfully or, what is counted as the same thing, by filing an application on it in the Patent Office.

If you file your application before the other man has conceived the invention or done anything, you win, of course, without more ado. But if he reduced it to practice by actually making and testing a specimen of the invention before you did, and before you filed your application, he wins. If, however, you can prove that you conceived it first and worked steadily and diligently on the idea, perfecting it and making it practical from before the time your rival entered the field until you reduced it to practice or filed your application, you win. This shows the great advantage of keeping accurate records of what you do in conceiving and perfecting an in-

vention, and signing and dating all your sketches and records and having them witnessed, preferably by someone you trust, who can understand the invention and to whom you describe it. It also shows that if you have something that seems valuable and you have not or cannot reduce it to practice, you should file an application as soon as possible, since your delay, if not excused, may cause you to lose an interference, if you should get into one.

The Protection that a Patent Affords

As to the question of what protection a patent purports to give you; it gives you the right to exclude everyone else from making, using, or selling the thing patented, without your permission. It does not, necessarily, give you the right to make, use and sell the thing yourself, although it is a very common mistake to think that it does. You may not be able to make, or use, or sell, your own invention—even though you have a perfectly good patent on it—because your invention may be an improvement on an earlier patented invention, and the use of yours may infringe the claims of the earlier patent. To illustrate: Alexander Graham Bell was granted the first patent in telephones, and this was of an all-embracing character. The courts held that Bell had discovered, and that his patent in 1876 pointed out, the great principle that electrical impulses, induced by the vibrations of a current produced by sound waves, correspond in form and character to the sound vibrations which they represent. This is embodied very broadly in a claim in his patent, as follows. "The method of and apparatus for transmitting vocal or other sounds telegraphically as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

In the course of time it developed that this claim was so broad as to dominate the whole telephone industry. Practically, no improvement in the telephone could be used without using Bell's invention and infringing his patent until the end of the seventeen-year life of the patent. It was what is called a pioneer patent. Bell's actual device was crude, of course, and later inventors improved on it and took out patents on their improvements. For instance, Edison invented and patented the carbon transmitter. This was a long step in advance, for Bell's first telephone, using a magneto instrument like the present receiver for both transmitter and receiver, was much too faint. Edison's patent was a pioneer patent so far as transmitters of the carbon, or variable resistance type go; but it was merely an improvement on the broad invention of Bell, and Edison's transmitter could not be used without infringing the broad claim of Bell's earlier patent, since using the carbon transmitter in any telephone system would cause electrical undulation similar in form to the vibrations of the air accompanying the vocal sounds of the person using the telephone, as claimed by Bell. Therefore, Edison could not use his invention without Bell's permission. Also, neither Bell nor any one else could use Edison's transmitter without his permission. And when later inventors improved on Edison's transmitter, they could not use their improvements without his permission, if using or making their improvements involved using or making the combination of elements claimed in the Edison patent; and at the same time, neither Edison nor anyone else could use their patented improvements on the Edison transmitter without permission.

All this shows that before you buy a patent, or build a plant to manufacture something under a patent, you should first make sure that you are free to use your own patented device or process. A good patent lawyer should be employed to make an infringement search, and report to you what your rights are. Maybe all of the earlier patents in your line having broad claims have run out. Or maybe, while some of the earlier patents have pretty broad claims, your invention reaches its result in an entirely different way and does not infringe any of the claims of the earlier patents. Or you may find that while some of the earlier patents have claims which you seem to infringe, they are, as a matter of fact, broader than they had any right to be because of what was already old at the time they were taken out. In this case, the earlier patents will have to have their claims narrowed by construing their language to mean only what the patentee really did invent, and in that case you may not infringe. Or your lawyer may tell you that you infringe some patent with the exact device you intended to make, but that if you make certain changes you will escape the patent. Or it may be that you cannot get around some broad earlier patent at all, and then, if you cannot show that the earlier patent is invalid for some reason, you will have to either sell out or take your chances of not being molested, or else just keep the patent for what it may be worth to you to prevent competitors from using your patented improvement.

The Scope of a Patent

The scope or value of a patent, as you will now readily understand, depends largely on the claims. The claims are broad when it is hard to get around them and narrow when it is easy to get around them. As a general rule, the more details that are set forth in a claim the narrower it is, because competitors can supply other details or leave some of them out, and so avoid infringing. The Bell telephone claim was very broad, because it covered the method and apparatus necessary for telephone communication in its essentials, without being limited to any details. If Dr. Bell and his attorney had not realized the true fundamental scope of his invention, and had claimed it only by its details, it could easily have been gotten around and the Bell companies would not have had the monopoly they did for the life of his first patent. For example, Bell might have claimed "Apparatus for transmitting vocal or other sounds telegraphically, consisting in an electrical circuit, connecting two distant points; a magnet situated at each of said points, the coils of which are included in said electrical circuit; a diaphragm of soft iron positioned to act as a vibrating armature for each magnet; and a mouthpiece in front of each diaphragm, whereby vocal or other sounds impinging on either diaphragm cause electrical undulations similar in form to the vibrations of the air accompanying the said sounds to pass over the line to the distant coil, substantially as set forth."

That would claim the invention only with respect to the particular means for carrying it out, which Bell had in mind when he filed his application—one main line circuit in which the magnetic transmitting and receiving instruments are placed, the electric impulses generated directly by the sound waves passing over the line. That would not have been infringed by Edison's invention, since his sending instruments are not in the main line circuit at all, as claimed in my hypothetical claim, but in local circuits with the batteries and primaries of the induction coils; and because Edison's transmitters do not include magnet coils, but are devices for varying the resistance in the closed local circuit with the battery.

So you see how Bell might have lost his monopoly by claiming his invention too narrowly—that is with too many details in the claim. But he could very well have had some narrower claims like the one I made up, in addition to his broad claim, and then if the courts had held that he wasn't entitled to the broad claim but was entitled to some of the narrower claims, he would have had a monopoly so far as the narrow claims went. Each claim is like a separate invention, and they all have to be considered separately, without reference to each other.

When it is Worth While to Take Out a Patent

The question of when it is worth while to make inventions and take out patents should be considered in a business-like way, and not gone into as a blind speculation. The farmer who passes the long winter evenings by inventing and patenting a non-refillable bottle probably loses his time and money, since he doesn't know what the practical conditions and needs of the bottling business are. But he does know something about plows, and if he sees how an improvement can be made which will cheapen the plow or make it do better work, he has something he can figure on. You, as engineers, are in a better position to realize on inventions than the farmer, for engineering problems are involved. Suppose, for instance, you are familiar with the coal business and get an idea that would seem to make the dumping of coal cars a much cheaper

and quicker proposition, and would simplify the construction of the cars. You calculate as an engineering proposition that it can be done practically and that there are no objectionable features about the scheme which would overcome the advantages. You look over the trade catalogues and decide that your scheme would really effect a considerable saving over any of the advertised devices, so much so that different concerns should be very glad to get it.

Then you go to any good patent lawyer and have him make or have made what is called a preliminary examination. This is inexpensive, and results in showing you the four or five earlier patents which are nearest to your scheme. Some of these may be so similar that it is evidently not worth while going to the expense of applying for a patent, in spite of the fact that you never heard of such a device being on the market. Or it may be that yours is quite different, or again that some of these patents are similar in a general way to yours, but lack some important details, which make yours a practical success, while they were practical failures. If your attorney tells you that the improvement is something that amounts to invention, as it probably does, the patent that you then apply for and get will be valuable in spite of being only for an improvement, since the improvement is needed to make the device a real practical success.

While I have emphasized the necessity of only trying to patent practical things, that does not necessarily mean that what you have invented must be in highly perfected form before you apply for your first patent. If you feel that you have the principle of something that will work, and that there will be a future demand for, it does not so much matter that your first device is crude. Bell's first telephone, Edison's first phonograph, and Selden's automobile were all crude; but their patents were gold mines because they described the big, fundamental ideas that, in the form of patent claims, gave them broad protection. The crude devices they described as particular embodiments of their inventions would work to some extent, and illustrated the principles which the inventor had discovered.

What to do with Your Patent

This brings us to the question of what to do with the patent when you get it. If you already have a manufacturing business in which your invention can be used it is simply a matter of stamping "Patented" with the date, on the thing you make—if the patent is on a product of your factory—and seeing to it that your rights are respected. When your competitors know that you operate under a good patent, they will be likely to keep off, or will stop upon your notifying them that they infringe. Sometimes it is necessary to actually bring suit, and the defendant may decide after you have started the suit that it is better and cheaper for him to give up rather than to fight the suit to a finish; and either pay you a royalty in future, or get out of that line altogether. If your competitor is big and rich, and unscrupulous, it will be a question whether the expense of fighting him through to a finish will be compensated for. This should be calculated in advance, so far as possible.

Once you have won one suit on your patent and had the patent declared valid by the court, you are in a much better position; and you can almost immediately get preliminary injunctions against other infringers, to have their operations stopped. You should understand that when you bring suit for the infringement of a patent, the defendant can—in most cases—allege and attempt to prove that your patent is invalid, as well as that he does not infringe it. It may be invalid, for example, because the claims are too broad in view of earlier patents. The court may either decide that your patent is valid and infringed, as to the particular claims you allege are infringed, or that some of them are; or that it is valid but not infringed in the particular case, decided, or that it is invalid. If the verdict is against you, and the matter is of sufficient importance, you may appeal from the United States District Court where the case was tried to the United States Circuit Court of Appeals for the circuit in which that particular district court is situated.

The result of having your patent sustained by a suit may be to cause all the infringers, or those who would like to use the invention, to pay you royalty for the life of the patent. Or you might decide to license a limited number, giving each one rights for a different part of the country on payment of royalty; or, of course, you could sell outright, or else give an exclusive license to one concern alone.

If you take out the patent as an individual, without any manufacturing connections, the first thing to decide will be whether to manufacture under it, sell the patent, or license one or more parties to use it on payment of royalty to you. To get the greatest advantage out of any of these courses requires the expenditure of thought, time and money. This is obvious as to the manufacturing. Perhaps you can sell out, if the patent is for something useful, without much trouble; but the patent will have much more value after it has been declared valid as the result of a suit brought for its infringement. A good scheme for an individual patentee who does not expect to manufacture, himself, is to form a small company to develop and exploit the invention, and thus get in some money as working capital. You will then be in good position to bargain with people whom you may hope to interest or to give licenses to, and to protect your rights in such fashion that it will be plain you are not to be trifled with. I know one man who recently took out some broad patents on automobile mechanism, started various suits against owners of automobiles who went back to their dealers for protection, and eventually signed a license agreement giving an important association of manufacturers rights on royalty, from which he is realizing a very considerable sum. Another inventor I have in mind—a chemist—has associated himself with another man as a sort of manager; and they are continually forming small companies to exploit his inventions, which they license manufacturers to use and thus make a good income.

Conclusion

In conclusion, patents have been a tremendous aid to the business and manufacturing of the country, and to the inventors themselves when they have been good business men or have associated themselves with good business men, and when they have applied good practical and engineering sense to their problems. The patent system may well be improved in some ways to make its operations cheaper and quicker, and something has lately been done in this direction, but legislation which has been proposed to cut down the inventor's reward, or that of a corporation to which he sells his patent should not be approved, and various engineering societies are on record as being opposed to such changes.

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WESTINGHOUSE ELECTRIC VETERANS' ASSOCIATION

The employes of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., who have been in its employ for a period of twenty years or more held a meeting and organized the Veteran Employes' Association of the Westinghouse Electric & Mfg. Co., Saturday evening, February 21. About 325 employes of the company are eligible to membership and approximately 315 of these were at the meeting. L. A. Osborne, vice-president of the company, was toastmaster at the dinner. E. M. Herr, president, Charles A. Terry, vice-president, and James J. Barrett, representing the shop, made speeches. Guy E. Tripp, chairman of the board of directors, was elected an honorary member of the association, as was also Mr. Herr, neither of whom have been connected with the company the required twenty years. A standing toast was drunk to George Westinghouse, who was unable to be present on account of illness.

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It is stated in the *Railway Age Gazette* that a large increase in the capacity of passenger locomotives has been made possible by the use of alloy steel, properly heat-treated, for the reciprocating parts. This material effects a considerable reduction in the weight of the counterbalances, and thus allows an increased load to be applied to the driving-wheels. Hence, the boiler can be materially enlarged and the capacity of the locomotive as a whole increased without adding to the total weight.

COUNTERBALANCED AND INDEXING FIXTURES

VARIOUS TYPES OF SPECIAL FIXTURES ILLUSTRATING DIFFERENT METHODS OF COUNTERBALANCING AND INDEXING

BY ALBERT A. DOWD*

Work of irregular form having several holes to be machined, and castings or forgings in which a single hole is to be bored at one side of the piece, require special fixtures upon which they can be clamped for the machining operations. There are a number of conditions which affect fixtures of this kind; for instance, the work may be small and of light weight,

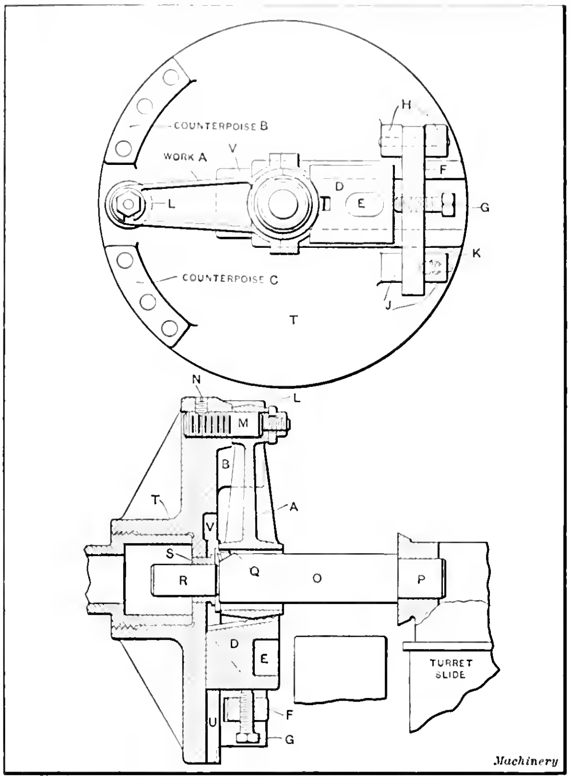

Fig. 1. Counterbalanced Fixture for Connecting-rod

or it may be large and very heavy; it may have several parallel holes, or they may be at various angles, sometimes even converging to a common center; the part may be very much one-sided; it may have been partially machined in some previous setting, or perhaps is a rough casting or forging. All these things affect the design of the fixture, as does the type of machines to which the fixture is to be applied.

Counterbalanced fixtures are used only on the class of machines where the work itself revolves, such as engine lathes, turret lathes, boring mills and cylindrical grinding machines. Indexing fixtures, however, can be used on all the foregoing, and also on many other machines, such as drill presses, milling machines, planers, shapers, slotters, etc. Very frequently indexing fixtures are supplied with some provision for counterbalancing, when used on the first-mentioned group of machines. Sometimes this counterbalance is so arranged that it can be moved to suit different conditions, and, in other cases, it is made solid with the fixture and is carefully balanced at the time the fixture is made. There are two things which must be carefully considered before any attempt is made to design a fixture, *viz.*, the machine most suited to the work in question, and the speed at which it will have to run in order to be thoroughly efficient. The latter is important if a counterbalance is to be used, because more care must be exercised in the balancing if the fixture is to be run at high speed. In addition to this, a high-speed fixture should be arranged with a suitable guard (if cutting lubricant is to be used) so that the operator will not have to wear a bathing suit. It is evident, therefore, that these things should be thought of before the design of the fixture is started. This is one of the cases where "an ounce of foresight is worth a pound of hindsight," for when a device of this kind is finished and ready to put on the machine, it is very annoying to be obliged to hold up the work a couple of days while a guard is being made and fitted. Incidentally, it does not redound to the designer's credit, for it should have been thought of in advance.

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A Few Points on Fixture Design

1. Rigidity. This is of prime importance in every kind of a fixture, and when the fixture is designed for use in a horizontal machine, the overhang from the end of the spindle should be made as short as possible in order to prevent vibration.

2. Positive location for the work and rapid-acting clamping devices of such a nature that it is not necessary to disturb them when indexing the fixture. In this connection it might be mentioned that the writer has seen indexing fixtures which were so designed that the clamps holding the work required loosening before indexing. Needless to say, this is very poor design.

3. Method of obtaining accurate indexing with provision for taking up wear at the locating points. Either taper pins or taper wedges are suggested.

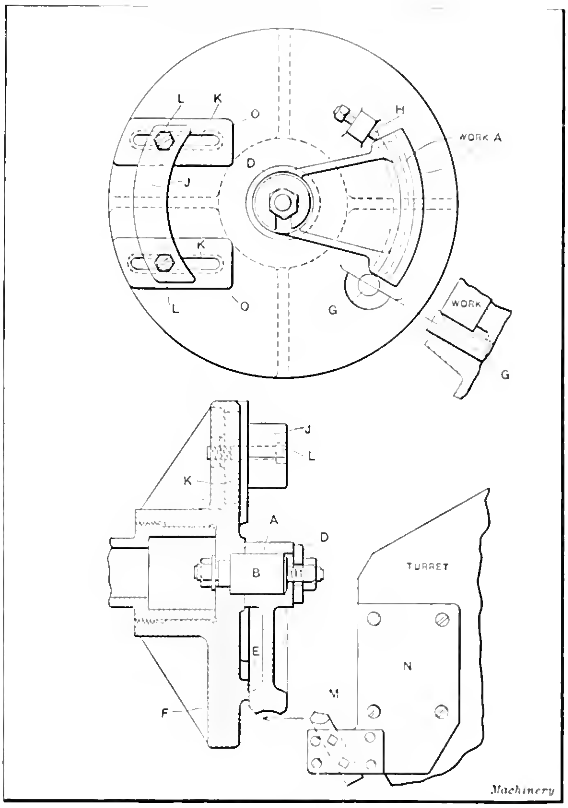

Fig. 2. Fixture with Adjustable Counterbalance

4. Adequate protection from dirt and chips so that errors in indexing will not be caused by imperfect contact at locating points. This point is of special importance on fixtures indexing in a horizontal plane, as for example, those used on a milling machine or a vertical boring mill.

5. The method of counterbalancing. If the counterbalance is to be a part of the fixture, the weight must be figured so that it will slightly exceed the portion which it balances in

order that it can be drilled out or chipped off when assembled with the work in position, to obtain a smoothly running fixture. A sliding counterpoise is a very good arrangement when several pieces of a similar kind are to be machined, for it can be so proportioned that it will take care of varying conditions.

6. Rapidity of handling, both in clamping the work and in the operation of the indexing mechanism. As these two points make considerable difference in the cost of the fixture,

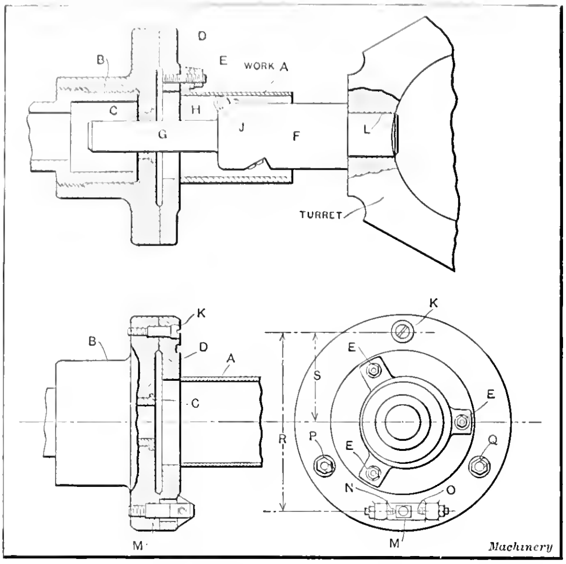

Fig. 3. Swinging Fixture for Eccentric Piston Ring

they should be proportional (to a certain extent) to the number of pieces which are to be machined. In fact, the entire fixture should be designed with this point continually in mind, so that its cost as a whole will not be too great.

Counterbalanced Fixture for a Connecting-rod

A very good example of a simple counterbalanced fixture is shown in Fig. 1. In this case the work *A* is a steel connecting-rod forging which has been faced on both sides and the wrist-pin hole in the small end has also been bored and reamed in previous operations. This fixture is used to bore and ream the large hole at a fixed distance from the wrist-pin hole and parallel thereto, the machine being a horizontal turret lathe. The body of the fixture *T* is of cast iron and is screwed to the spindle. The steel stud *M* is screwed into the body and is held in position by the pointed set-screw *N*. It is located at the correct distance from the center of the spindle and is turned down and threaded at one end to receive the U-washer *L* which is clamped down on the work by the hexagon nut shown. The sliding V-block *D* is dovetailed to fit the slide *U* in the body of the fixture. This centers the work from the outside of the forging and it should be noted that it also has a holding down action due to the angularity of the V-block. This is clearly shown in the lower view. The lugs *H* and *J* act as supports for the swinging latch *F*, and the detent pin *K* keeps the latch in position. The block *D* is clamped against the work by the square head set-screw *G*, located in the latch. The elliptical hole *E* is a finger hole by which the block is pulled back out of the way when removing and placing a new piece of work in position. The cored pocket *V* in the body of the fixture is provided so that the V-slide can be planed without difficulty, the pocket allowing a place for the tool to "run out."

The lugs *B* and *C* serve to counterbalance the weight of the latch and blocks on the opposite side and are at first proportioned so that they are somewhat heavier than necessary. After the work is put in place on the fixture it is carefully balanced by drilling into these lugs until sufficient stock has been removed to secure this result. Attention is called to the fact that the counterbalance is located as far from the center of the fixture as possible. This is done in order to make the weight more effective. A hardened and ground tool steel bushing *S* is located in the fixture body and acts as a guide for the boring-bar pilot *R*. The bar *O* is turned down at the rear end, as shown at *P*, so that it fits the turret hole. A recess in the fixture allows the boring tool *Q* to pass slightly beyond the work. A pilot bushing in the spindle might have been preferable, in that there would have been more space in front of the tool. If this had been done, however, the fixture would not have been self contained.

Adjustable Counterbalanced Fixture for a Worm-gear Sector

A condition which is somewhat out of the ordinary is illustrated in Fig. 2. The work shown at *A* is of two different sizes. The outside diameter is almost the same, but there is considerable difference in the weight of the two castings, one of them having a much wider rim than the other and also a heavier web section. Therefore it was necessary either to make the fixture in such a way that it would take care of both pieces, or else make two fixtures. As all other points in design would be the same, it was decided to make a movable counterpoise which could be adjusted to take care of the difference in weight.

The fixture body *F* is of cast iron, and is screwed onto the spindle as shown in the lower view. The locating stud *B* is shouldered and is held in place by a nut and washer on the inner end; the outer end is turned down and threaded to receive a hexagon nut which clamps the work through the U-washer *D*. The pointed set-screw *H* is set at a slight downward angle and forces the work over against the stud *G*. The partial section shows how the angular part of the stud tends to overcome any tendency to lift or strain the casting out of

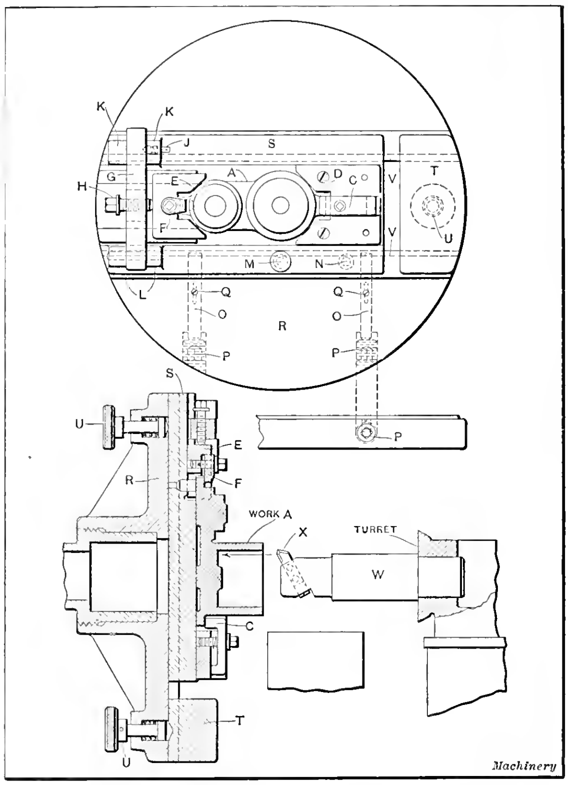

Fig. 4. Fixture with Adjustable Slide and Counterbalance

its correct position. The circular pad *E* forms a resting place for the work. The counterpoise *J* is a cast-iron segment resting on the two finished surfaces *O*. Two slots *K* permit the passage of the screws *L* which clamp the counterpoise in the desired place. An enlargement of the slots on the back of the body serves to prevent the hexagon nuts from turning when the weight is being adjusted. The lower part of the illustration shows the tool-holder *N* fastened to the face of the turret and ready to take a straight cut on the outside of the

sector with the tool M. This arrangement was very satisfactory in every respect. The two sectors were put in position and the counterweight adjusted for each piece, the pads being marked by a scratch line so that the counterweight could easily be placed in either position.

Swinging Fixture for an Eccentric Piston Ring

The work A shown in Fig. 3 is a cast-iron ring-pot from which eccentric packing rings are turned and cut off. Previous to the machining operation indicated, these pots are rough-ground on the back of the clamping lugs E, and are also

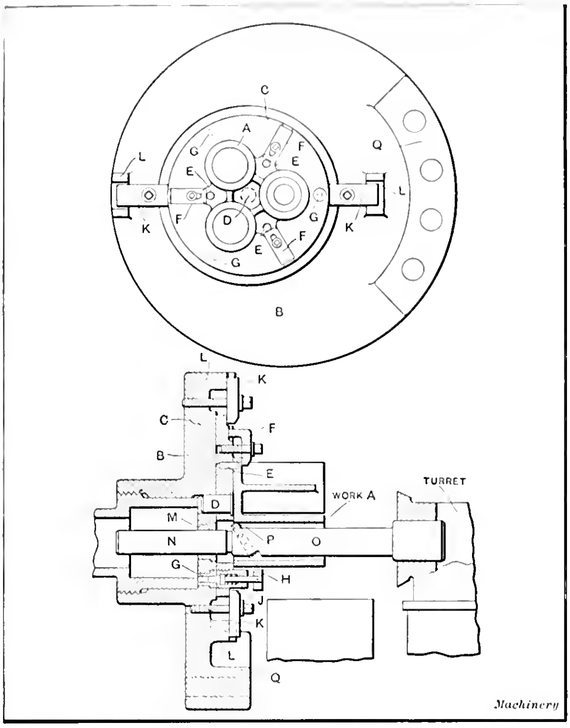

Fig. 5. Counterbalanced Indexing Fixture for Triple Cylinder

jig-drilled at these points. The customer for whom this fixture was designed did not wish to go to the expense of a special attachment for boring and turning eccentric at the same time. Therefore it was considered expedient to design the holding device so that it could be set over to produce the proper amount of eccentricity without re-setting the casting. The machine on which the work was done was a horizontal turret lathe of standard make.

The work A is located on the three studs E, and held fast by nuts and washers. The body of the fixture B is of cast iron and is screwed onto the end of the spindle. It is fitted with a bushing C which acts as a guide to the pilot end G of the boring-bar F. The swinging plate D is pivoted on the shouldered screw K, and it should be noted that this screw is set well down into the body of the fixture to give additional strength. An opening is provided in the plate D so that the square stud M in the body can extend out through it to act as a stop for the screws N and O in the swinging plate. These screws are provided with check-nuts so that they can be locked after being properly adjusted. In this particular case, the eccentricity of the ring was 1/16 inch and, as the distance R on the fixture was made exactly double the distance S, only 1/8 inch adjustment between screw O and stud M was required to obtain the correct setting. The studs and nuts P and Q are used for clamping the plate firmly to the body, the holes being slightly elongated to permit the necessary movement. In the operation of this device, the tool J in the boring-bar F was first used to bore the hole. The plate was then swung over against the stop and the turning tools machined the outside eccentric. Excellent results were obtained with this device.

Counterbalanced Indexing Fixture for a Carbureter Body

The work A in Fig. 4 is a brass carbureter body, and the fixture for it is considerably out of the ordinary in regard to the counterbalancing. The shifting of the slide from one side to the other makes it necessary to arrange the weight in such a way that it can be changed quickly from one side to the other, as occasion may require. The machine used with this fixture is a Pratt & Whitney turret lathe. Prior to this operation the casting is milled on one side on a vertical milling machine. It should be noted that a lug is left on the casting at each end for clamping purposes; this is cut off after the machining operations have been completed.

The body of the fixture R is cast iron and it is screwed onto the spindle. The slide S is fitted to the dovetail V in the body of the fixture, and the indexing locations are obtained by a taper pin in the bushings M and N. The clamping of the slide in each position is effected by the shoes O; these are beveled to the same angle as the dovetail and are prevented from turning by the set-screws Q which bear against the flat portion of the shoes. The hollow set-screws P act against the ends of the shoes and hold them firmly against the dovetailed portion of the slide. The work is located by the V-blocks D and E, which center the rough casting. The block D is screwed and doweled to the slide and contains the clamp C which bears against the lug on the casting. The block E at the other end is dovetailed on its lower side and fits the slide. The clamp F grips the lug and draws it up against the stud shown in the lower view. A latch G is pivoted on a pin in the lugs L and enters a slot in the opposite lugs K where it is retained by the detent pin J. The screw H forces the V-block against the casting. It will be noted that the latch is so hung that if the machine should be accidentally started while the latch is open, the latter would tend to close without damage to the fixture. This point in design is frequently overlooked and yet it is well worthy of attention.

The counterpoise T is of cast iron and is an easy sliding fit in the dovetail of the body, so that it can be removed without difficulty. It is countersunk on its lower side to receive

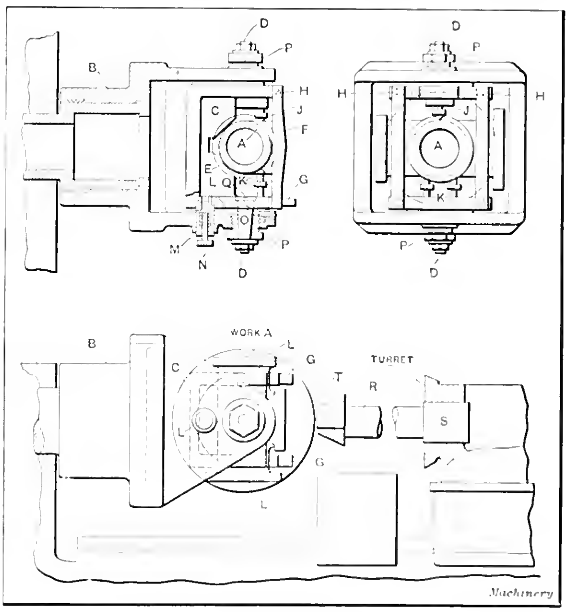

Fig. 6. Indexing Fixture for Cast-iron Valve Body

the spring detents U, which are located on opposite sides of the fixture. It is evident that this counterpoise must be transferred from side to side as the slide is indexed from one position to the other, so that the balance of the fixture can be preserved. The boring-bar W is shown in position in the turret; the tool X is used to rough out the pocket, as indicated by the arrow. This fixture was made up several years ago for an automobile factory in the eastern states, and it was used with good results for one season's production. It was

abandoned only on account of a change in the carbureter design and not because of any fault in the fixture itself.

Counterbalanced Indexing Fixture for a Triple Cylinder

The work *A* in Fig. 5 is a triple cylinder of cast iron with three bored and reamed holes equidistant about a common center *D*. The fixture was used on a horizontal turret lathe. The arrangement of swivel-plate, clamps and counterweight was made as symmetrical as possible so that very little change in the balance of the fixture would take place when indexing from one cylinder to another. The work was milled across the base and the holes *E* jig-drilled before the turret lathe operation took place. The body of the fixture is screwed onto the spindle and is made of cast iron. The swivel-plate which holds the work is also of cast iron and is pivoted on the hardened and ground steel stud *D* which enters the body. The three pins *E* act as locaters and drivers; they are in the plate and match the jig-drilled holes. Three clamps *F* are used to hold the piece, and they are bent over on the ends so that they enter a slot in the plate, which prevents them from turning while the screws are being tightened. They are also slotted so that they can be pulled back out of the way when putting the work in position.

A hardened and ground steel plunger *H* (shown in detail in the lower part of the illustration) is tapered to fit the

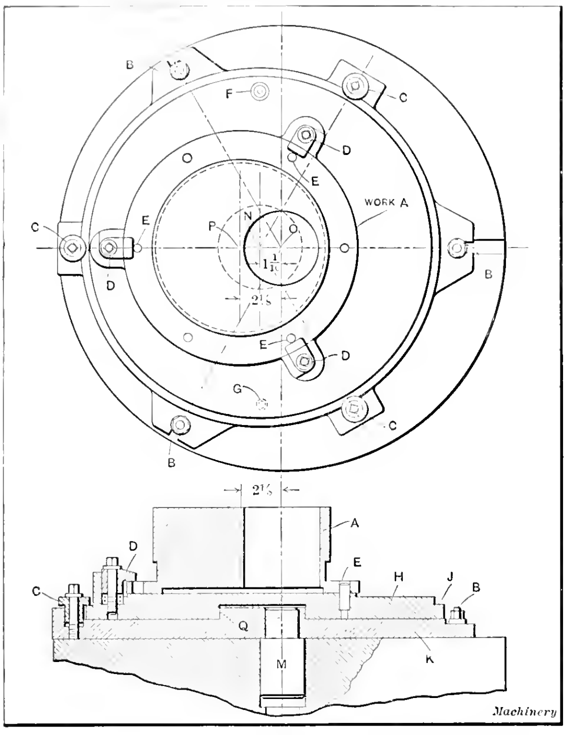

Fig. 7. Indexing Fixture for turning and boring Eccentric

bushings *G* which control the indexed locations as the plate is swiveled. The steel bushing *J* acts as a bearing for the pin and also forms a pocket for the spring. The clamps *K* are loosened when indexing the plate but are set up again before the machining is done, so that rigidity and freedom from chatter are insured. The counterpoise *Q*, in this instance, is a part of the body casting. At first it is somewhat heavier than the parts to be balanced; it is then brought to the required weight by drilling out the stock after the work is clamped in position. Attention is called to the fact that the body *B* contains a bushing *M* in which the piloted end *N* of the boring-bar *O* is guided. It will also be seen that considerable chip room is provided for the tool *P* when it passes through the work. The results obtained by the use of this fixture were perfectly satisfactory.

Indexing Fixture for a Cast-iron Valve Body

The work shown at *A* in Fig. 6 is a cast-iron valve body to be machined complete at one setting. It will be noted that the holes are at 90 degrees with each other, so that the fixture required indexing through an arc of 180 degrees during the process of machining. The casting is in the rough state when placed in this fixture. The cast-iron body *B* is screwed to the spindle, and its forward end is formed like the letter *U* to receive the swivel-bracket *C*, which holds the valve body. This swivel has a pair of V's which serve to

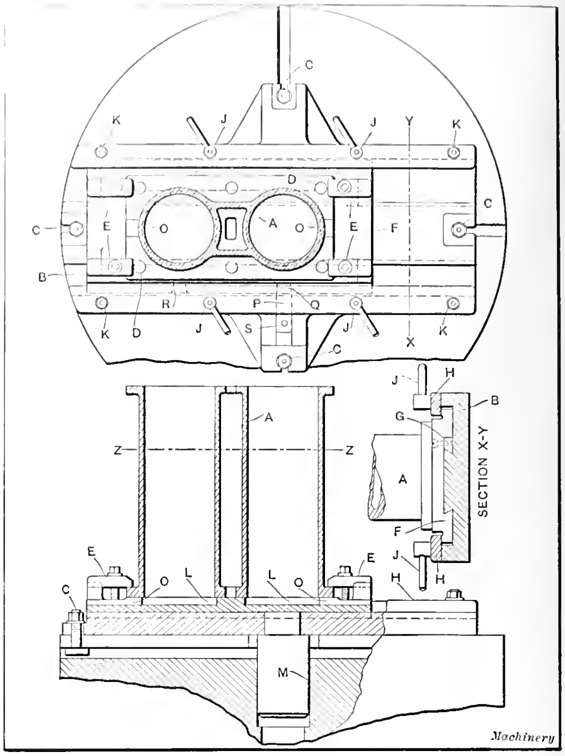

Fig. 8. Adjustable Fixture for Twin Cylinder

locate the casting centrally in one direction. The swinging clamps *F* are pivoted at one end on the shouldered screws *H*, and they are clamped against the casting by the action of the thumb-screws *G*. The work is centered in the other direction by the steel "bull-center" *T*, which is forced onto the shoulder of the bar *R*. This center is used in the rough cored hole before the clamps have been set up tightly, and while it is in

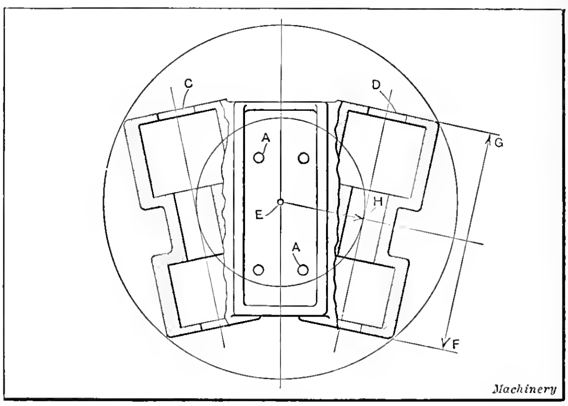

Fig. 9. Roller Bearing Bracket machined with Fixture shown in Fig. 10

position, all screws and clamps are tightened. The pointed set-screws *J* and *K* overcome any tendency of the casting to move during the machining operations. The bearings for the swivel are somewhat out of the ordinary as they are provided with a "take-up" for wear. The hardened and ground steel studs *D* are screwed into place in the swivel and are tapered on their outer ends to form the pivots. The threaded

bushings P are milled hexagon on the ends and are tapered on the inside to fit the pivots. Headless set-screws prevent the bushings from turning.

The indexing locations are determined by the bushings L, which are forced into the swivel at the three points shown. These bushings are tapered on the inside to fit the pin N, which is also encased in the bushing M. A coil spring assists in keeping the pin in position. This fixture was not satisfactory due to the overhang of the spindle and a certain tendency to chatter caused partly by the excessive overhang

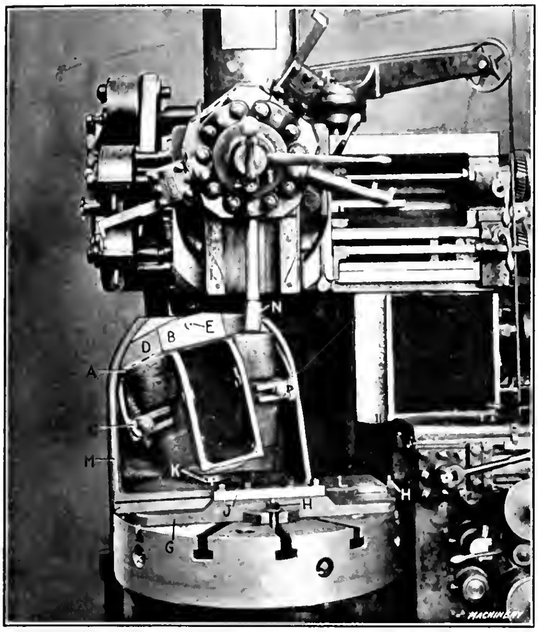

Fig. 10. Bullard Vertical Turret Lathe arranged for machining Roller Bearing Bracket

and partly by imperfect balance when in either of the positions not shown in the illustration. The writer has, however, applied a fixture of very similar construction to a vertical turret lathe with perfectly satisfactory results, showing that the greatest fault was in the excessive overhang when used on the horizontal type of machine. Some of the details of construction in this fixture may, however, be applied to advantage on other work, and it is of considerable value in showing "what not to do," for we really learn more by failures than we do by successes, although a failure may be somewhat expensive.

Indexing Fixtures for the Vertical Turret Lathe

Let us now take up the subject of fixtures which are designed for use on machines of the vertical spindle type. In the majority of cases, it is not necessary to provide counterbalances for this type of fixtures because of the construction of the table bearing which always tends to center itself on account of its conical form. The great weight of the table is also of assistance in overcoming trouble which might be caused by heavy castings of an eccentric or one-sided form. It might be possible to have a manufacturing proposition come up which called for a great number of very heavy eccentric castings of the same kind. In a case of this kind, a counterweight might be used in order to save the machine from excessive strains and unequal wear on the spindle and table bearings. It is not, however, the usual practice to make any provision for counterbalancing.

Indexing Fixture for an Eccentric

A rather peculiar fixture is shown in Fig. 7, this having been made for a vertical turret lathe. The work A is of cast iron and is an eccentric strap. In a previous operation this has been turned, faced, and recessed on the flange side, having been held by the solid portion of the body at this setting. The operation of drilling the flange holes in a jig also took place before the setting shown in the illustration. The work for which this fixture was designed is the boring of the eccentric hole, the facing of the top, and the turning of the outside portion. The casting is located by the three pins E in the swivel-plate H and is clamped down by the three hook-bolts D. It will be noted that these hook-bolts are well backed up by bosses on the swivel plate. The backing is cut away on one side so that the bolt can be swung around when placing a new casting in position. The coil springs underneath assist in releasing. This swivel plate has the point N (shown in the upper view) for its center and swings on the boss Q. As point N is equidistant from O and P, it follows that when the swivel-plate is swung around 180 degrees, it will be in the correct position for turning the outside diameter. The three buttons C are set in the base K and act as clamps on the annular shoulders J of the swivel plate. The base itself is held down to the table by the T-bolts B, which enter the table T-slots. It is centered on the table by the plug M. The indexing locations are determined by the bushings F and G in the base. These bushings are tapered to fit a taper spring-pin in the swivel-plate. It will be noted that this method of holding the work made it possible to perform all the turning operations in two settings.

Twin Cylinder Fixture for the Vertical Turret Lathe

The casting shown at A in Fig. 8 is a twin cylinder which has previously been machined across the bottom, and in which the flange holes have been jig-drilled. The casting is placed on the sliding plate F and is located by the two pins D which are diagonally opposite each other. The four clamps E are used on the flange to hold the work in position. It will be noticed that the two recesses at L permit the boring tools to pass completely through, and provision is made for cleaning out these pockets by sweeping the chips into the two grooves at O. Attention is also called to the fact that these pockets are not bored entirely through the slide, for if this were done trouble might be experienced with chips or dirt. The slide is dovetailed on its lower side, as shown in the section X—Y, and provision is made for take-up by the gib G.

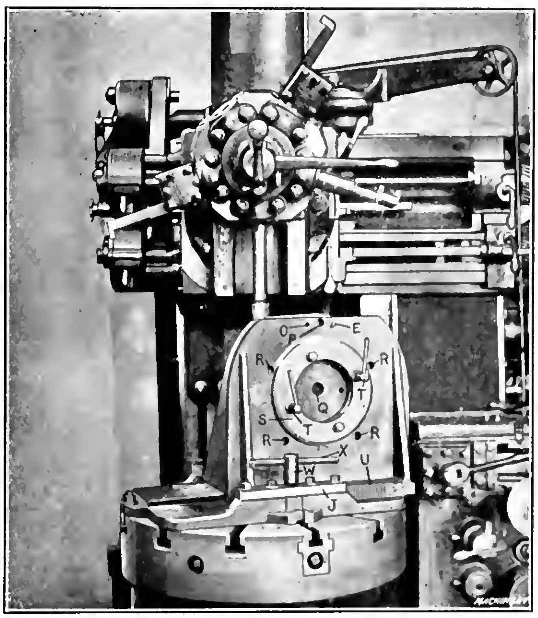

Fig. 11. Rear View of Fixture for Roller Bearing Bracket

The base of the fixture B is bolted to the table by the T-bolts C and is centered by the stud M. The steel strips H are so fitted that a sliding fit is insured when the binders J are loosened. The indexing is governed by the taper wedge shown at P in the upper view. This wedge enters the two slots Q and R which are tapered to receive it. The pin S is used to pull the wedge out of engagement. It will be noted that the view of the work shown in the upper illustration is a section taken on the line Z—Z, in order to make the construction more apparent.

Indexing Fixture for a Difficult Piece of Work

Fig. 9 shows a partial section of a steel casting which is of considerable size and weighs nearly 300 pounds. It is a tangential roller bearing bracket in which four large pockets are provided to receive the rollers. The center-lines of each pair of pockets *C* and *D* meet at a common center, which is so far outside of the casting proper that it is obviously out of the question to design any sort of fixture for it using this center as the pivot point. Therefore an arbitrary center *E* was used as a pivot for the work, this point being half way between *F* and *G* and on a line perpendicular to the axis of the bearings. It is apparent that the work can readily be swung on this center a sufficient amount to bring the center-lines parallel to the axis of rotation. The back of the casting has been milled off on two parallel pads (not shown in the illustration) and four small holes jig-drilled before the work is placed in the indexing fixture. The two holes *A*, which are engaged by pins on the fixture, are used for locating the casting.

Fig. 10 shows a front view of the vertical turret lathe having the fixture in position on the table. The work *A* is slipped onto the two pins mentioned and is drawn back against the finished surface *B* by the two clamps *C*, which are C-shaped to permit rapid handling. The swivel-plate *D* is of cast iron and has an 8-inch annular ring at the back on which it pivots. This ring is made of generous size in order to give greater rigidity, and also to provide a means of clamping when the work is indexed. The pin *E* is tapered and fits the tool-steel bushings which determine the swivel locations. The sliding portion *M* of the fixture is dovetailed to fit the base *G* and rigidity is secured by gibs *J* in addition to a dovetail gib not shown in the illustration. The screws *H* hold the base down at four points where they enter the table T-slots. Another taper pin shown at *K* is used in obtaining the longitudinal locations. A core drill *N* is shown in position in the turret, and other tools used in machining may also be noted in their respective positions.

Fig. 11 shows a rear view of the fixture; the protruding end of the taper locating pin may be noted at *E*. The other bushing *O* gives the correct location for the other hole in the casting. The two holes *P* and *Q* have nothing to do with the fixture itself, except that they were used by the toolmaker in order to fix his locations more conveniently. A steel clamping ring *S* draws up the swivel-plate tightly after indexing, by means of the two binders *T*. The four holes at *R* give access to hollow cup set-screws in the swivel-plate. These set-screws are brought up against the rough casting to give additional support. A clamping gib on this side of the fixture is provided with a hole through which the squared stem of a twelve pitch pinion protrudes. This pinion meshes with the rack *U* on the slide. The socket wrench *W* fits the squared head of the pinion, and it is provided with a sliding handle *X*. This sliding handle was a necessary feature as several revolutions of the pinion had to be made to obtain the required movement of the slide. As the sliding portion of the fixture with work attached weighed about 800 pounds, it will be seen that some method of traversing the slide was necessary, so that the operator would not be compelled to push it over by hand. This fixture was built for the Bullard vertical turret lathe and its action was very satisfactory.

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THE SOCIETY OF AUTOMOBILE ENGINEERS AND STANDARDIZATION

Howard Marmon, secretary of the Nordyke & Marmon Co. and retiring president of the Society of Automobile Engineers, recently stated that the society is now one of the great engineering bodies of the world. It has a membership of nearly 2000 and is a most vigorous expression of the world's fourth industry. It is, in many ways, a unique organization, but it is not merely an organization—it is a working agency of high efficiency. Every day the work of this society leaves its mark on the American automobile industry. The problems that this body has had to solve were much the same problems, diverse and complex, that faced the railroads and their allied industries in their days of rapid growth. The automobile business brought with it almost innumerable engineering, manufacturing and industrial questions that demanded, and that still demand, quick and skillful consideration.

The modern car has reached its present stage only after a great amount of experimentation. During the past few years the Society of Automobile Engineers has directed this work. What, then, has the society accomplished? Among other things, it has raised the standard of design and effected the standardization of parts. This may not mean much to the average user, but the engineer and the producer know very well how large an undertaking it has been. To standardize an apparently unimportant part often means an amount of labor incomprehensible to the non-mechanical mind. Past construction must be borne in mind, and yet the advance to a new standard of merit must be made. The varying views of engineers must be considered and commercial demands must be regarded, for after all automobiles are made to be sold. Where motor-car companies used to pay eight to ten cents a pound for "double extra special" crankshaft steel they now buy "S. A. E. Specification 10-40" at two or three cents a pound—the same quality in every respect. The engineers of the steel division of the standard committee got together, and using common sense as a text, obtained from the steel makers a commercial price for their wares.

Before the standard committee had formulated its specifications there were 1100 sizes of seamless steel tubing, differing by a few thousandths inch—just enough to make life miserable for the manufacturer. Now the "Data Book" which is rapidly becoming the automobile engineer's bible specifies 160 sizes only. These made up in large quantities come cheaper and delivery is quicker. The result is that the prices of the motor car are less. The owner may now try various carbureters without having his car entirely rebuilt. Gasoline pipe sizes and threads have been made standard, as have the lever connections and the flanges which are joined to the engine or the intake pipe. No longer is a car owner unable to shift from one magneto to another. Again the reason is that magneto bases and connections are now made the same. Wheels for motor trucks have been standardized. They used to vary by small dimensions, and the manufacturer ought to keep in stock four sets of wheels for each truck to meet the varying sizes of tires produced. Now all the tire manufacturers make their tires to conform to S. A. E. standards. Tires are interchangeable on the same wheels. It is estimated that this reform alone has saved $300,000 within the past year.

* * *

INFLUENCE OF VARIOUS METALS ON THE CORRODIBILITY OF IRON

Silicon in iron increases greatly its tendency to corrode; 0.3 per cent of silicon will make iron rust 20 per cent more rapidly than would ordinary iron free from silicon. On the other hand, alloying steel with nickel or copper gives it increased resistance to corrosion; 0.20 per cent of copper in steel produces a material which is attacked by acids at one-tenth the rate of ordinary iron. The corrosion in the atmosphere is only one-third that of iron free from copper. An increase of copper above 0.20 per cent does not add to the corrosion resisting qualities of the iron. These results have been obtained not merely by laboratory experiments, but in practice. Roofs have been covered in and around Pittsburg with ordinary sheet steel and also with a sheet steel containing 0.20 per cent of copper. The copper alloy roofs were in good condition when the ordinary sheet iron roofs were completely corroded. The results of these experiments also showed that the metals are less attacked in rural districts than in cities, this being due probably to the carbon and acid fumes present in the city atmosphere.

* * *

During 1913, 302 people were killed by automobiles in New York City alone. The controlling mechanism of automobiles may have been developed to perfection, but the reckless driver seems beyond control.

ADJUSTABLE CAM-SHAFT AND TIMER DRIVE

BY JOHN L. ALDEN*

The cams and timer contacts of a gasoline engine must bear a precise relationship to the throws of the crankshaft. This means that the error in timing and cam-shaft gear setting must be very slight, and that any angular adjustment, to be of value, must be very close. On motors built in quantities, it is customary to mark the meshing teeth on the crankshaft, cam-shaft, and magneto or timer gears. In this case, no provision is made for changing the timing of the valves and ignition closer than the variation obtained by shifting the meshing gears one tooth either way. When this scheme is used the gears are either keyed to the shaft or bolted fast to a flange.

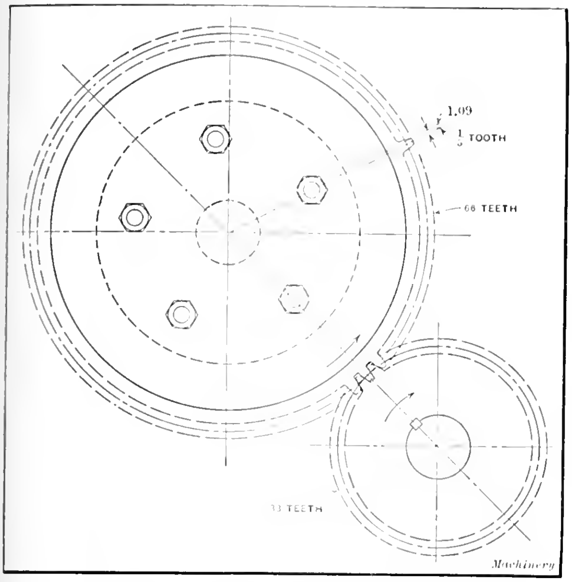

Fig. 1. Diagram illustrating Method of adjusting Cam-shaft Gear with Five Bolt Holes

However, it is frequently desirable to provide means for making finer adjustments than are possible by the method just noted. In fact, this is absolutely necessary in the case of experimental motors, racing motors, and other special machines of this kind. In such installations, means should be provided for shifting the gears with respect to the shaft in steps not greater than 2 degrees each. The most common method in use in this country consists of a gear bolted to a flanged shaft, one member having a greater number of bolt holes than the other. Thus, if two bolts are used, and there are twenty holes in the flange and eighteen in the gear, the closest angular adjustment possible is:

$$a = \frac{360}{18} - \frac{360}{20} = 2 \text{ degrees.}$$

Hence, to be of much value, at least eighteen holes must be used in each member. This makes a rather expensive installation, and is somewhat unsatisfactory in that it does not permit a high degree of precision in gear setting. There are a number of other contrivances in use, most of them, however, employing the slotted hole principle in one form or another. A bolt hole of this kind must be close to size, and, owing to its form, is expensive to machine. Therefore, it is readily seen that none of the devices in common use today are wholly satisfactory, there being some decided drawback in each case.

It is the intention of this article to present an improved adjustment which is not, to the writer's knowledge, common property in the American automobile and machinery field. This design is being employed with considerable success abroad, and it is hoped that the idea may be of service to designers on this side of the Atlantic. Like the methods previously described, this design requires a flanged shaft, drilled with a number of bolt holes exactly in register with corresponding holes in the gear. The holes in the latter must, of course, be located accurately with respect to certain teeth. The adjustment of the gear depends entirely upon the fact that the number of bolt holes is not an even divisor of the number of teeth. The relation between the number of teeth and the number of holes is most simply expressed by the formula:

$$N = kn + r.$$

$$\frac{N}{n} = k + \frac{r}{n} \qquad (1)$$

where N = number of teeth in gear;
n = number of bolt holes;
k = integral part of quotient obtained by dividing N by n;
$\frac{r}{n}$ = fractional part of quotient obtained by dividing N by n.

The angular adjustment, expressed in degrees, is represented by:

$$a = \frac{360\,r}{N\,n} \qquad (2)$$

The method of making this adjustment is very simple. When the setting has been made to within one tooth of the desired point, the operator should ascertain whether the valves have lag or lead. For the sake of illustration, assume that the valves have a slight lead. The gear is then removed from the flange and turned backward against the direction of rotation, one or more holes, the shaft being held stationary. After remeshing the teeth, the cam-shaft gear is again fastened to the flange thereby completing the operation. In case the valves lag, the gear should, of course, be turned ahead. To make the matter clearer, let us consider a numerical example taken in connection with Fig. 1.

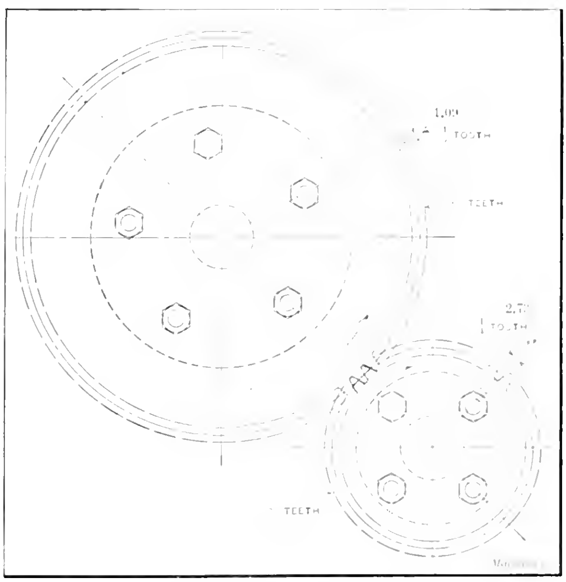

Fig. 2. Bolt Holes in both Cam-shaft and Crankshaft Gears to provide for Finer Adjustment than can be made with Arrangement shown in Fig. 1

It is required to find the finest angular adjustment which can be given to a cam-shaft whose gear has sixty-six teeth and five bolt holes. From Equation (1):

$$\frac{66}{5} = 13 + \frac{1}{5}.$$

Hence $k = 13$ and $\frac{r}{n} = \frac{1}{5}$.

From Equation (2) the angular adjustment is:

$$a = \frac{360}{66} \times \frac{1}{5} = 1.09 \text{ degree.}$$

In case even closer regulation is required, the driving gear

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— in this instance the crankshaft gear may be provided with precisely the same type of adjusting device. If this is done, the angular adjustment becomes:

$$a = \frac{1}{2} \times \left(\frac{360\, r_1}{N_1 n_1} - \frac{360\, r}{N\, n} \right) \qquad (3)$$

where N_1, n_1, and r_1 are the corresponding values of N, n and r for the driving gear on the crankshaft. Thus for the example shown in Fig. 2 the possible adjustment is:

$$\frac{1}{2} \times \left(\frac{360 \times 1}{33 \times 4} - \frac{360 \times 1}{66 \times 5} \right) = 0.275 \text{ degree.}$$

This provides an adjustment which is delicate enough for any ordinary purpose, and has the additional advantage of being relatively inexpensive. It will, of course, be understood that it is only the fractional part of a tooth, $\frac{r}{n}$, that affects the adjustment, as the movement of a whole number of teeth k does not affect the relative positions of the shafts when the gears are remeshed after making the adjustment.

* * *

CHARACTER OF PAPERS TO BE READ AT THE ENGINEERING CONGRESS

In the December number of MACHINERY mention was made of the International Engineering Congress which will be held September 20 to 25, 1915, in connection with the Panama-Pacific Exposition in San Francisco. This congress is conducted under the auspices of the great national engineering societies in the United States. The character of the papers that will be read will be of especial interest. As a general rule, it is intended that each paper shall treat its assigned topic in a broad and comprehensive manner and with special reference to the important lines of progress during the past decade, the present most approved practices, and the lines of present and future development. It is intended, furthermore, that all such papers shall be accompanied with a reasonably full bibliography of the subject, giving reference to the important original papers and sources of information relating to the special topic of the paper. In this manner the reader will be furnished with a rapid and comprehensive review of the recent important work relating to such topic, together with references to individual papers and sources of information for more complete and minor details. Papers of this type, rather than those which deal with individual constructions or special and individual problems or investigations, will generally serve the purpose of an engineering congress better. Papers of the latter type will naturally find their place in the proceedings of the regular sessions of the various engineering societies, while the occasion of a great engineering congress furnishes a more appropriate opportunity for papers of the broad survey or encyclopedic type.

An important exception to this general plan, however, will be found in a series of papers relating to the Panama Canal, of which it is intended to make a special feature of the congress. These papers will deal with the engineering of the Panama Canal in all its branches, with the influence of the canal on world commerce, commercial trade routes and general transportation problems. Colonel Goethals has promised his aid in securing this series of papers, which will thus form a definite and authoritative discussion of the engineering problems involved in this great undertaking.

In other special fields it may be found desirable to depart somewhat from the character of the papers outlined above, but, in general, and aside from those relating to the Panama Canal, the papers will be of the character indicated. In order to realize these various purposes with regard to the papers and especially to avoid either the overlapping of two or more, or the omission of some important topic, the Committee on Papers is now preparing a carefully considered list of topics to be treated in the various branches of engineering, together with a general syllabus or outline of the specific ground to be covered by each paper, and to which each contributor will be asked to adhere as closely as practicable.

PROPERTY RIGHTS IN ENGINEERING DRAWINGS AND DATA

In an address before the student branch of the American Society of Mechanical Engineers, at Cornell University, Prof. Frederick R. Hutton touched upon the subject of the relations of the draftsman and engineer as regards his proprietary right in the designs which he creates. This question is closely allied with that of ownership of patents which originate during the work carried out by the draftsman. The subject was divided into four principal questions, as follows:

1. May a draftsman make blueprints from his own drawings embodying his own computations, and take these home with him or away with him when he leaves his job? May he do this with the drawings of his fellow workers? These will enhance his value to any subsequent employer. Are they *his?*

2. Suppose he bought his own paper, and did his printing at home on Sundays and holidays, so that his records were not made at his employer's expense? Does this change anything?

3. Suppose that this same information, tables of sizes and proportions, design data and standards, are in note-books, may the draftsmen copy these, and carry such priceless information gathered through years of wage-paying and experiment with him to his next place, and perhaps to a competitive concern?

4. Can an improvement in a process, or a new process or an improved design, or a new mechanical movement be patented by the draftsman for himself, while he is working for an employer on a similar problem, and be used to hold up his employer until the parties can agree as to the terms of use or sale?

The accepted answer, emphasized by decisions of Court, and embodied in codes and standards of professional ethics, is that drawings and data belong to the employer, and the engineer or draftsman may not take them away with him. The reasons back of this practice include: 1. The shop furnished the plant—rent, heat, light, tools, etc.—where these ideas were conceived. 2. The shop presented the problem—without this the invention or the design would never have been created. 3. The shop furnished antecedent knowledge and acquired experience, which molded the creation, and prevented mistakes and waste. 4. The shop furnished experimentation, actual or precedent, which gave the creation its practical or commercial shape. 5. For many creations, the shop furnished or will furnish the manufacturing facilities which the inventor would otherwise have to struggle to find or pay for heavily elsewhere. 6. For many creations, the shop furnishes the selling or marketing facilities of its commercial organization.

Again, the draftsman or engineer may contract by a signed instrument to give shop or manufacturing rights to the employing shop, while retaining the right to sell or license to outside parties. Or, again, this principle may be made applicable to patents which relate to the employer's business, while patents in no way related thereto may be expressly excluded, and the employer stands as an outsider would, in relation to purchase or license.

Closely interwoven with this matter is the "trade-secret" problem. Here the employer confides to his engineer or draftsman or other employe knowledge of immense commercial importance to him, and which for many practical reasons he cannot protect by the procedure of the patent. The European practice has some vogue where the engineer and draftsman agree by signed instrument not to enter another concern in the same line of production for five years after leaving his confidential relation. Five years will render much of his inside knowledge obsolete; and the first concern will not suffer from a breathless and panting chase of another five years behind it. Many of these contracts have, however, been declared void by the Courts in the United States.

* * *

Fine spun theoretical knowledge, unless mated with horse sense, breeds frills and gewgaws in design and causes waste of effort and money.—*Journal Worcester Polytechnic Institute.*

HEAVY-DUTY SHAFTS WITH TWO AND THREE BEARINGS

AN INVESTIGATION OF SHAFT DESIGN WITH TWO AND THREE POINTS OF SUPPORT

BY W. G. DUNKLEY*

Many cases arise in machine tool design in which one or more gears have to be placed near the middle of a shaft owing to the location of other gears. In such cases, the shaft may either be designed to carry the load when it is supported in two end bearings or a third bearing may be provided at the middle. The latter method of procedure is coming into very general use. The purpose of this article is to investigate the design of a shaft under both these conditions and discuss the various points which arise when three bearings are used instead of two.

Fig. 1 illustrates the conditions which have been assumed for the purpose of discussion. In this illustration, W_1 is the driven wheel and W_2 the following driver, the shaft between these wheels transmitting the torque. The calculations are based on the assumption that the wheels are capable of transmitting the full horsepower of the motor when running at their lowest speed. The tangential tooth loads are 5 tons on wheel W_1 and 7.5 tons on wheel W_2; the torque on the shaft is $5 \times 19 = 95$ inch-tons. The bending moment on the shaft will approximate its maximum value when the shaft centers lie in a straight line as shown in Fig. 2, *i. e.*, when the lines of action of the tangential tooth loads are parallel. The dotted arrows in Fig. 2 show the actual directions in which the tooth loads act if the obliquity of action is taken into account. Strictly speaking, it will be seen that the greatest possible bending moment on the shaft S_2 will be produced when the lines of centers S_1 and S_2 and S_2 and S_3 are each inclined at an angle of 14½ degrees to the horizontal. With lines of

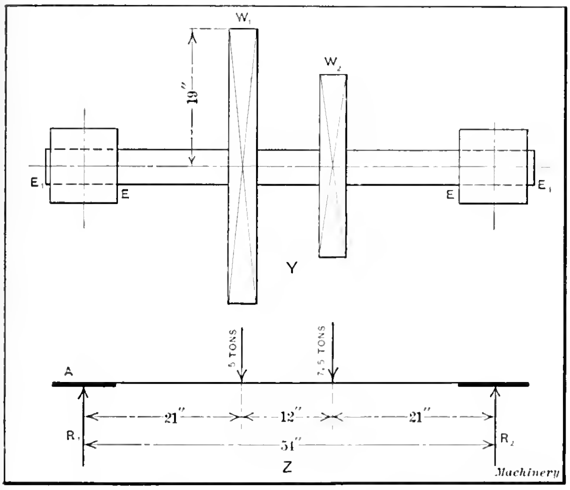

Fig. 1. Diagrams illustrating Conditions assumed for Discussion of Shaft supported by Two Bearings

contact inclined in this way the dotted arrows representing the actual direction of the pressure on the teeth would be parallel.

Shaft Carried in Two Bearings

To obtain the maximum bending moment it is assumed that the shaft is simply supported at the middle of each end bearing as shown at Z in Fig. 1. For this to be the case, it would mean that the reactions at the bearings are evenly distributed over the entire bearing surface. This point will be referred to in detail in a later paragraph. By taking moments about A, we have:

$$54\,R_2 = 5 \times 21 + 7.5 \times 33$$

$$R_2 = \frac{352.5}{54} = 6.5 \text{ tons}$$

$$R_1 = 12.5 - 6.5 = 6 \text{ tons}$$

The maximum bending moment M will occur under the 7.5-ton load.

$$M = 6.5 \times 21 = 136.5 \text{ inch-tons}$$

$$T = 95 \text{ inch-tons}$$

The diameter of the shaft that is required for carrying this combined bending and twisting load can be quickly obtained from the charts which were published in connection with an

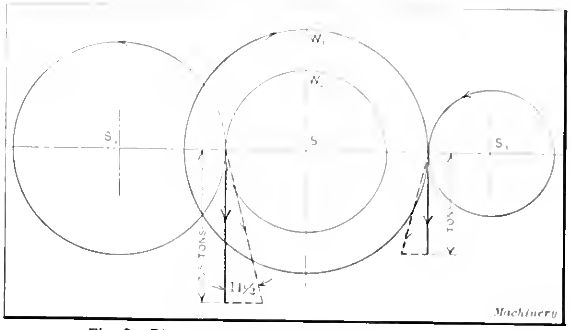

Fig. 2. Diagram showing Direction of Lines of Action of Pressures on Gear Teeth

article by the present writer that appeared in the August, 1913, number of MACHINERY. Using the chart, the value of the shaft diameter is found to be 7.5 inches. If the charts are not available, the result may easily be obtained by calculation. Denote the twisting moment that is equivalent to the combined bending and twisting moments acting on the shaft by T_1.

$$T_1 = M + \sqrt{M^2 + T^2} = 136.5 + \sqrt{136.5^2 + 95^2} = 302 \text{ inch-tons.}$$

The required diameter D of the shaft is obtained from the following equation:

$$D^3 = \frac{16\,T_1}{\pi f}$$

where

f = safe fiber stress = 3.5 tons per square inch;

$$D^3 = \frac{16 \times 302}{3.1416 \times 3.5} = 439;$$

$D = 7.5$ inches (approximately).

The next point is to make sure that the deflection of the shaft due to the load is not excessive. For the given arrangement of the loading the most convenient method of obtaining the deflection would be by graphical analysis. This amount of work is hardly necessary in the present case, however, as a sufficiently accurate idea of the deflection can be obtained by regarding the loads as concentrated at the middle of the shaft. For this condition, the deflection d is given by the following equation:

$$d = \frac{WL^3}{48\,EI}$$

where

I = moment of inertia $= \dfrac{\pi D^4}{64} = 156$;

W = load on shaft = 12.5 tons;

L = length of shaft = 54 inches;

E = modulus of elasticity = 13,000 tons.

Then

$$d = \frac{12.5 \times 54^3}{48 \times 13{,}000 \times 156} = 0.0202 \text{ inch.}$$

The actual deflection will be slightly less than the preceding value because the loads are not actually concentrated at the center of the shaft in the way that was assumed to facilitate calculation. Consequently, a shaft rather smaller than 7.5 inches in diameter might be used with safety.

If, instead of acting in parallel directions, the loads on the shaft are inclined in the directions of the arrows indicated at X in Fig. 3, the maximum bending moment is obtained as follows: The inclined load W_2 is resolved into components $W_2 \sin \theta$ acting vertically and W_2 cosin θ acting horizontally.

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At Y is shown the arrangement of the vertical load W_1 and the vertical component of the load W_2; at Z, the arrangement of the horizontal component of W_2 is shown. Call F and F_1 the reactions due to the vertical loads shown at Y, and P and P_1 the reactions due to the horizontal load shown at Z. Then there will be one bending moment $M_1 = F_1 \times 21$ which acts under the load W_2 and also a second bending moment $M_2 = P_1 \times 21$ acting under the load W_2 at right angles to the first bending moment. The resulting bending moment M under the load W_2 is then obtained by the following equation:

$$M = \sqrt{M_1^2 + M_2^2} \quad (1)$$

Similarly there are two bending moments acting at right angles to each other under the load W_1 which have values given by the following:

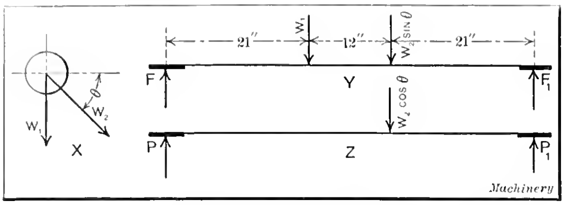

Fig. 3. Diagrams showing Condition of Shaft carrying One Vertical and One Inclined Load

$$M_3 = F \times 21 \quad \text{and} \quad M_4 = P \times 21$$

The resultant of these bending moments is given by the following:

$$M = \sqrt{M_3^2 + M_4^2} \quad (2)$$

The maximum bending moment M is obtained from either Equation (1) or (2), the bending moment being the result of the equation which gives the greatest value. This result is then used with the twisting moment in order to obtain the required diameter of the shaft by the method of calculation previously explained.

To return to the question of the pressures being evenly distributed over the bearings of the shaft shown in Fig. 1: When the loads are first applied on the shaft the resulting deflection will tend to lift the ends E_1 off the bearing, thus concentrating the full bearing load at a point nearer the inner ends E of the bearings. As a result, the bearings will wear at the points where the load is greatest and this wear will tend to continue until it reaches a point where the pressure is evenly distributed. When this condition is reached, any wear which develops in the bearings will be uniformly distributed. If, however, the deflection of the shaft is of considerable magnitude, the condition indicated in Fig. 4 may be produced, *i. e.*, the ends E_1 of the shaft may be raised sufficiently to induce downward pressures L_1 and L_2. The total downward pressure will then be the loads on the shaft plus these induced loads L_1 and L_2, and this pressure will be concentrated at the points E. This condition will obviously tend

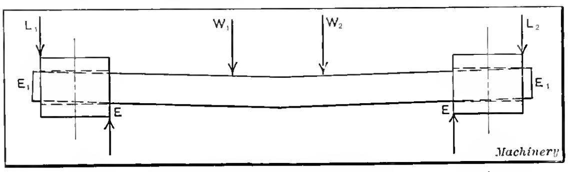

Fig. 4. Diagram illustrating Possible Result of Excessive Deflection of Shaft

to cause trouble in the bearings and such trouble may be experienced by having the shaft too weak, even though the load is not excessive or the design of the bearings defective in any way. Considering the large diameter that was found to be necessary from the preceding calculations, it is not surprising that it is becoming a general practice to support such a shaft on three bearings as shown at X in Fig. 5.

Shaft Carried in Three Bearings

In order to investigate the conditions of a shaft supported by three bearings, it will be necessary to not only obtain the required diameter of the shaft but also to investigate the distribution of the total load over the three bearings. The latter will be found to constitute an extremely important factor. The first step is to obtain the maximum bending moment on the shaft. Regarding the spans AC and CB as simple beams supported at the ends and loaded with 5 and 7½ tons, respectively, the negative bending moment diagrams are as illustrated at Y in Fig. 5. For the simple beam AC let R_a equal the reaction at A.

Then

$$R_a \times 27 = 5 \times 6$$

$$R_a = \frac{30}{27}$$

The maximum bending moment M is given by the following:

$$M = R_a \times 21 = \frac{30}{27} \times 21 = 23.3 \text{ inch-tons}$$

The ordinate DD_1 in the negative bending moment diagram is therefore made to represent 23.3 inch-tons. By a similar method of procedure it will be found that the maximum bending moment on the beam CB is 35 inch-tons and the ordinate EE_1 is laid off to represent this value.

The positive bending moment diagram is next superimposed upon the negative bending moment diagram. For the present, the value of the positive bending moment at the middle sup-

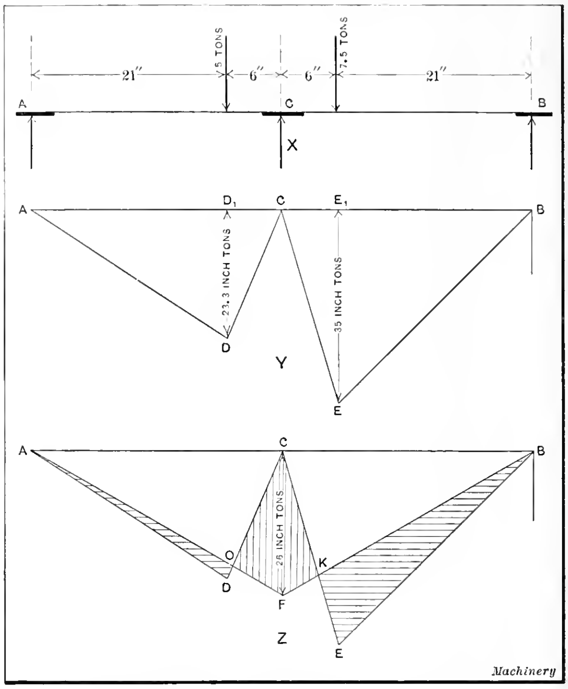

Fig. 5. Diagram showing Shaft supported by Three Bearings and Bending Moment Diagrams

port is unknown. The positive bending moment is obtained from the equation deduced from the theorem of three moments given by the following:

$$\frac{6\,Z}{L_1} + \frac{6\,Z_1}{L_2} = M_a\,L_1 + 2\,M_c\,(L_1 + L_2) + M_b\,L_2$$

where

Z = moment about A of the negative bending moment diagram for the span AC, *i. e.*, the moment of the triangle ADC about A;

Z_1 = moment of triangle CEB about end B;

M_a = positive bending moment at support A; the value of this moment is zero in the present case since the ends are simply supported.

M_b = positive bending moment at B = zero for the present case;

M_c = positive bending moment at C = ordinate CF;

L_1 = length of span AC = 27 inches;

L_2 = length of span CB = 27 inches.

For the present case the equation derived from the theorem of three moments reduces to:

$$6(Z + Z_1) = 4 \times 27^2 \times M_c \quad (3)$$

Sinco

$L_1 = L_2 = 27$ and $M_a = M_b = 0$

$$Z = \frac{23.3 \times 21}{2} \times \frac{2}{3} \times 21 + \frac{23.3 \times 6}{2} \left(21 + \frac{6}{3}\right) = \text{mo-}$$

ment of ADD_1 + moment of D_1DC about the end A.

$Z = 23.3 \times 147 + 23.3 \times 69 = 23.3 \times 216 = 5032.$

Similarly $Z_1 = 35 \times 216 = 7560.$

Substituting the preceding values of Z and Z_1 in Equation (3) gives

$$6\,(5032 + 7560) = 4 \times 27^2 \times M_c$$

$$M_c = \frac{6 \times 12{,}592}{4 \times 27^2} = 26 \text{ inch-tons}$$

Making the ordinate $CF = 26$ inch-tons, the triangle AFB, shown at Z in Fig. 5, represents the positive bending moment diagram which is to be superimposed on the diagrams of negative bending moments shown at Y. The shaded portions of the diagram show the resultant bending moment diagrams. The triangles ODA and KEB are the negative bending moment diagrams and the area $OCKF$ is the positive bending moment diagram. Consequently the maximum bending moment M occurs at the point C and has a value of 26 inch-tons. The twisting moment T has a value of 95 inch-tons, as previously determined. For this combined twisting and bending load the required shaft diameter is obtained from the chart or by means of the formula previously given, and is found to be 5.75 inches. This figure is based upon an allowable fiber stress of 3.5 tons per square inch.

Distribution of the Load on the Bearings

Let R_a represent the reaction at the bearing A (Fig. 5). Taking moments about the point C of all loads to the left of C gives $5 \times 6 - R_a \times 27$ = positive bending moment at $C = 26$ inch-tons.

$$R_a = \frac{4}{27} = 0.148 \text{ ton.}$$

Taking moments about the point C for all loads to the right of C gives $7.5 \times 6 - R_b \times 27 = 26$ inch-tons.

$$R_b = \frac{19}{27} = 0.7 \text{ ton}$$

From the preceding we obtain

$$R_c = 12.5 - R_a - R_b = 11.6 \text{ tons.}$$

It will, of course, be evident that the reaction of R_c represents the load on the middle bearing, from which it will be seen that by far the greater portion of the load is carried at this point and it is extremely important for this fact to be remembered when determining the dimensions of the middle bearing. In the case of the shaft carried by two end bearings, the most important factor was the deflection, and as it is obvious that the provision of a central bearing will materially reduce this deflection, the necessity for providing a large central bearing may easily be overlooked. If this mistake is made, the provision of the central bearing may actually do more harm than good. Although the end bearings A and B in Fig. 5 take only a small part of the load for the conditions shown in the illustration, it must not be forgotten that the maximum loads on the end bearings probably occur when other gears on the shaft are carrying the load. The fact that the load is distributed over the middle bearing will make the shaft slightly stronger than it was found to be by the preceding calculations.

Finally, it is desirable to examine the torsional stiffness of the shaft, particularly for cases where the gears have to slide on keys. For the case under consideration, where the twisting moment $T = 95$ inch-tons, let

L = the length in inches of shaft carrying the torque;

N = modulus of rigidity = 5000 tons;

θ = angle of twist in degrees.

Then

$$\theta = \frac{583\,LT}{ND^4}$$

Assuming that under certain circumstances the whole length of the shaft is under torque, *i.e.*, $L = 54$ inches

$$\theta = \frac{583 \times 54 \times 95}{5000 \times 5.75^4} = 0.55 \text{ degree, approximately}$$

The value obtained by the preceding equation is, of course, an extreme case which would seldom arise in actual practice, but calculating on this basis insures having a shaft of ample strength.

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PIECE-WORK AND PROGRESS

BY J. CROW TAYLOR*

Perhaps the strongest point that can be raised by manufacturers and shop superintendents against piece-work is that it often proves a handicap to progress. Piece-work primarily makes for higher efficiency with the equipment and the men at hand. It encourages effort and makes its return in proportion to the amount of effective effort put forth.

The trouble comes when new improvements are offered in the way of machines and equipment to reduce cost. Here the piece-work system stands as a bar that sometimes may be let down easily and sometimes may not. There is always more hesitancy about installing labor-saving machines and devices where the piece-work system is in vogue than where day-work prevails, because, if for no other reason, it calls for a readjustment of piece-work prices. This is always a difficult and trying problem—one that too often results in dissatisfaction and labor troubles.

An illustrative instance of this kind was given by a factory owner recently in connection with their molding department. As any one familiar with molding knows cutting the sand is one of the unliked and tiresome jobs connected with the work. This man said that there was brought to him a proposition in the shape of a mechanical device that would do the work of cutting the sand for the molders in his place for less than half what it was costing him. Most of them were shirking this task themselves by letting it out to others on a contract basis. The man with the mechanical device would not offer to sell his device outright, but wanted to operate it on a contract basis. This involved more complications than would have been met with had the proposition been for the owner to buy the equipment and readjust his molding scale accordingly. The proposition involved giving the molders the benefit of the saving effected, yet a share of it must needs go to the factory owner, too, because some power was required to drive it and the power would have to be supplied by the factory. He said that he had been trying for some time to figure out a scheme by which they could use it because it could easily effect a saving for them and at the same time help the molders to make more money.

He will perhaps find a way somehow, some day, but the incident serves to illustrate how piece-work is often a handicap to progress, not necessarily because the piece-workers are opposed to innovations and labor-saving devices, but because any new thing of this kind calls for an entire reorganization of the system. This is troublesome and results in grumbling and dissatisfaction, and the upshot of it all is that many factory owners operating on the piece-work basis let opportunities to improve their plant in efficiency go by because of the handicap of piece-work.

Perhaps in a general readjustment of industrial affairs between employers and employes there will be devised some scheme for a satisfactory day wage regulation supplemented with a profit-sharing proposition that will be satisfactory all around. Then progress in the way of efficiency through new machines and appliances and methods will be made easy and freed from some of the handicaps that seriously retard it today.

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Iridium was once cheaper than platinum, but at present its value is about twice that of the latter metal. Up to a few years ago, there was no other use for it except for the points of gold pens, but since then it has found extensive use as a hardener for platinum. Very little pure platinum is now being used and nearly all of the commercial metal going under this name is the so-called "hard" platinum which is an alloy of platinum and iridium.

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THE ACCURATE HEAT-TREATMENT OF ROLLER BEARING PARTS*

EQUIPMENTS AND METHODS WHICH FACILITATE RAPIDITY IN HANDLING AND UNIFORMITY OF WORK

BY E. F. LAKE†

The manufacture of bearings of either the ball or roller type has grown into a good sized industry in the past few years. The automobile industry is responsible for a large part of this growth, as it would have been difficult, if not impossible, to make the automobile a success without these anti-friction bearings. This is especially true of roller bearings, which are used on nearly all automobile wheels and are a special benefit. They must be made as small and light as possible and, at the same time, strong enough to carry the load of the car, combined with that of the passengers or other weight that the car may carry.

The first essential of either type of bearing is a steel that possesses the qualities that will enable it to withstand the strains to which the bearings may be subjected. The second essential is correct machining operations, as the parts must be made within a fraction of a thousandth of an inch of the correct size. The third essential—and perhaps the most important one—is the heat-treatment that these parts receive. This must be of such a nature as to make the steel resist the crushing, vibrational, frictional, or other strains to which all bearings are submitted. The reason this is considered the most important factor in the process of manufacture is that the strength, wearing qualities, resistance to fatigue, etc., can be greatly increased or decreased by accurate or inaccurate heat-treatment. It is an easy matter to accurately heat-treat ordinary carbon steels and make them excel the highest grades of alloy steels which are not correctly heat-treated. At the same time, it is possible to give such alloy steels double the elastic limit and reduction of area of the ordinary carbon steels when both are correctly heat-treated. Likewise, the resistance to fatigue, or vibrational strains, of the alloy steels can be made more than quadruple that of the carbon steels.

After the steel parts of bearings have been machined to their correct size and shape, it is essential that they be thoroughly annealed before they are carbonized, hardened and tempered, or subjected to both these treatments. This relieves any internal strains, making the physical properties the same in all parts of a piece and the strength uniform in all directions from any given point. For this reason the annealing of all other steel parts is just as essential, and particularly those parts that have to resist strains of any kind. It should always be remembered that a steel piece is greatly weakened when more of the cohesive force, which binds the molecules together, is concentrated at one place than at another. When steel leaves the rolling mill it is full of these unequal strains.

Fig. 1. Casehardening Pots and Special Heating Furnaces used by the Timken Roller Bearing Co.

All steels that are used in the manufacture of ball and roller bearings are first poured into ingots that may be anywhere from 6 to 18 inches square. These ingots are usually hammered to a size that will make them small enough for the rolling or forging operations. The grain of the cast ingots is very crystalline and, hence, very weak in comparison with the same steel after it has been hammered, rolled, forged, etc. The mechanical working crushes the crystals together and gives the metal a more fine and dense structure. It increases the elastic limit and other static properties of the metal, as well as its dynamic properties.

While doing this, however, it sets up unequal internal strains in the steel which should be removed before attempting to give it its final heat-treatment. Therefore, the various parts that enter into the construction of the complete

* For other articles on the heat-treatment of steel published in MACHINERY, see "The Heat-treatment of Gears at the Boston Gear Works" by George L. Colburn, published in MACHINERY, June, 1913, and other articles there referred to.

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bearings of the best grades are always thoroughly annealed just before they are carbonized, or hardened and tempered. Sometimes steel is annealed before any machine work is performed. This first annealing is usually done at the steel mill before the steel is shipped, but it will not take the place of the annealing that should be done after the steel is manu-

Fig. 2. Use of Truck in placing a Pot in the Furnace

factured into the different pieces. This is because the machining operations are likely to set up other internal strains.

In heating steel, the temperature will reach a point at which there occurs a change in the grain, or a new grain structure is born. With this rearrangement of the grain structure any unequal strains will disappear. Annealing consists of raising the temperature of the steel high enough to be assured that the metal has had time to thoroughly complete this change of structure. The steel is then allowed to gradually cool to the temperature of the atmosphere. The slower this cooling takes place the more thorough will be the annealing and the obliteration of any internal strains. If cooled too quickly, a hardening of the metal takes place and other strains are likely to be set up; this is especially true if it cools unevenly or more quickly in some sections than in others. If the steel is heated too high above the transforma-

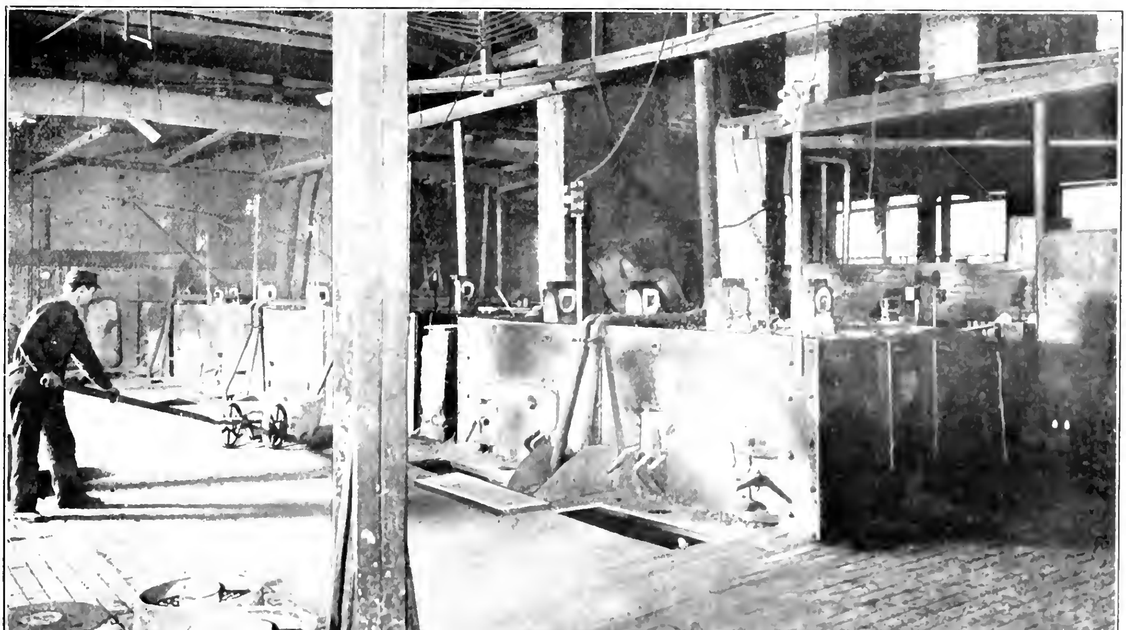

Fig. 3. Furnace with Floor-plate removed to show Burner

tion point the grain will become coarsened, as each degree of temperature above this point adds to the coarseness of the grain structure.

This information is the basis of three rules that it is well to follow when annealing all steels. First, heat the metal to a temperature above the highest transformation point but not far enough above to coarsen the grain; second, hold the temperature at this point long enough to allow the transformation to be completed but do not prolong it beyond that; third, make sure that the rate of cooling is sufficiently slow to prevent even a superficial hardening.

To insure a uniform heating in a neutral atmosphere and a slow cooling, small parts should be packed in some non-carbonizing material held in metal pots, the covers of which are sealed on with clay before the pots are put into the furnace to be heated up to the annealing temperature. The Timken Roller Bearing Co., of Canton, Ohio, probably handles this work as economically as it is possible to and still obtain the accuracy that is required. The method of procedure is shown in Fig. 1. Round cast-iron pots with hollow centers are used,

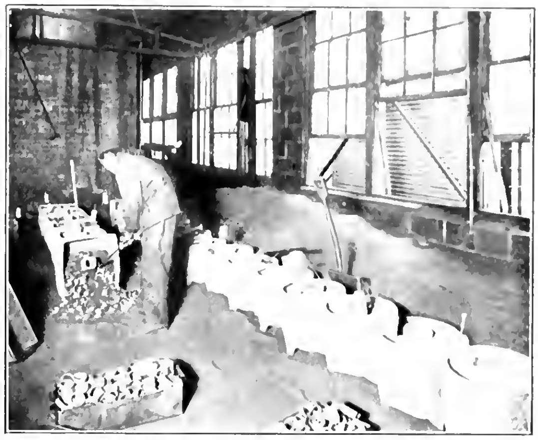

Fig. 4. Dumping and sorting Work that has been carbonized

in which the work is packed in the non-carbonizing material. When the pots are filled, they are lifted by the two-wheeled truck shown to the right and wheeled into the furnace, as shown in Fig. 2. Then the pot is dropped on its four legs, the truck pulled out and the door closed.

The oven of each furnace has been lowered so that its bottom is level with the shop floor, and thus a great deal of time and labor is saved in charging the work into the furnaces. In front of each furnace there is a pit covered with floor plates. The burners, piping and valves that convey and regulate the fuel and blast which supplies the furnaces with

heat are located in these pits, the combustion chambers of the furnaces being below the floor level. The burner in the first furnace is clearly shown in Fig. 3, by the white spot under the door of the heating chamber, the floor plate having been removed for this purpose. These furnaces were built by the company from their own special designs, with a view of obtaining accuracy and uniformity of temperature in the heating chambers. They are built in pairs.

Before adopting this method the pots were gripped with long tongs by one man, and two other men, one on each side of the furnace door, lifted each pot into the furnace or took it out, the furnaces being set on top of the floor, as is the usual custom. By lowering the combustion chamber below the floor level and thus bringing the floor of the heating chamber on a level with the shop floor, one man with the truck shown in Figs. 1 and 2 is able to handle larger and heavier pots in less time than that formerly taken by the three men. Thus, the saving in labor has more than paid for the lowering of the furnaces.

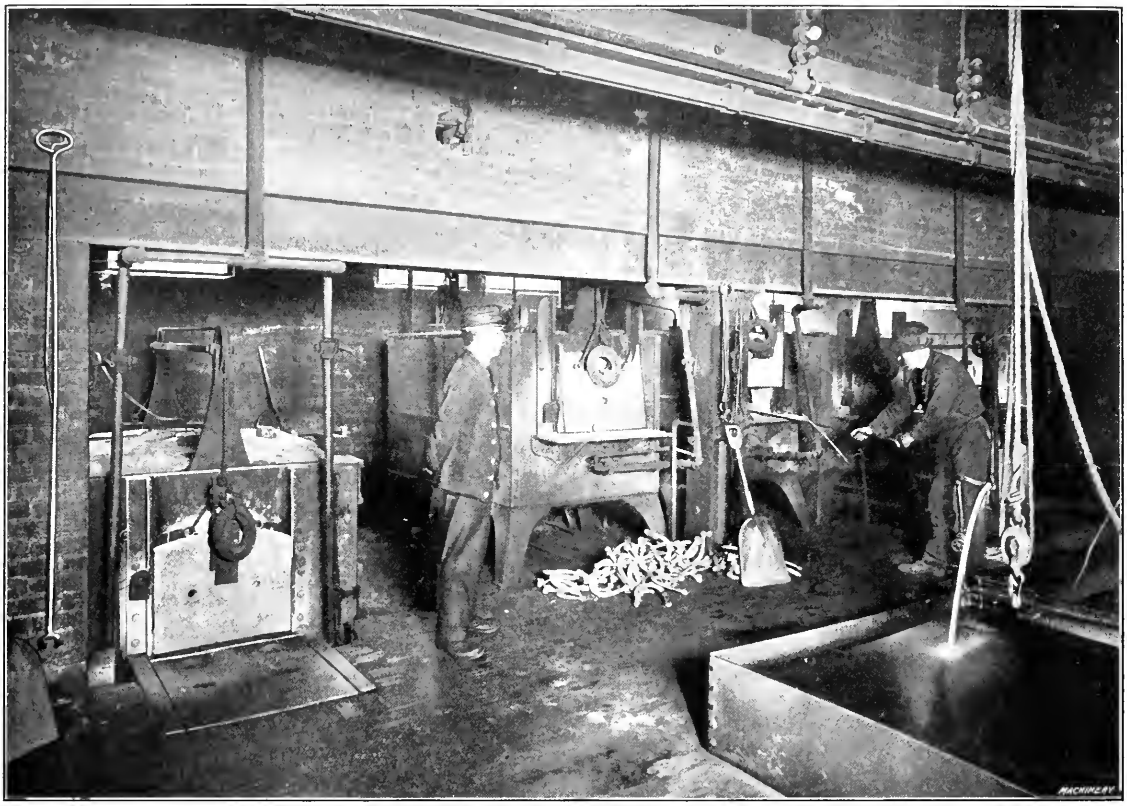

Fig. 5. Arrangement of Hardening Furnaces and Quenching Tanks

To be assured that the furnace temperatures are correct, a pyrometer system has been installed. Thermo-couples have been inserted in each furnace and the indicating meter is located in a separate room. Only one indicating meter is required to show the temperature in some twenty-four furnaces. One man has charge of this room and his only duty consists of operating the pyrometer to ascertain the temperature of each furnace at intervals of a few minutes, and to see that the furnaces are kept at the temperature desired. By means of electric lights, he gives the furnace operator a signal when the temperature of any furnace is too high or too low; and then he insists that the man at the furnace adjust the valves to bring it back to the correct temperature.

The signals consist of three incandescent lamps that are shown on a steel bar above the door of each furnace. The central light is clear glass, while the upper one is red and the lower blue. When the temperature of the furnace is correct the central light is the only one that shows. This is best illustrated in Figs. 2 and 3, where all the furnaces show the white light burning. If the temperature goes too high, this central light is turned off and the red one above it is lighted. Then the furnace operator must lower the fuel oil and blast that is going through the burners and thus reduce the size of the flame. When the temperature is too low, the blue light is turned on and the others are switched off. Then it becomes necessary to increase the column of the flame entering the furnace.

Fuel oil and dry steam are used for heating the furnaces. This oil is located in large tanks underneath the floor of the shop and quite a distance away from the furnaces. As pressure on the oil is needed, a pump drives the oil from this tank through the burners at a pressure of about 15 pounds per square inch. The steam passes through the burners at a pressure of about 60 pounds per square inch and this gives the proper combustion.

Some parts of bearings withstand the strain much better if made from low carbon steel and carbonized. This gives the outer surfaces of such parts a high carbon content that can be made hard to resist frictional wear or any tendency to crush or deform, while the low carbon center, or core, will remain soft and ductile, and thus make it difficult to break the piece with any of the severe shocks or strains it receives when in use. This carbonizing is done after the piece has been machined to the proper size and shape. Grinding is the only kind of work that is practical after the steel has been carbonized.

In performing the carbonizing operation, the work is packed in iron pots and heated in furnaces in just the same manner as shown for the annealing operations. The material in which the work is packed differs, however, as it must be a carbonaceous instead of non-carbonizing material. Bone, charcoal, charred leather and numerous other materials have been used for this purpose, both alone and in various combinations. Figs. 1 and 3 illustrate the methods of packing the work. Fig. 1 shows the bank of furnaces used for carbonizing. The first of these is a Frankfort furnace, which was installed by the Strong, Carlisle & Hammond Co., while

the others were built by the Brown & Sharpe Mfg. Co. The special annealing furnaces built by the company for their own use are shown in Fig. 3.

In the lower left-hand corner of Fig. 3 will be seen part of a pot that has been sealed up ready to insert in the furnace with the two-wheeled truck that is being handled by the man at the left of the picture. Beside it are two pots that are only partly filled. These show the way the work is laid in the carbonizing material. Each steel piece is kept at least one inch away from all other pieces. Then the carbon can penetrate all parts of the outer surface when the pot and its contents are heated to a temperature that is high enough to make the steel so hot that it will absorb carbon.

The amount of carbon that is thus injected into the outer surfaces of the steel and the depth to which it penetrates are governed by the composition of the steel; the nature of the carbonizing material; the temperature of the furnace; the larger will be the amount of carbon that it will absorb in a given time; and the greater the depth to which it is possible to make the carbon penetrate. Owing to the grain of the steel becoming gradually coarsened by each degree that the temperature is raised above the transformation point, there is a limit to the heat that can be successfully used when carbonizing steels. When heated too far above the transformation point the grain begins to crystallize, and at still higher heats the crystals begin to separate from one another. When these small cracks appear between the crystals the usefulness of the metal has been destroyed and it can only be restored by remelting and rerolling or reforging. Before the crystals begin to separate, the original fineness of grain can be restored by allowing the steel to cool and afterward heating it to a little above the transformation point and then suddenly cooling it by quenching in oil or water. This is the hardening operation and if properly done it will

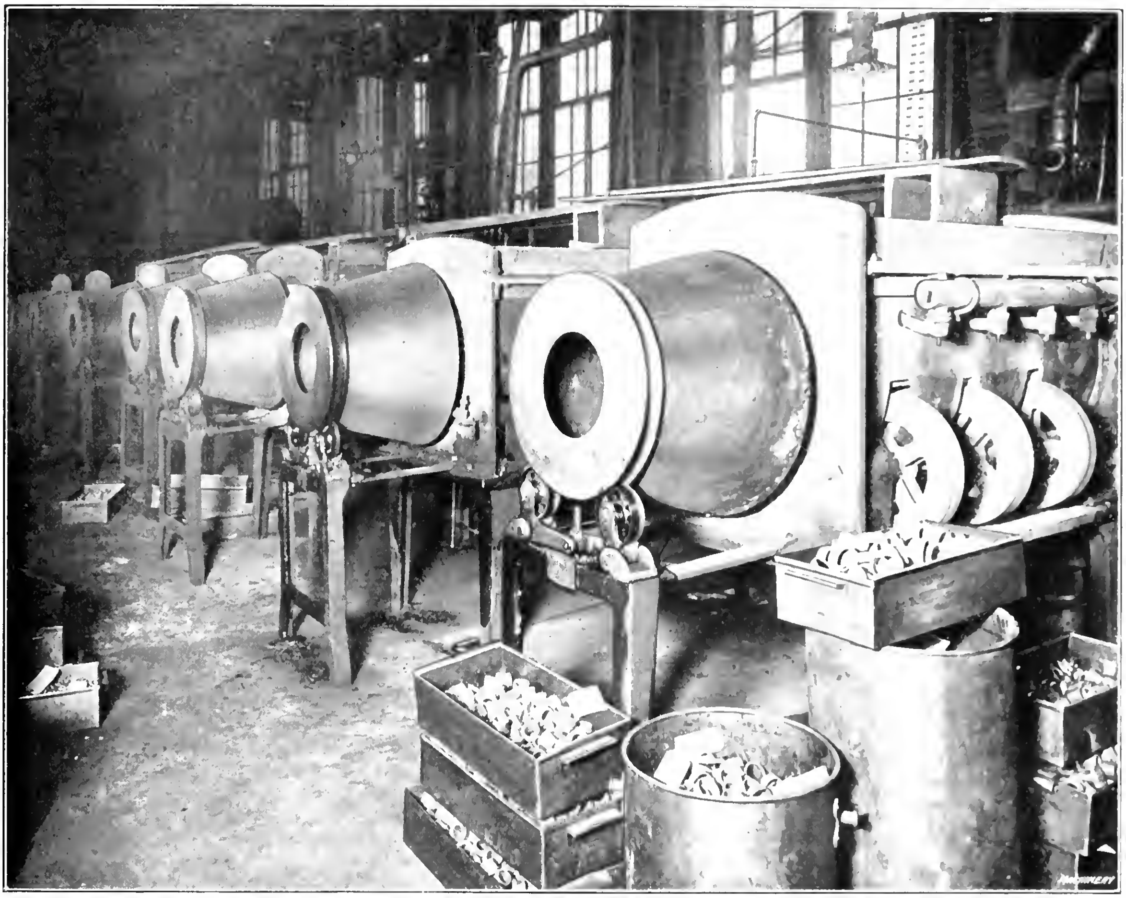

Fig. 6. Rotary Furnaces used for drawing the Temper of Roller Bearing Parts

and the time the work is held at this temperature. The outer shell of the steel piece is usually made to absorb enough to give it 1.00 per cent of carbon. This percentage of carbon gradually diminishes toward the center of the piece until the low carbon content of the original metal is reached. This will vary from 0.10 to 0.20 per cent of carbon, as it is such grades of steel that are used for parts that are to be carbonized. Many of the high-grade alloy steels, as well as the ordinary carbon steels, are carbonized to various depths and with various percentages of carbon. These alloys give much better results in bearings than any of the carbon steels, and are nearly always used for the parts of bearings that have to withstand great strains. They are more expensive, however, and hence some of the cheaper bearings are made from the carbon steels.

The higher the temperature to which the steel is raised, the more quickly will it absorb carbon to a given depth; put the steel in as good a condition as though the grain had not been coarsened by overheating.

Therefore, carbon steels with a transformation point of 1500 degrees F. or below can be held at a temperature of 1650 degrees for several hours, when carbonizing them, and the coarsened grain can then be brought back to its greatest degree of fineness by the subsequent hardening operation. Some of the alloy steels with a transformation point of 1650 degrees F. can be heated to 1750 degrees for the carbonizing operation. These temperatures will give a rapid penetration of carbon; they also give as high a percentage in the outer shell as is required for practical work and to the necessary depth. Under ordinary conditions, a temperature of 1650 degrees F. maintained for one hour will cause the carbon to penetrate to a depth of 1/64 inch; three hours will give a depth of case of 1/32 inch; nine hours a depth of 1/16 inch; and twenty-four hours will give a depth of 1/8

inch. It is very seldom that the high carbon content is required for a depth of more than 1/16 inch and thus each lot of steel parts can usually be carbonized in a day's run.

After deciding what is the best temperature for the carbonizing heat, the best results can only be obtained by keeping the furnace uniformly at that temperature during all the time the work is in the furnace. Hence the same pyrometer is installed on these furnaces that is used on the annealing furnaces and on all other furnaces used in the heat-treating department. Then the time will decide the depth of penetration, and when the desired depth has been obtained the pot should be taken out of the furnace and allowed to cool slowly to below 600 degrees F. After that, the work can be taken out of the pot and allowed to cool quickly. Then it is ready for any hardening and tempering that is required. In Fig. 4 is shown the way the work is removed from the pot and sorted. The square pots are used for carbonizing work and the round ones for annealing. Thus there is no excuse for getting the work mixed in these two operations. Some take the pot out of the furnace and dump the work directly into the quenching bath for the hardening operation. The carbonizing temperature is usually too far above the transformation point, however, to give the steel the finest grain that it is capable of assuming. Thus it is far better to allow the work to cool down from the carbonizing temperature and then re-heat it for the hardening operation.

In hardening carbonized bearing parts, the best results are obtained by giving them a double heating and quenching to get the proper degree of hardness in both the hard outer shell and the soft core. This is due to the fact that the transformation points of high and low carbon steels occur at different temperatures, which are often 200 degrees apart. The steel should first be quenched from the high transformation point of the low carbon steel in the core and then reheated to the lower transformation point of the high carbon steel of the outer shell and again quenched. This produces bearings that it is almost impossible to break or crush under the load that they are designed to carry. It also gives them a wearing surface that will last a long time, as its grain is very fine and dense.

Some parts of the bearings are made from steel that contains the desired amount of carbon. These parts are hardened and tempered without being subjected to the carbonizing process. Such work is inserted in furnaces and heated to the hardening temperature without being packed in iron pots. When it has reached the correct heat for hardening, it is quenched in tanks of oil or water. If the hardening temperature has been just right, *i. e.*, just above the transformation point, the steel will then be in the hardest state to which it can be brought. It will be what is termed "glass hard," and hence brittle, and must be heated again to a high enough temperature to draw out enough hardness to obtain the desired degree of toughness.

The hardening temperature is the most important one and will not allow of as much variation as the annealing and carbonizing temperatures, if the best results are to be secured. If the steel is not heated up to the transformation point before it is quenched, the change in grain structure will not take place and the steel will be no harder than when it leaves the rolling or forging operations. If heated above the transformation point the grain coarsens in proportion to the number of degrees of temperature above this point. As it coarsens, the physical properties of the steel deteriorate. Each rise of 50 degrees F. above the transformation point will lower the elastic limit of carbon steels something like 5000 pounds per square inch, and other physical properties in like proportion. Thus the greatest strength that can be given the steel can only be obtained at a certain temperature. Any variation from this means weaker metal. Its capacity to resist fatigue also loses somewhat over 15 per cent with each 50 degrees rise above the transformation point.

In hardening the various parts of Timken roller bearings, furnaces similar to those shown in Fig. 5 are used. These are the Strong, Carlisle & Hammond Co.'s furnaces. When the correct temperature has been obtained, the work is thrown into one of the tanks shown at the right, so it will suddenly cool. The hot steel would naturally raise the temperature of this bath, and when raised too high the steel would not be cooled quickly enough to produce the greatest degree of hardness. To overcome this difficulty, the liquid is kept constantly in circulation by allowing the hot fluid to overflow at the top of the tank and run into a larger tank which is located below the level of the floor at a considerable distance away. This allows the liquid to cool by radiation, and it is then pumped back into the tank. The stream that can be seen steadily flowing into the tank is the cool liquid coming from this pump. A wire basket lies in the bottom of the tank and covers nearly the entire bottom. When the hot steel is thrown in the bath it is caught in this basket. The block and tackle shown is used to raise the basket out of the tank when it becomes filled with work which has had time to cool. The basket is merely raised above the level of the tank and the work dumped into cars or trucks that convey it to the other parts of the shop where it is to be used. Thus large quantities of work can be handled during a regular work day at a very small cost.

The accuracy of the drawing temperatures is also very important. When too much of the hardness is drawn out, the bearing parts will be too soft and will compress when under load. When too little of the hardness is drawn out, they will be too hard and brittle and thus likely to crush or break. To get the greatest accuracy in the drawing temperatures, the furnaces shown in Fig. 6 are used. The heating chambers of these furnaces are revolving retorts through which the work slowly travels until it has absorbed the highest temperature of the furnace. It then drops out at the far end into receptacles which are removed when they are full. The retort has a spiral web on the inside and this, in connection with the speed at which the retort is revolving, controls the time that is consumed for the work to travel through. The work is dumped into the round hole shown at the near end of the furnace. Thus the tempering is done automatically and the furnace operator can devote most of his time to adjusting the burners, so the furnace will be maintained at the correct drawing temperature. These furnaces can also be used for automatically heating bearing parts to the hardening temperature and then dropping them into a quenching bath at the far end of the furnaces. The retort would then have to travel slower to allow the work more time in which to reach this higher temperature.

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THE FIRST STEAM ENGINES

The first steam engines are said to have been built for use in pumping water out of mines. They were connected to vertical reciprocating pumps and were built with vertical cylinders. As it was not considered practical to place the engine directly over the mine-shaft, the heavy parts were placed at one side and a beam was used to reach over the shaft and make connection with the pump rod. At a later date the same style of engine was applied to drive mill machinery, the pump rod being connected with the crank which drove the shafting. This type of engine was used for several generations before a man came along who saw that the beam was unnecessary where there was no pit's edge to reach over. This is but an indication of the value of experience in power transmission and other engineering problems, and it is the accumulation of knowledge in this way that enables present-day designers to work out a transmission system to meet existing conditions. Various types of transmissions are used to meet the complex requirements of modern manufacturing plants. The development of these drives is the result of experience, and in order to get the most satisfactory results from a given installation it must be of the type best suited for the work; the equipment must also be correctly installed and properly cared for after installation in order to obtain the maximum efficiency.

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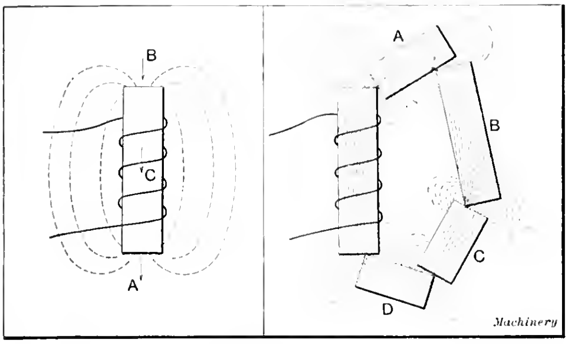
If iron is present in sufficient amount in brass castings, they will be hard and difficult to machine. The iron content should not exceed 0.5 per cent, in order to make good yellow brass castings that can be easily turned.

THE INSIDE OF THE MAGNETIC CHUCK—1

CHUCKS FOR VARIOUS PURPOSES AND PRINCIPLES OF DESIGN

BY HERBERT L. THOMPSON*

From the average mechanic who is not familiar with their various uses, magnetic and electrical appliances for shop use still receive a certain amount of distrustful indifference. This is undoubtedly the reason why they are not in more general use, and it is reasonable to believe that a better knowledge of the simplicity of their construction and operation would greatly add to their prevalence in all modern shops, both for tool work and manufacturing. Prejudice is often responsible for discrimination against magnetic chucks,



Figs. 1 and 2. Diagrams illustrating the Flow of the Magnetic Current

but if the tool designer would only realize how extremely simple they are, and how efficient for certain classes of work, we would see a great many more of them in use.

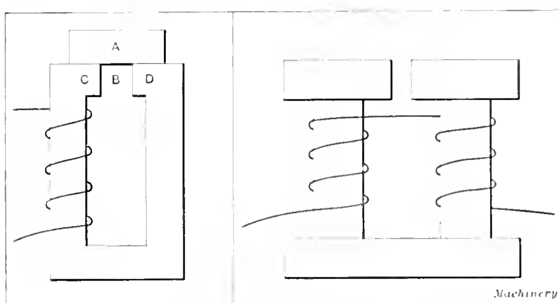
It is not difficult for anyone with an elementary knowledge of the principles involved to make good serviceable magnetic chucks; chucks that will hold any kind of iron or steel work and will operate on any direct-current lighting circuit of the voltage for which the coils are wound. The amount of machine work required in making them is generally slight and of the simplest kind, and when the low cost of the material and the operating current is considered, it is positively an expense to be without them, if any quantity of surface grinding, planing or milling is being done.

Every tool designer and tool-room foreman should be able to produce magnetic chucks for any work to which they are adapted. It is not a problem to which only an electrical engineer can aspire; on the contrary, the ordinary possessor of common sense and a little ingenuity can originate chucks of suitable sizes and shapes for a great variety of purposes, if he but knows approximately how to provide a proper magnetic circuit, energizing coils of proportionate size, and can use Ohm's law to determine the size of wire to employ in the coils to accommodate the voltage upon which the chuck is to be used. By computing the absolute resistance of the magnetic circuit and using a technically correct coil, a chuck could be made that might operate on a few cents worth less of current per week than one designed by the layman, but it is extremely doubtful if the possible economy would repay one for the extra effort. At any rate electrical formulas of this kind are very unsatisfactory, owing chiefly to the fact that the magnetic resistance of iron varies greatly, even in different parts of the same piece.

Comparatively few magnetic fixtures are employed for other than plain flat work on the surface grinder, the many obvious advantages obtained by the use of even an indifferent chuck in this connection having won them a place of some prominence. For milling, planing or turning, however, they have never been taken as seriously, and the reason is simply a deplorable lack of confidence in the holding power of a magnet for work of this character. While it is true that the ordinary surface grinder chuck is not intense enough to hold some of the heavier work, it is a simple matter to design chucks of enormous holding power for almost any shape of work. Of course, it is necessary to provide stops to take up the tool thrust on most heavy work, but as this in no way detracts from the value of the chucks as operation savers, it cannot be urged as an argument against them. Even non-magnetic metals such as brass or aluminum can be held on specially designed magnetic fixtures. To be sure, they cannot be held directly by the magnetism, as iron or steel could, but iron or steel clamping levers can be provided which are so disposed that the magnetic force will draw them against the work to be held. Perhaps this would not constitute a magnetic chuck, strictly speaking; but it is one of the variations that can be resorted to, and it will give instantaneous clamping and unclamping of the work which is the main consideration. Sometimes it is necessary to hold even iron or steel pieces in this way if they are very small or thin, as it is unhappily a fact that a piece of work must have a certain amount of cross-sectional area in order to be strongly held by any magnet.

Elementary Principles of Magnetic Chuck Design

The range of work that can be done with magnetic chucks is so enormous and of such diversified character that a description of a few of the different forms would avail little toward imparting useful knowledge to one who wishes to design them for special work, unless some attention was given to the elementary principles governing the production of an efficient electro-magnet. In other words, while the common type of chuck for flat work is very useful in the tool-room and at times in the manufacturing departments, it is the ability to adapt the magnetic circuit to any special work of varied shapes and sizes that is particularly valuable, for often work is held in a clamping fixture which consumes from 20 to 80 per cent of the operation cost in the clamping and unclamping, though it could be held with a magnet and gripped or released by simply throwing a switch. While it is not necessary to have more than a rudimentary knowledge of electricity in general to construct a good serviceable magnetic chuck, there are a few simple facts that must be borne in mind if the greatest success is to be obtained. The formulas given in the textbooks are suitable for dynamo design, in which a fraction of one per cent in efficiency is important; they are quite intricate, and as such accuracy is



Figs. 3 and 4. Diagrams showing the Function of the Air Gap and the Method of winding the Coils

unnecessary for magnetic chuck purposes, it would be a waste of time to master them. In fact, it is possible to explain all that is necessary by the use of a few simple diagrams.

A bar of iron upon which a coil of insulated wire is wound in one direction becomes a magnet when a direct current of electricity is passed through the coil. The greater the amperage (quantity) of the current, the stronger the magnet will be, up to a maximum point, which is called the "point of saturation." If the number of turns of wire about the bar is increased, the magnetism will increase in direct proportion, provided the amperage of the electric current is maintained and the magnetism does not approach too closely to the point of saturation.

The magnetic force caused by the passage of the electric

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current around the bar exists in the form of a magnetic current which enters one end and leaves at the other, as shown by the dotted lines in Fig. 1. It is apparent that the current that leaves at *A* is the same as that entering at *B*, and that there is a circuit up through the iron bar and back to the starting point through the surrounding air outside of the coil. Iron is an excellent conductor of magnetism, and for that reason the current travels easily through the bar; but in its effort to return outside of the coil it is greatly spread out, because it requires as much more air for its path as air is a poorer conductor than iron. To be more explicit, a conductor for either a magnetic or electric current must present a path of a cross-section increasing directly as the resistance of the material used. This is of paramount importance, as any increase in resistance results in a corresponding decrease of current, and if the material composing the circuit is of poor conducting quality, there must be enough of it to carry the current, as the resistance of any conductor varies directly as its cross-sectional area.

A bar magnet such as shown in Fig. 1 is not fit for any but explanatory purposes, as it really constitutes only a part of a magnet. That is to say, a complete magnet would be one in which the whole magnetic circuit was provided with a path of good conducting material, both inside and outside of the coil, so that there would be no loss through the resistance of an air gap. An approximation of this condition can be seen in Fig. 2, in which the poles of a bar magnet like Fig. 1 are roughly connected by the pieces of iron *A*, *B*, *C*

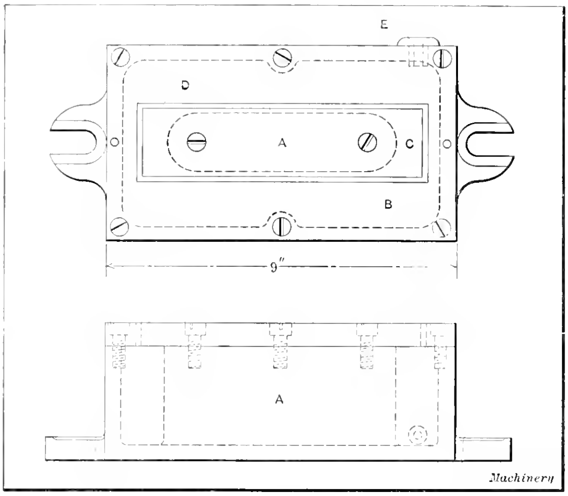

Fig. 5. Three-piece Gray Iron Chuck for grinding, planing or milling Work

and *D*. The dotted lines show how the magnetic current flows through them, and how it is no longer necessary for it to use the air except at the joints between the pieces, which offer too small a cross-section of iron for the conduction of all of the current without some help from the surrounding air.

A magnet will attract outside iron or steel only when the piece attracted constitutes a part of the path of the magnetic current, and the more its presence lowers the resistance of the circuit, the more forcibly it is attracted. Thus, at *C*, the magnet shown in Fig. 1 is not attractive, because a good conducting path is here already established, but at the poles *A* and *B* a strong attraction is felt, which is greatly increased by helping the outside part of the circuit with the pieces *A*, *B*, *C*, and *D*, Fig. 2. The magnet shown in Fig. 2 is feebly attractive only at the junction of the various pieces, as these are the only places where an improvement could be made in the conducting path; but any one of the pieces would resist being separated from its neighbors, and if, for instance, the piece *B* was removed, pieces *A* and *C* would become poles with the entire magnetic current spreading through the air between. They would strongly attract each other or any piece of iron brought within range of the greatly widened current between them. In fact, the entire energy of the magnet would be concentrated toward closing the gap between the pieces *A* and *C*.

The Function of the Air Gap

If the various pieces composing the system shown in Fig. 2 were welded into one continuous link, it would become a perfectly closed magnetic circuit, as there would be no gap for the current to cross through the air. If this was the case, however, the link would be useless as a magnet, as the whole of it would be as inactive as the magnet shown in Fig. 1 is at *C*, and for the same reason. As this is the case, it is highly essential in order to obtain the best results that a magnet should have a continuous conducting path of ample cross-section, except for one gap across which the work is to be held. Fig. 3 shows an example of a magnet of this kind and *A* represents the work in place across the gap *B* from pole *C* to pole *D*. It should be noted that the work *A* has sufficient area of contact with both the poles *C* and *D* to carry all of the magnetism, and that as the work *A* has approximately the same cross-section as either side of the link, it will form a path for the current without appreciably increasing the resistance of the whole circuit; therefore, the entire energy of the magnet will be expended upon holding the work *A* in place.

It is not strictly true that the iron path of any magnetic circuit will carry all of the current. It is necessary for all of the current to pass through the coil, but as the resistance of the iron is increased as the amount of current it carries increases, it is a fact that there will always be some small part of the current that will follow back through the air; for while air is greatly less conductive than iron per unit of cross-section, still there is always so much more air than iron available that it offers some inducement to the current. To receive the greatest possible efficiency from any magnet, it is necessary to have the polar gap adjacent to the coil, so that the piece to be held will bridge the most intense part of the circuit. With this object in view, it is desirable at times to use magnets of the form shown in Fig. 4, in which there are two coils with each pole piece as close as possible to the place where all of the magnetic current concentrates to enter or leave the coils. It is necessary to wind the coils of the magnet illustrated in Fig. 4 in directions as shown, as the direction in which the magnetic current travels is dependent upon the direction in which the energizing electric current flows; and if both magnetic currents moved in the same direction in each core (conductor inside of coil) they would oppose each other and result in no magnetism if they were of equal strength.

It is always desirable to have any magnet as nearly integral as possible, as a joint between two pieces of iron composing a magnet will always impose some resistance upon the current, however well they may fit. At least three pieces, however, are necessary to compose most magnets, as it would be very difficult if not impossible to apply the coils to the cores if the enlarged pole pieces were not removable. The objection to these joints is overcome by giving them as much area as possible and making them very smooth and close fitting. Careful workmanship at these points will make it possible to use more than three pieces in one circuit, when necessary, without unduly impairing the pulling power of the magnet.

Materials for Electro-magnets

Strictly speaking, iron is the only material that will make a satisfactory electro-magnet, but certain kinds of iron give better results than others, owing to their lower magnetic resistance. From the standpoint of efficiency, well annealed Swedish iron is not surpassed for magnetic chuck work, but as it is necessary to forge it into shape and do a great amount of machine work on it afterward, gray iron generally proves to be more practical, especially for chucks of the larger sizes. A magnet composed of soft Swedish iron would possibly hold with as much as 30 per cent more than one of similar design made of gray iron; but it would cost so much more than the cast-iron chuck that, except in case extremely small work was to be held, it would prove an unnecessarily expensive refinement. However, small rotary chucks are often advantageously made of Swedish iron forgings, as it is necessary to

machine them all over to insure good running poise. Whatever iron is used, it must be soft. Forgings should be well annealed after hammering, and if the gray iron castings should be somewhat chilled on the corners, it would pay to discard them and get new ones.

Forms of Magnetic Chucks

The simplest form of magnetic chuck is one having but two poles. There may be any number of coils, but if there is only one gap in the magnetic circuit it constitutes a "bipolar" chuck, and where the work to be done will permit its use, this form of chuck is the simplest and by far the cheapest one to make. Figs. 5, 6 and 7 are examples of bipolar chucks for various purposes. Fig. 5 is a three piece gray iron chuck having only one coil. It will hold any kind of flat work very nicely for surface grinding, and will also hold pieces that are of fair size and have a good contact surface for milling or planing, if suitable stops are provided so that the cutter thrust cannot slide the work off the chuck surface. This is probably the simplest kind of a chuck and is a very good one for the milder kinds of work. The coil is entirely enclosed with the iron frame, making it dirt and moisture proof. It is almost as easily made as an iron box, and while the drawing shows only a gap of plain rectangular outline, it could be made very intricate, if the nature of the work to be done required it.

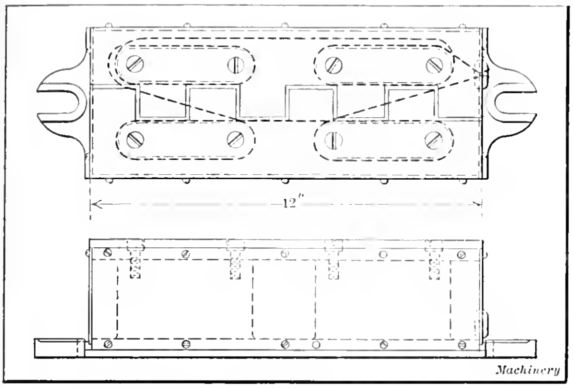

Fig. 6. A Four-coil Electro-magnetic Chuck

The core *A* of this chuck is cast integral with the base and sides. The top is composed of two separate pieces *B* and *C*, and a filler *D* which prevents magnetic contact between the pieces *B* and *C*. The form wound coil is dropped over the core *A*, and the supply wires enter and leave through the fiber bushing *E* in the side of the chuck. When an electric current flows in the wire composing the coil, a magnetic current is generated in the core *A* which circulates from end to end of the core *A* through the base, sides and top of the chuck, jumping the gap through the filler *D* and the air above and below the top plate. The filler *D* is an alloy composed of nine parts lead, two parts antimony and one part bismuth. It has the peculiar property of expanding upon cooling from the molten state. This greatly simplifies the making of the top of this chuck, which is accomplished in the following manner: The parts *B* and *C* are separate rough castings, each having been snagged fairly smooth on one side. They are laid with this smooth side down upon a flat surface, with the piece *C* carefully centered in the hole in the piece *B*. The molten filler alloy is poured between them until it overflows on the top, and when it cools its expansion holds the pieces *B* and *C* in position with absolute rigidity, though they are magnetically separated. The entire rough top plate can now be planed on both sides and the edges, exactly as if it was one piece, it being only necessary while planing the edges to maintain the position of the piece *C* so that when screwed to the base of the chuck it will center fairly well upon the core *A*, as of course, *C* acts as the pole piece of core *A*, while the piece *B* conducts the magnetic current from the sides and becomes the other pole when close to the gap. The piece *C* could be made almost any shape that would facilitate holding the work, but should be made as short in outline as possible, as the magnetic leak through the filler and air across the gap will depend upon the amount of pole area and the distance across the gap, which should never be less than 1/4 inch.

After the top plate is planed, drilled and counterbored for the screws and dowels, it only remains to plane the bottom and top of the base, and drill and tap the holes for the screws, dowels and the fiber bushing *E*, which completes the machine work on this chuck. If the work to be done warrants it, more than one top plate could be made for the base, each having a form of gap to accommodate a certain piece of work; it is such a simple matter to change them that it would probably prove an economy. Stop-pin holes can be drilled into any of the top plates to completely outline the work, if necessary, so that work requiring close location can be handled rapidly. Compared to any form of clamping jig, this little chuck should make an excellent showing both as regards adaptability and cost for any work within its scope.

Perhaps the chief objection to this form of chuck is the fact that one of the poles is too far from the coil, resulting in some loss of holding power; but for light work the simplicity and general compactness make it ideal. Such a chuck should not be made much larger than the dimensions on the illustration; in fact, no single coil chuck should be made much larger unless for holding single very large pieces; and even then a number of small coils would concentrate the force more and make a much more satisfactory chuck.

A Four-coil Magnetic Chuck

For holding work for severe planing and milling operations a chuck like the one shown in Fig. 6 is to be recommended. It will hold considerably more than the design illustrated in Fig. 5, because it has four coils and each pole is adjacent to the coils for its whole length. It is almost as simple as the chuck shown in Fig. 5, as it comprises only three iron parts. However, as it cannot be enclosed by integral iron sides without short-circuiting the polar gap, it is necessary to enclose the sides and ends with some non-magnetic material, so sheet brass is used. Of course, this does not make it water-tight, but as magnetic fixtures are seldom used with water or oil this does not detract much from the value of this shape. The top plate for this chuck is made in the same manner as the one in Fig. 5, but as neither pole piece in this instance embraces the other to any extent, it is doubtful if the expansion of the filler alloy would bind the two halves together firmly enough unless anchor holes were drilled or milled in the pole surfaces to insure a good grip. This can be done very easily though, by drilling quarter-inch holes at varying angles along the edge of the rough plate. The shape of the gap line can differ from the one shown, but it must not approach too

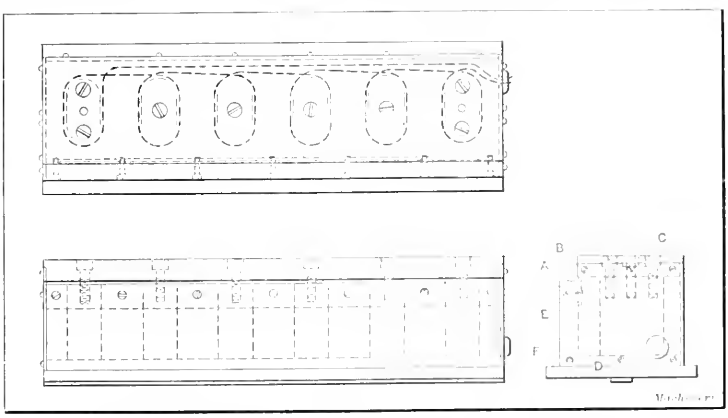

Fig. 7. A Magnetic Chuck adapted for Planing and Milling Operations

close to the junction of the cores with the top plate, as this would result in a partial short-circuit that would ruin the holding power of the chuck.

Very long pieces of work can be held with a chuck of this kind, as there is no limit to the length of gap line that can be made active if enough coils are used. The dimensions on the illustration show good proportions, and approximately the same number of coils should be used per unit of length, on any longer chuck. That is, if a chuck were to be made one-half again as long as the one shown, it should have six coils instead of four. In placing the coils on this chuck, great care should be used to see that they are connected as the drawing shows. Both coils on one side have the same polarity, and in order to accomplish this the electric current must pass around them in the same direction. The coils on the other side must both have opposite polarity to those on the first side, and any deviation from this order will result in partly or wholly neutralizing the chuck.

A Useful Chuck for the Planer or Milling Machine

When work is to be planed or milled parallel and at some definite angle with sides already established, a chuck of the form shown in Fig. 7 is certainly the most inexpensive and accurate fixture imaginable. The work is held by the poles *A* and *B*, and as the force is applied in both the vertical and horizontal planes, perfect location upon the chuck is the result. There are only two pieces of iron used in this chuck, the top plate *C*, the edge of which serves as pole *B*; and the base *D* which is integral with the six cores and the pole piece *A*. The filler in this case is a piece of one-eighth inch brass plate screwed to the pole *A*. It is shown on the drawing at *E*. One side and both ends of this chuck are enclosed by sheet brass, but the front is covered by the pole piece *A* and the filler *E*. No coils are supplied for the pole *A*, but their absence is compensated for by the shape and position of the poles, which present only their corners for magnetic leakage across the gap. As this chuck will often be made in very long lengths, the ledges *F* are provided for clamping it to the platen of the machine on which it is to be used. When in use, the current always warms the chuck to some extent, and if a long chuck were simply clamped at both ends to a cold platen, it would tend to bow up in the center to relieve the strain due to its linear expansion. For this reason it is preferable to place most of the clamping straps near the center of its length, and it is poor practice to draw them up very tight.

The poles *A* and *B* on this chuck are shown as they would be made for holding rectangular or cylindrical work, but they can be made to fit any shape of stock that would be necessary. Among other rather difficult operations that can be accomplished to advantage by the use of this chuck is the cutting of a perfectly accurate spline, or a flat side on a long piece of small round rod, the milling of absolutely parallel dovetail slides, or a number of parallel shoulders or slots in any long pliable work. This kind of work can even be done with the greatest accuracy when one or more rechuckings are necessary, as, for instance, in reversing to cut opposite sides of a dovetail slide or the vees of a straight ball race. Long work of this kind is seldom straight, owing to slightly unequal strains throughout the material; and this adds to the difficulty of holding it in any kind of a clamping fixture, as it will almost invariably bow up between the clamps. For this reason, a magnet is the only logical method of chucking, and it is also by far the most economical. The perfectly uniform attraction draws the kinky rod down to intimate contact with the chuck poles, and even though it is necessary to rechuck several times and the work springs a different amount after every cut is made, still each cut is parallel with its neighbor, regardless of how badly the whole piece may be bent. Of course, if the long pieces to be milled are castings, it will be necessary to give the first locating sides a fair average surface by hand or with the disk grinder, to prevent straining the crooked work straight for the first cut.

Light milling operations can be performed on this chuck without the use of stops of any kind, and if a stop is provided, the heaviest kind of back-gear milling cuts can be taken without fear of lifting or slipping the work. When a large number of duplicate parts of certain shapes require hand filing operations, no better bench vise could be wished; no manipulation is needed, and the pieces locate themselves if simply dropped near the poles. A magnet of this shape is also useful for locating work within its scope for jig-drilling; it is absolutely accurate, can be operated with one hand and in less time than any clamp. This is indeed a very useful form of chuck.

* * *

LIFE OF ELECTRIC POWER PLANTS

In a paper presented by C. M. Ripley before the annual meeting of the American Society of Heating and Ventilating Engineers, some statements were made regarding the long life of private electric power plants. It is an interesting fact that the oldest plant for generating electricity in a building in New York City was installed and put into operation less than four years after Thomas A. Edison announced the discovery of the incandescent electric light in October, 1879. George B. Post let the contract for a private electric plant in the Mills Bldg., opposite the Stock Exchange on Broad St., New York City, in 1883. This plant is still in daily operation. The fifteenth and nineteenth dynamos made by Edison have run every day for over thirty-one years and are still in perfect condition. Not only are the same dynamos in operation, but the original steam engines installed at the time by the New York Safety Steam Engine Co., now long out of business, are the sole means of driving the dynamos. H. J. Hardenbergh installed a private electric plant in the Dakota Apartments, New York City, in 1885 and some of the same apparatus is still in operation every day. The Evelyn apartment house has a twenty-five year old plant, consisting of one engine and dynamo, which is running every day. The Bank of New York has an outfit twenty-five years old which is held as a reserve but is run once a week to keep it in good condition. The Union Trust Co. for twenty-five years has had its same engines and dynamos running and at the present time they operate from eight in the morning to ten in the evening. The Tower Bldg., the first of a modern skyscraper type recently razed, had a power plant twenty-four years old. Many more examples of plants a long time in operation are quoted by the author. It has been the custom of many engineers and architects to assume a five per cent depreciation as the proper annual charge off on such installations, but this evidently is too high. Taking into consideration private electric plants installed as early as 1900, the results of the investigation show that twenty-four plants show less than five per cent depreciation, twenty-nine plants show less than four and a half per cent depreciation, seventeen plants show less than four per cent, sixteen plants show less than three and a half per cent depreciation and four plants show less than three per cent depreciation.

* * *

AN UNUSUAL MODEL SHOP

We usually think of a shop where miniature models of machinery are being made as occupying one or two rooms in an out-of-the-way corner, and employing but a few men. In view of this, it is interesting to note that the Peter Koch Model Works, at Koln-Nippes (near Cologne), Germany, devoted entirely to the making of models of machinery, steamships, etc., employ 200 men on this work. Models are made for experimental and demonstration purposes, engineering education and for exhibitions, museums, etc. As an example of what is accomplished in this line of work may be mentioned a model of a universal rolling mill for I-beams having a capacity for beams up to 40 inches high. This model was made on a scale of from 1 to 20, and when completed was about 8 feet long, 3 feet wide and 20 inches high. The model was so perfect that machine steel billets could be rolled in it into I-beams 3/4 inch in height. Steamboat models with all the external fittings almost perfect are also made, as well as miniature models of bridges and other structures and buildings. One of the particular uses for miniature models is for expositions, as it is often impossible to exhibit large machinery, and further, the model permits a much better perspective view of the whole mechanical arrangement.

COMMERCIALIZING A PRODUCT BY THE USE OF PRESS-WORK

PRESS-WORKING METHODS IN THE ECONOMICAL MANUFACTURE OF A PATENTED AUTOMOBILE WINDOW REGULATOR

BY CHESTER L. LUCAS*

Many a creditable device falls flat commercially because it cannot be marketed at the price which the cost of production demands. In this article will be described an ingenious device for the operation of the windows of an enclosed motor car, and the methods by which the product was gotten out at a price which would permit of its being marketable, still maintaining the highest possible quality. Figs. 1 and 2 show both sides of this device which is called the "perfect window regulator." It was designed and the details of production were worked out by A. K. Ternstedt, general manager of the Perfect Window Regulator Co., New York City. Its purpose is to raise or lower the window of a motor car, leaving it locked in any desired position; a side movement is also given to the window to throw it into its final position at the upper end of its travel. The "Perfect" window regulator is produced by press-work. Over twenty punched pieces, not including the chain, are employed in making, and no other machining operations, with the exception of the turning of a ball groove and the drilling of two or three holes, are resorted to. The remarkable part of the manufacture of this device is that it is almost entirely a product of punch and drawing presses. The die work is so perfect that the pieces are assembled without any fitting whatever, and the final operation of the mechanism is better than it would be if the pieces were produced by the more expensive machining operations often used on other products. The only parts of the regulator which are not made by press-work are two studs, three springs and a few screws, in addition to the balls in the bearings.

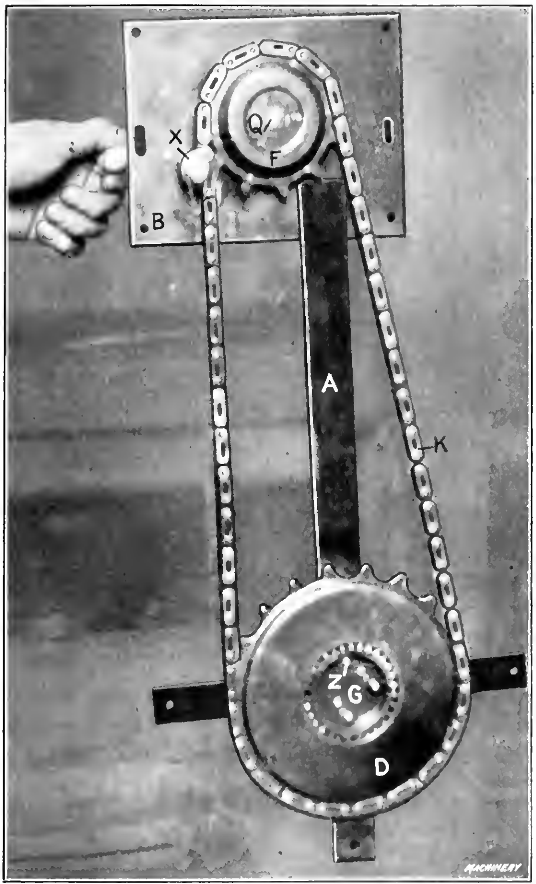

Fig. 1. The "Perfect" Window Regulator in Place on Rough Frame of an Automobile

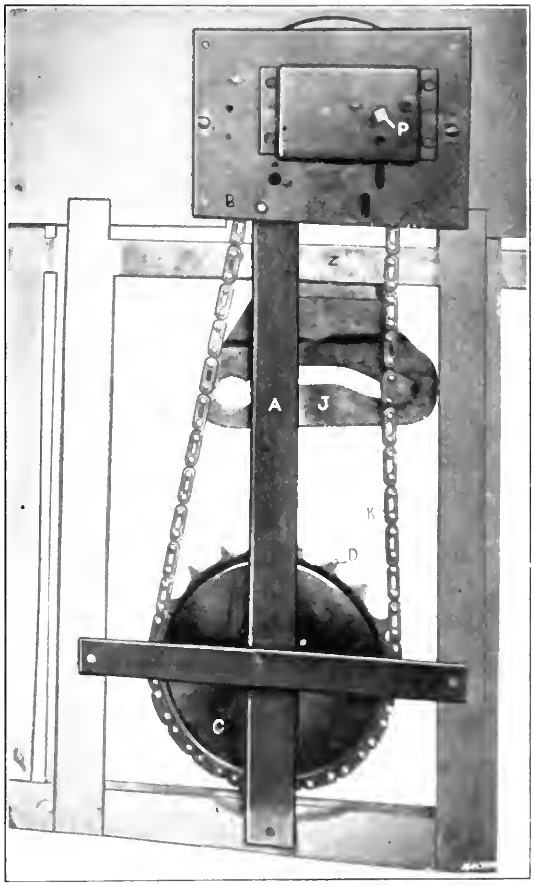

Fig. 2. Opposite Side of "Perfect" Window Regulator shown in Fig. 1

By referring to the various illustrations, some idea of the amount of press-work necessary may be obtained. Fig. 1 shows the assembled device from the rear; in Fig. 2 it is shown in place in the automobile before the inside finish has been applied to conceal it; in Fig. 3 are the various parts laid out for inspection, while Figs. 4 and 5 are sectional views through the sprocket mechanisms. The principal parts are the spacing bar *A*; the back-plate *B*; the cover *C* which fits over the lower sprocket; the lower sprocket *D*; the two halves *E* and *F* of the upper sprocket; the lower sprocket ball-race *G* and the upper sprocket ball-race *H*. The gear-box may be seen at *I*, the cam-plate at *J*, and the operating chain at *K*. These parts are the principal ones that are visible in the assembled device, but in the mechanism there are also smaller parts which can best be seen by referring to the sectional drawings, Figs. 4 and 5, showing the upper and lower sprockets, respectively. The mechanism in the upper sprocket is composed of the clutch shown at *L*, the clutch-cam *M* and the small torsion spring *N*. The pinion *O*, mounted on the stud *P*, is within the gear-box and meshes with a thirty-five-tooth gear on the spindle for the upper sprocket *Q*. The three parts which comprise the thirty-five-tooth gear are shown at *R*. A coil spring *S* is used for compensating the weight of the window frame and glass. This spring works within the sprocket cover *C* and cover *D*, one end of the spring being looped around the lug that has been bent up out of the sprocket, and the other looped around the stud on the spacing bar that projects through a hole in the sprocket cover.

The chain is built up of punched links *T* and studs.

* Associate Editor of MACHINERY

Mounted on the chain are two hooks V, on which is supported a spiral spring W that takes up the slack of the chain. A roller stud fastener X is applied to the chain to support the stud and roller which operates in the cam-plate attached to the window sash. The spring Y that is mounted on the roller stud to prevent rattle at the cam-plate and the clip Z for closing the ball bearing filling slot in the lower sprocket, the miscellaneous screws and the steel balls complete the parts of the device. The thirty-five-tooth gear is composed of three punchings and the small pinion, while not made completely by press-work, has its teeth formed by a punch-press broaching operation, as will be explained later.

In order to understand the functions of the different parts, it will be best to first explain the operation. This can best be done by referring to Fig. 2, which shows the device installed in the framework of the limousine, for after it is in place the only visible part is a handle which fits upon the squared section P of the pinion shaft. This handle is not shown in the illustration. The window regulator is supported in the framework of the car by screws in the ends of the spacing-bar and cover plate. The glass window of the car is represented by Z in this illustration; the lower edge of the window, being mounted in a metal channel, forms the base that supports the cam-plate. Fig. 2 shows the window in its lower position; by turning pinion-shaft P with the handle which is provided the chain travels upward over the sprocket, carrying the stud that is mounted on the chain which, in turn, causes the cam-plate and window to be raised. As soon as the cam-plate, which fits around the stud, reaches the level of the upper sprocket's top edge, the stud slides along the slot in the cam-plate. The cam-plate is bent so that its surface lies in two different planes as is shown at J, Fig. 3. Therefore when the stud passes the bent section of the cam-plate, the cam-plate, and consequently the window, is thrown over sideways for the necessary distance to fit the window over the ledge which supports it when closed.

Taking up the parts of the device separately, the spacing-bar is made of two sections of strip stock which are sheared, the holes punched in the ends, offset and riveted at the center. In the back plate, which is made of sheet steel 5/64 inch thick, there are twenty-nine punched holes. No drilling or counterboring is done on this plate. It comes from the punch press direct to the assembling bench. The lower sprocket cover C is a plain cutting and drawing operation, but the lower sprocket, itself, shown at D, is a more complicated piece of press-work. This is made from sheet steel 0.080 inch thick, and to leave it in its finished shape requires nine operations. These are as follows: rough-blanking and drawing, first redrawing, second redrawing, annealing, drawing edge down and setting up the center, swelling out for the ball-race, closing in the edge of the ball-race, trimming the piece and shearing in the spring lugs. A section of this sprocket appears in the line-drawing, Fig. 5, and the most unusual part of the work is the forming of the ball-race in the stock at the center, for it should be remembered that the ball-race is not finished by grinding or turning. When it leaves the dies it is done. The economy of producing this part alone by press-work will be readily appreciated because the stock required and the machining operations that would be necessary to make the piece from solid stock or from a casting would be considerable in themselves.

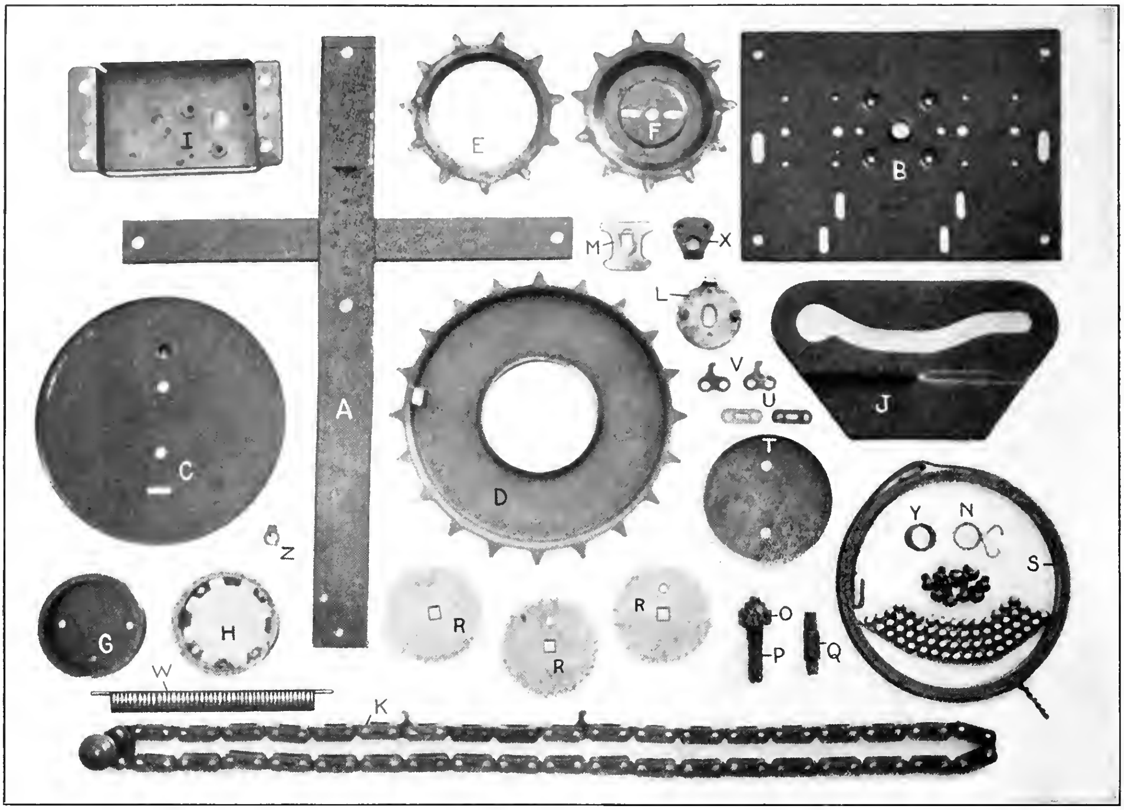

Fig. 3. The Various Parts of the Device—Nearly All Products of Press-work

The halves E and F of the upper sprocket are made in the same die. The first operations are comparatively simple, comprising the blanking and drawing of the piece, the trimming of the piece and the piercing of the hole. The top half of this sprocket is made by simply punching out the center of the bottom half stamping. The ball-race sections for the top and bottom sprockets are also both made in the same die. These two pieces are shown in Fig. 3 at G and H, G being the ball-race for the lower sprocket and H the ball-race for the upper sprocket. These are formed from steel 5/32 inch thick. On account of the drawing operation, the sides of the cup that comprise this part are much thicker than the bottom—the edge being thickened as the result of the drawing operation. The thick edge, of course, forms the section in which the ball-race is turned. The lower sprocket ball-race has three holes punched in it and also a filling slot punched

in the edge. This filling slot, after the balls have been put in place, is closed by the small spring clip that may be seen at Z, Fig. 3, and thus the balls are prevented from coming out of the groove while in action. The upper sprocket ball-race is formed from the same cup as the lower ball-race by punching out the center. In punching out this center, the stock is removed so as to leave the edge in the form of clutch teeth. By referring to the line illustration Fig. 4, the purpose of these clutch teeth will be seen. The clutch is shown at L, Fig. 3, and is a plain punching with a lug that is afterward bent up. Two pins are forced into holes that have been punched and an oblong slot in the center provides for a plain in-and-out motion of the clutch that acts in conjunction with the clutch teeth in the ball-race.

The purpose of this mechanism is to provide for the raising or lowering of the sash to any desired point, with the

Broaching the Teeth on the Pinion

The pinion blank and pinion spindle shown at O and P in Fig. 3 are, of course, produced on the screw machine, but the forming of the teeth on the pinion blank, leaving it in the condition shown in the illustration, is a press operation, and one that is worthy of description. These gear teeth, ten in number, are formed on the 3/4-inch diameter section of the pinion blank by a broaching operation, the piece being finished to the entire depth at one pass of the broach. The fact that the pinion face is one-half inch wide makes this operation of decided interest.

The die used for this broaching operation is shown in section in Fig. 6, and Fig. 7 shows it in place in the press. This illustration is intended to give only a general idea of the tools for broaching these gear teeth, but from it will be seen that the press has an extra long stroke. The punch is fluted

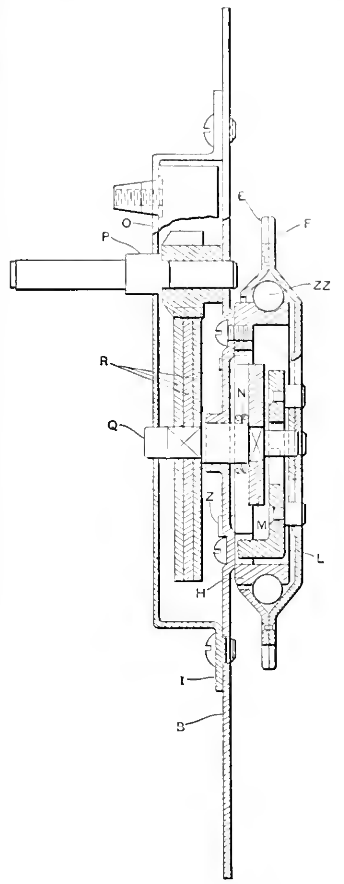

Fig. 4. Sectional View through Upper Sprocket and Gear-box

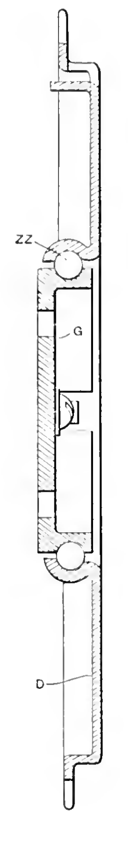

Fig. 5. Sectional View through Lower Sprocket

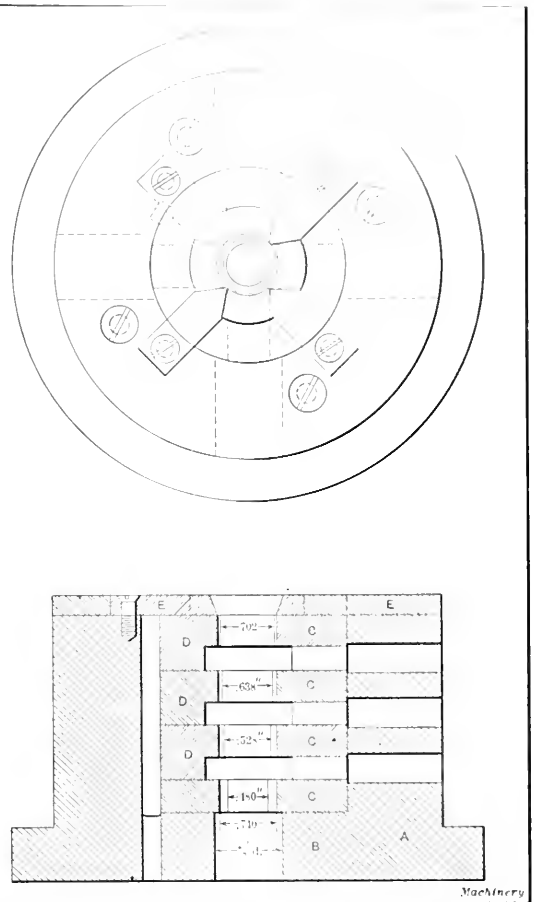

Fig. 6. Sectional View of Broaching Die for cutting Teeth on Steel Pinions

surety that it cannot be pushed open by an outsider or jar out of position. When the handle on shaft P is turned, the pinion O and gear R cause shaft Q to turn. As the clutch-cam M is anchored to this shaft, it also turns, of course, causing its sides to act on the two pins in the clutch, and giving the clutch a longitudinal movement to disengage the teeth. Continued turning raises or lowers the sash, as the case may be, and when pressure is released from the handle, spring N throws the clutch-cam in mesh again.

The spring-case, cam-plate and gear cover are all good examples of press-work, but there is nothing extraordinary in the production methods that are employed. The three gear-blank punchings shown at R in Fig. 3 are lined up when assembled on the square section of the sprocket spindle so that the three gears form a composite or sectional gear as shown at R, Fig. 4.

for its entire length with grooves corresponding to the gear teeth so that there will be no interference when pushing the gear blank through the die. The die is fitted with a lubricant pipe for supplying oil to the broaching sections of the die. Now, by referring to the line illustration which shows the die in section, it will be seen that it is built up within the heavy casing A. A base-block B is fitted at the bottom of this casing and four sets of broaching dies C are used for cutting the teeth. These broaching dies are separated with spacing blocks D at intervals of 5/16 inch; thus the first broaching die measures 0.702 inch at the bottom of the teeth. As the blank is 0.750 inch in diameter, it will be seen that the first die section removes 0.048 inch. The second die section measures 0.638 inch internal diameter, thus removing 0.064 inch additional from the gear teeth. The third section which is 0.528 inch diameter reduces the teeth in diameter

to this size, removing 0.110 inch of metal. The fourth and last section measures 0.180 inch in diameter, reducing the blank by 0.018 inch only; thus the last cut is more of a finishing operation than a metal removing process. A pilot on the punch serves as a locating point for starting the gear blank, and as the sides of the gage strips *E* are slightly beveled, the blank is made to enter the broaching dies straight. This broaching operation is very successful, and the teeth are cut much more rapidly and accurately than could be done by ordinary gear-cutting methods.

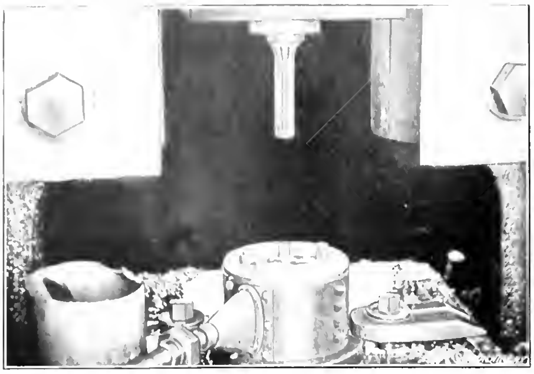

Fig. 7. Gear-teeth Broaching Punch and Die in the Press

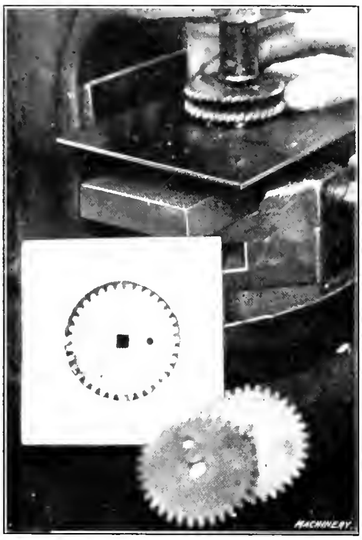

Fig. 9. Assembling the Sections of the Thirty-five-tooth Gear

Assembling the Regulator

The assembling operations are shown in Figs. 8, 9, 10, 11 and 12. Fig. 8 shows the assembling of the chain. This is done in a foot press, inserting the rivets through the links and upsetting them sufficiently to keep the parts in place until they can be riveted on a power riveter. In each chain must be correctly located two of the hook links for supporting the spring that takes up the slack and correctly tensions the chain, and also a stud supporter for carrying the stud-roller which works in the cam-plate and acts on the window frame, as has been previously described.

Fig. 11. "Running-in" the Clutch Mechanism

Fig. 9 shows the building up of the thirty-five-tooth gear, using the three punched sections that were shown at *R*, Fig. 3. These are assembled on the square section of the spindle by using a hollow punch in a foot-press. The ring shown before the press has aligning teeth to engage the three punchings and is used for locating the sections when being forced into position so that the teeth will match up correctly.

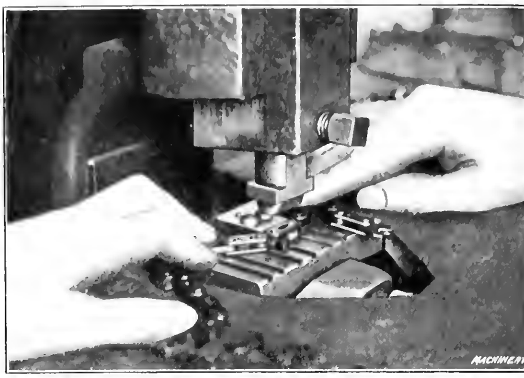

Fig. 8. "Building" the Chain

In Fig. 10 may be seen the assembling operation on a back-plate. The screws are driven into place with an Errington stud-setter, using a screw-driver for this particular job. By this means the screws are all driven to the same tension a great deal faster than they could be by hand. Fig. 11 shows the "running in" of the upper sprocket. In order to insure that this part of the device works successfully, it must be run in so that it is free from all jumpy action or sticking. Here again an Errington stud-setter is employed having a square socket to take the place of the handle. This is used on the end of a horizontal shaft and any excessive friction causes the stud-setter to slip, thus showing that the part in question is defective.

Fig. 10. Errington Stud-setter used as a Screw-driver

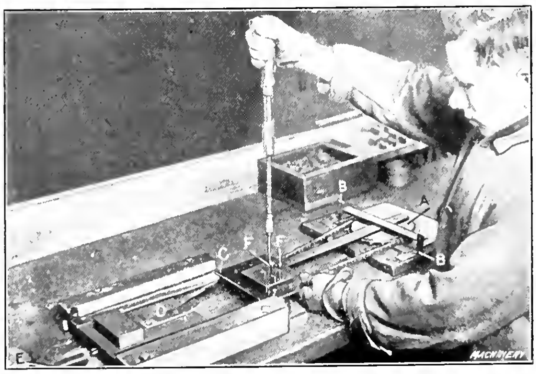

Fig. 12. Adjusting the Tension of the Chain

Fig. 12 shows the final assembling operation; *viz.*, the tensioning of the device. At this time the device has been as-

sembled in two sections: the spacing bar with the lower sprocket, and the back-plate and upper sprocket. It now remains to locate the back-plate and upper sprocket on the spacing bar at the correct distance from the lower sprocket so the chain will operate freely under load. This is tentatively done by two screws in the spacing bar that pass through slots in the back-plate. These slots are about one-half inch long, which gives considerable latitude. The tensioning device is shown in Fig. 12. The spacing bar and lower sprocket, shown at *A*, are held against the brackets *B*. The chain is passed around the sprockets and the back-plate by means of two corner holes located on the slide *D* that is drawn back by the tensioning spring *E*. The spring used is sufficiently strong to give tension enough to counterbalance the weight of the automobile sash and window that the device is to be used in connection with. As soon as the spring has drawn the back-plate to its position, the operator sets up screws *F*, after which he drills and rivets the back-plate to its permanent position on the spacing bar.

This operation completes the regulator and it can now be appreciated that the entire device has been built to the "tune" of a punch-press—no castings, forging or other machined parts being used. It will also be noted that all the way through, as far as possible, simple dies have been used and whenever it was found possible to produce more than one part from the same die by a little change in design, this was done. The simplified design and the elimination of all operations except that of press-working has made it possible to produce this device at a marketable price, and it has been very successful.

* * *

FILING YOUR OWN PATENT—A REPLY

BY A. P. CONNOR*

In the February number of MACHINERY there was an article entitled "Filing Your Own Patent"; there are many inaccuracies in this article. In order to correct the wrong impressions which its publication may have created, the present writer will analyze it, so that the reader may not only be warned of the pitfalls which lack of knowledge may lead him into, but be equipped with that information which will serve to assist his judgment in determining the proper course to take in such matters.

The title itself, "Filing Your Own Patent," is subject to criticism. The writer did not refer to the *filing*, but the *prosecution* of a patent *application*. Hence, the article should have been entitled, "Prosecuting Your own Application for Patent."

[On page 167 of the *World Almanac*, 1914, in a statement revised by the Patent Office, the following appears: "If an inventor wishes to file an application for patent * * *" This would indicate that the expression "filing" is not entirely incorrect in this connection.—EDITOR.]

In the first paragraph of the article in question, it would seem that the previous writer intended to keep on both sides of the matter, first by pretending to discourage the inventor against applying for his own patent, and then advising him to do so, through insinuations that his path would not be so difficult, if he really wanted to try it. The writer evidently thought that some excuse for his article was necessary, as he assigns the ground that "stern necessity may compel the inventor to prosecute his own application for patent." This reason is worth analyzing. When does this "stern necessity" compel an inventor to take the course suggested? The most practical reason which may appeal to many readers is the financial one. It may be suggested that the inventor is penniless, which, however, is seldom a fact, because invention is dependent on industry, and industry keeps a person with some loose change. Secondly, if his invention is valuable and worthy of a patent, can he not get someone to pay the costs of the fees for the patent application, in exchange for an interest in the invention? If not, the case is a very rare one in our present age, when the value of patents is appreciated.

The writer is frequently requested, by persons he knows personally, for opportunities to get an interest in good inventions. Almost anyone would risk the moderate cost necessary in patent matters for a chance to make a substantial fortune out of it. Then, again, an attorney will usually be reasonable in pressing financial matters on his clients, so the inventor will not be unduly embarrassed. Can any one of intelligence imagine a case where it would be advisable for an average inventor, or even a person of exceptional ability, who is inexperienced in patent matters and practice, to prosecute his own application, and expect to be as amply protected as his invention merits?

We are further informed that "it is a notorious fact that there are a great many incompetent patent attorneys." The statement is so serious that it seems hardly possible to believe that it could be made with such *sang froid*, and the late writer should either prove it or withdraw it. A copy of any proofs in the matter should also be submitted to the Commissioner of Patents for appropriate action.

[On page 167 of the *World Almanac*, 1914, in a statement revised by the Patent Office, the following appears: "The Patent Office cannot recommend any particular attorney or firm, but advises applicants to avoid doing business with those who advertise the possession of unusual facilities for obtaining patents."—EDITOR.]

The present writer may incidentally say that the registration of patent attorneys is a very strict matter at the present time, and the requirements are severely enforced. Assume, for an argument, that the statement is true that we have incompetent attorneys. The inventor is advised to prosecute his application even though he does not know what he is doing, but he is warned to keep away from incompetent attorneys. It would seem that an application for patent would be safer in the hands of the most incompetent attorney, because he must know *something* about what he is doing, rather than in the hands of an inventor who knows absolutely *nothing*.

We are further informed "that most patents are valueless because they have no real invention behind them." Surely the country would like to have the authorities and proofs supporting the statement. However, the courts sustain the patent practice, all inventors of ability and consequence patronize the Patent Office, and the examiners have to pass the strictest examination in the whole civil service and are in addition usually trained as lawyers. All corporations, capitalists and other persons interested in patents will not consider inventions without patents protecting them. Have all these been fooled? Has all our industrial progress, and the fortunes made on patents been the outcome from inventions with no real invention in them? If the original writer has the key to the identification of valuable invention, which has been overlooked by everyone except himself, now is his opportunity to enlighten the world.

[In 1909, the *American Machinist* investigated the matter of how many patents paid back their own cost and found that only twenty-three patents out of a hundred paid their own cost. Note that this does not imply a profit, so that while it is not known how many of these twenty-three were actually profitable, it was certain that in the hundreds of cases covered, seventy-seven out of one hundred did not pay their own cost. This investigation carefully carried out under reliable auspices seems to give some strength to the statement of the former writer that most patents are valueless.—EDITOR.]

As to the suggestions for selecting an attorney: We are told that attorneys should "have built up a reputation over a long period of years, and be known to prominent attorneys, bankers and business men." Evidently the question of ability, technical training, energy and actual results are not worth consideration, nor would a young struggling conscientious attorney be considered. Yet, if the advice was made use of and it was found that the prominent attorney had turned the case over to an employe, and that the former in fact never saw the invention at all, what would the prior writer say, even if the original attorney has all the qualifications given? The writer has known of several instances where it proved more dangerous to make use of attorneys with reputation than the more mediocre ones, because of the fact that the former gave very few of the cases their personal attention. Therefore, the suggestions are by no means adequate, but rather misleading, especially to the inventor with more ability than money.

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MAKING FORMED CUTTERS*

MACHINING THE FORMER AND MASTERS, FORMING THE BLANK, AND CUTTING AND RELIEVING THE TEETH

BY F. H. JACOBS†

Milling cutters of irregular shape that can be sharpened without altering their contour, an example of which is shown in Fig. 1, are generally called formed cutters. They are used for milling irregular surfaces on gun and sewing machine parts and on other work of like nature. Perhaps the first formed cutters to be commonly used were the gear-cutters known to every mechanic. Satisfactory formed cutters can be procured from any cutter manufacturer at a moderate cost, but as several weeks often elapse before special cutters are delivered many shops are equipped to make their own cutters.

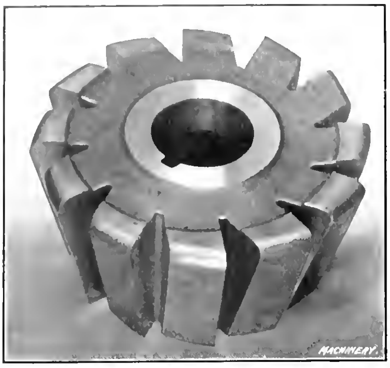
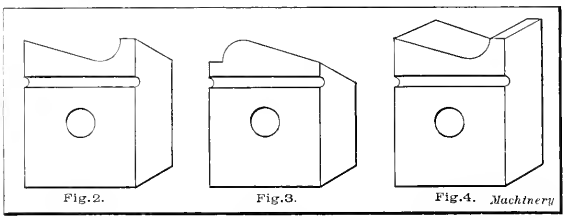


Fig. 1. A Typical Formed Cutter

In explaining the various steps in the making of a formed cutter we can use the tool illustrated in Fig. 1 as an example. As this is a male cutter it is formed and backed off with the female former shown in Fig. 2. As this former has to have a clearance of at least 15 degrees, with the original lay-out accurately preserved, it is necessary to form it at an angle by means of the master shown in Fig. 3. As this master has a convex surface that would be difficult to work out accurately by hand, a second or female master is made. This is shown in Fig. 4, and it is an exact counterpart of the shape we wish to mill worked out in a block of steel without any clearance. This piece is hardened and drawn to a medium straw color.



Figs. 2 to 4. Former and Male and Female Masters for producing Formed Cutters

To make the masters and former without distorting the contour, and at the same time give the former the necessary clearance, the angle block and tool shown in Fig. 5 are used. The angle block is strapped to the platen of the shaper and the female master is fastened to the angle tool. First, however, the outline is worked to shape as near as possible with regular tools, the female master being used only for finishing. As the illustration shows, it works with a drag cut which necessarily means slow procedure. It will also be seen that the faces of the two masters are parallel; this is why the proper contour can be maintained, notwithstanding the fact that clearance is imparted to the male master. This master is now hardened and drawn and the same process gone through with in making the female former.

The masters and former are sharpened by grinding their tops or faces. The slight groove shown is for the corner of the wheel to run into. They should be sharpened on the surface grinder, as their faces must remain flat; otherwise the contour will be changed. In finishing the master and former on the angle block, it is necessary to use a very slow cutting speed to avoid chattering. As a very smooth surface is desired, good lard oil should be used as a cutting medium.

Formed cutters can be made of bar stock chucked out and turned up in the usual way. About 0.003 inch should be left in the hole for finishing by grinding after hardening, and it is a good plan to relieve the sides as shown in Fig. 1, as this eliminates a certain amount of unnecessary grinding. The hole should be chambered and provided with a keyway. The form is turned on the cutter with the former previously made. This is done in the lathe, the former being fastened to the tool shown in Fig. 6. It is seen that both this and the angle tool are made on the goose-neck principle to obviate chattering.

The cutter is now ready for cutting or scoring. This is generally done with a 30-degree angular cutter rounded at the point. Before cutting, it is a good plan to drill holes as shown in Fig. 7. This leaves a slight clearance for the corner of the wheel to run into during the grinding operation. After this operation is finished, the cutter is ready for relieving, or as it is more commonly called, backing off. There are several appliances for this purpose in the form of attachments for the lathe and milling machine. The device shown in Fig. 8 is simple to construct, easy to set up and it gives very good results. Briefly described, it consists of a sliding base mounted in a bed that is strapped to the milling machine platen. A strong spring thrusts the base toward the spindle and cam. The cam is mounted on a cast-iron holder that screws onto the nose of the spindle, while the cutter is mounted on a stub arbor. The former, shown in Fig. 2, is fastened to a sliding head that is actuated by a screw. This regulates the depth of cut in backing off the cutter. The details are shown in Fig. 9, which illustrates an end elevation and longitudinal section. As each cam has a fixed number of teeth, three are generally provided for cutters with ten, twelve, and fourteen teeth, respectively. It is very necessary that these cams be accurately made; otherwise faulty cutters will result. The method employed in laying out and machining will be explained later.

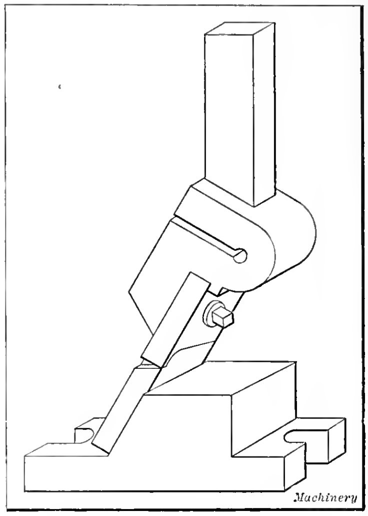


Fig. 5. Angle Block and Tool used for making the Former and Master

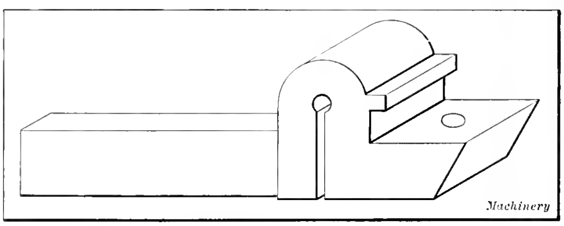


Fig. 6. Gooseneck Tool-holder on which Former is mounted for machining Formed Cutters

In setting up for the backing-off operation, it is necessary that the cutter be set so that the teeth are in the correct re-

* For additional articles on formed cutters and allied subjects, see "Importance of Grinding Gear Cutter Teeth Radially" published in MACHINERY, July, 1907; "A Formed Tool Problem," January, 1910; and "Milling Radial Teeth in Cutter Blanks," November and December, 1911, and other articles there referred to.

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lation with the corresponding cam rises. To this end, an arbor without a tang is used. A line is scribed on the cam meeting the high points of two rises that are opposite. The arbor is placed loosely in position, the cam set central by means of the scribed lines and a surface gage, and the arbor adjusted so that the cutter tooth does not meet the former within 1/16 inch. The arbor is now driven solidly into position. The object of the 1/16-inch leeway is to make sure that the former is moving toward the cutter before the tooth is reached.

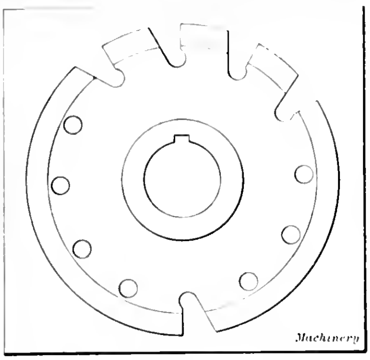


Fig. 7. Holes drilled in Blank before cutting Teeth

In backing off, a very slow speed should be used and the work should be lubricated with lard oil. Light cuts should be taken, as heavy cuts are likely to leave scores which result in unsatisfactory work on the part of the finished cutter. After the teeth have been backed off, the former should be reground and the top whetted on an India oil-stone wet with gasoline. It should be examined under a glass to make sure that it has a clean sharp edge without scores. It is then placed in position again and a light finishing cut taken. It is necessary that the top of the former be set central with the cutter, for if it is above or below, an incorrect contour will be formed.

The cutter is now hardened and drawn in the usual way. After hardening, the sides should first be ground. A Heald piston-ring grinder is an excellent machine to utilize for this purpose, but if one is not available the universal grinder can be used. After grinding the sides, the cutter is strapped to the faceplate of the grinding machine, the hole trued up with an indicator and ground to the desired size. The next operation is to grind the faces of the teeth. While this is a simple operation, care should be exercised to see that the teeth are equally spaced, for while they probably were equally spaced after cutting, the hardening process may have distorted them slightly. This grinding operation was fully described in MACHINERY, February, 1912.

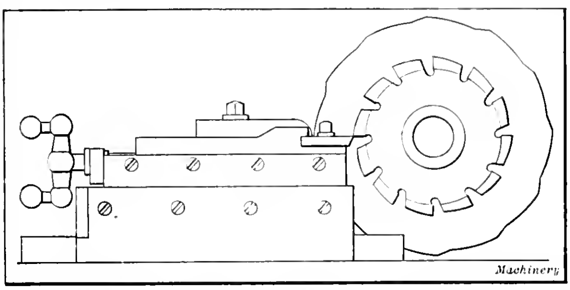


Fig. 8. Milling Machine Relieving Attachment for backing off the Teeth

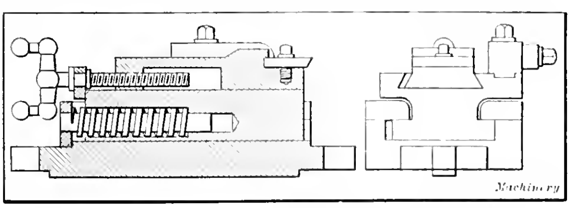


Fig. 9. End Elevation and Sectional View of Relieving Attachment shown in Fig. 8

As previously stated, the cams for relieving the teeth should be accurately made, and the most simple and efficient way is as follows: The cam plate is first chucked out to fit the mandrel *A* shown in Fig. 10 and the sides and periphery turned in the usual way. The hole is then plugged up, as this space has to be utilized in laying out. This lay-out is illustrated in Fig. 11. First one actual sized cutter tooth is drawn or rather scribed, as shown, the object being to determine the pitch of the clearance. It is necessary to have enough clearance to allow the cutter to take hold of the work; and at the same time, if too much is allowed, short-lived cutters having a tendency to chatter will result.

A good practical way to determine the correct amount of clearance is to use as a guide a formed cutter made by a reliable cutter manufacturer. Set this cutter central on the cam blank and carefully scribe the clearance line. This line is nothing more nor less than an arc set off center. With a pair of dividers, find the center and mark it with a center-punch mark. This center is shown at *B*, and the line of clearance at *C*. From the center *B* the arc *D* is scribed, which gives the same relation between the points *E* and *F*. The 30 degrees in the arc *G* represent one tooth. To make sure that the former will not start to return until the complete tooth has been gone over, and also that it will be ready to start cutting as soon as the next tooth strikes it, the time of return is confined between the lines *H*. Next the circle *J* is laid off. It is seen that this connects the lowest point of the stroke with the beginning of the next stroke. The center of this circle is carefully center-punched.

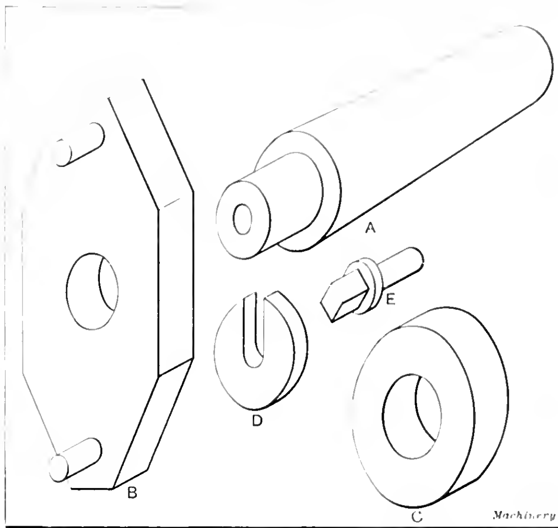


Fig. 10. Tools used in machining the Relieving Cams

The two holes *K* and *L* are next laid off, and the centers punched. There are twenty-four holes altogether, two for each tooth. These are used for locating the cam while machining the rises. Before doing this, it is necessary to be provided with the tools shown in Fig. 10, where *A* is a mandrel to fit the milling machine dividing head, and *B* is the locating piece, the hole in this locating piece being a driving fit over the mandrel. Before using this piece, however, it is necessary to finish the twenty-four small holes, also the twelve large ones in the cam blank. This is done in the milling machine, the dividing head being used for spacing the holes. The head is set at right angles with the platen, its center being on a plane with the milling machine spindle.

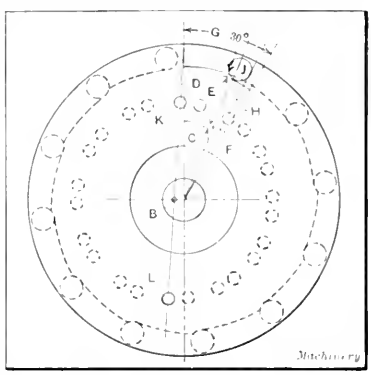


Fig. 11. Layout of One of the Relieving Cams

The cam blank is placed in position on the special mandrel with the collar *C* back of it. This collar is used simply to

fill up the space that is later occupied by the piece *B*. The screw and washer *E* and *D* are used in clamping the cam blank. The punch mark for the hole *K* is carefully centered, after which the hole is drilled, trued up with a boring chip and then reamed. The dividing head having previously been set for twelve divisions, the remainder of the holes corresponding to *K* are finished. Next the center for the hole *L* is located and all the holes in this circle finished. These holes are shown by the small dotted circles in Fig. 11. It is evident that these holes finished in the manner described will serve as an accurate means for locating the blank while machining the rises. Next the hole *J* is located, drilled, bored and reamed. As this is comparatively heavy drilling to do in the manner described, the superfluous stock can be drilled on the upright drill. The piece is then replaced in position on the milling machine and the holes bored and reamed. The center hole is now indicated and bored in the lathe to the correct size to fit the cam back.

By referring to the piece *B*, Fig. 10, it is seen that it has two holes in a line with the center. These holes are supplied with dowels. It is evident that when the holes *K* and *L* in the cam blank are slipped over these dowels, the arc *D* is thrown in a position where it can be machined as part of a circle. This is done in the shaper, the dividing head being used for the purpose, the cam blank and the piece *B* being held on the special mandrel. After planing one rise as shown by the dotted lines, the piece is moved into position for the next rise, and so on until all are gone over.

In the final finishing, all the rises are gone over one after the other with a very light chip, the set of the tool not being disturbed. It is very necessary for all the rises to be alike; otherwise, cutters with uneven teeth would be the final result. For this reason, after the final finishing chip has been started it should be continued, for if the shaper should be allowed to remain idle for a time—say over noon hour, or what would be worse, over night—some rises would surely be higher than others. Three of the holes can be used for dowels in locating the cam on its back, while three more can be countersunk and used for screw holes. The cam should be made of tool steel and it should be hardened in cyanide and oil, as any other hardening process might distort it.

* * *

A NEW FIELD FOR THE OXY-ACETYLENE CUTTING TORCH*

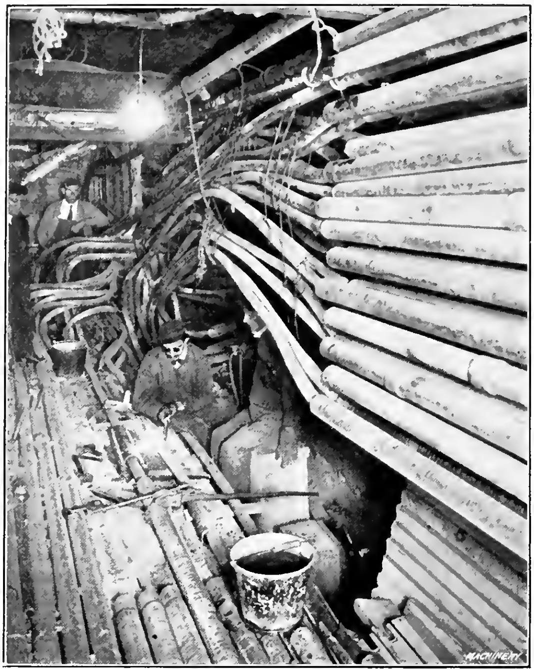
BY GEORGE G. PORTER†

A new field for the oxy-acetylene cutting torch is shown by the accompanying illustration which was taken in the basement of the Warren Telephone Exchange at Syracuse, N. Y. The underground lead cables carrying all of the wires from the city 'phones into the exchange, entered from the street first into a manhole which extended underneath the sidewalk to the wall of the building, and from there to the exchange room the cables were encased in three-inch iron pipes. After the consolidation of the two telephone companies in Syracuse, and the consequent increase in the number of cables coming into this exchange, the manhole soon became very much congested, which made an enlargement necessary. This was effected by removing a portion of the wall of the building and extending the manhole back into the basement a distance of about fifteen feet.

After the wall was removed it was necessary to also remove the iron casings from the lead cables so that they could be bent and re-arranged to make room for the new ones. This looked like an almost insurmountable task, as there were about eighty casings in the two tiers, over half of them containing cables, and to remove them by cutting off with hammer and chisel would have been an almost endless job, and practically impossible, as the pipes were so close together that swinging a hammer would be very difficult, and then too the noise would be transmitted through the pipes to the entire building—a most objectionable feature. It was suggested that a special machine be built which would mill slots in the sides of the casings, and then saw them around so that they could be removed, but this was also abandoned on account of the lack of room in which to operate it.

Finally the Porter-Cable Machine Co. of Syracuse was consulted about the job, and after looking it over a decision was made that it might be possible to cut off the iron casings with the oxy-acetylene cutting torch without damaging the lead cable underneath. This too seemed like an impossible thing to do, as the melting point of lead is about 600 degrees, while that of wrought iron is about 2300; and the oxy-acetylene flame has a temperature of over 6000 degrees. However, a piece of the cable and casing was obtained to experiment on in the shop. The first experiments were failures, as the lead was melted almost instantly, but a plan was finally developed, and special appliances were made, consisting of guides for the torch and semicircular copper shields to slip in between the cable and the casing. After a few trials this plan seemed to be so successful that the Porter-Cable Machine Co. was awarded the job of removing the casings. The job was handled as follows:

A copper shield about two feet long was slipped in between the cable and casing, then the casing was cut around with the



Oxy-acetylene Torch being used for cutting away Iron Armor of Lead covered Telephone Cables

torch for a short distance and at a safe distance from the inner end of the shield, so as not to allow the flame to come too near to the lead cable; the casing was then rolled over a small amount, the shield re-adjusted and another cut taken. This was continued until the casing was cut all the way around; it was then slid back on the cable and split in two lengthwise, allowing the pieces to be removed. The reason for making the shields of copper, was that the oxygen cutting jet will only cut wrought iron and steel, and does not have any cutting effect on copper.

At the time the photograph was taken, about half the casings had been removed, those on the floor tier still remaining to be done. As it was necessary to make two cuts lengthwise to allow the short pieces to be removed after being cut off, and as the circumference of the casings was about eleven inches, the total length of the cuts made by the torch was about 1500 feet.

The cables were practically uninjured, there being two small holes melted in them during the entire job. This was at the commencement before the operator had become thoroughly familiar with the requirements. This is believed to be the first time this kind of job was ever attempted.

* For articles on oxy-acetylene welding and cutting previously published, see "Machine for Making Welded Seamless Tubing," October, 1913; "Preheating Metals to be Welded by Oxy-acetylene Process," October, 1912; and other articles referred to.

† Address: 230 South Ave., Syracuse, N. Y.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

FEED CHUTE FOR DRAWING PRESS

Figs. 1 and 2 illustrate the application of an interesting form of feed chute that is used to prevent the breakage of drawing punches. The press on which this device is used is employed in performing a drawing operation on the cups shown in the illustration. These cups enter the chute *A* from a hopper and pass down at high velocity; when the bottom of the cup strikes the pin *B* the cup rebounds and drops into the feed-pipe *C*, which leads to the feed fingers of the press.

It is necessary to have the cups feed into the press with the closed end down, as shown in Fig. 1. It sometimes happens, however, that a cup enters the chute *A* in an inverted position, as shown in Fig. 2. If the cup reached the die in this position, it would result in breaking the drawing punch. Fig. 2 shows how this is avoided. The cup enters the chute *A* and slides down until it catches on the pin *B*. Thus it cannot rebound, but swings on the pin *B* and drops into the feed-pipe *C* with the closed end down in the manner illustrated. This device is carried by a bracket which is attached to a stationary part of the press.

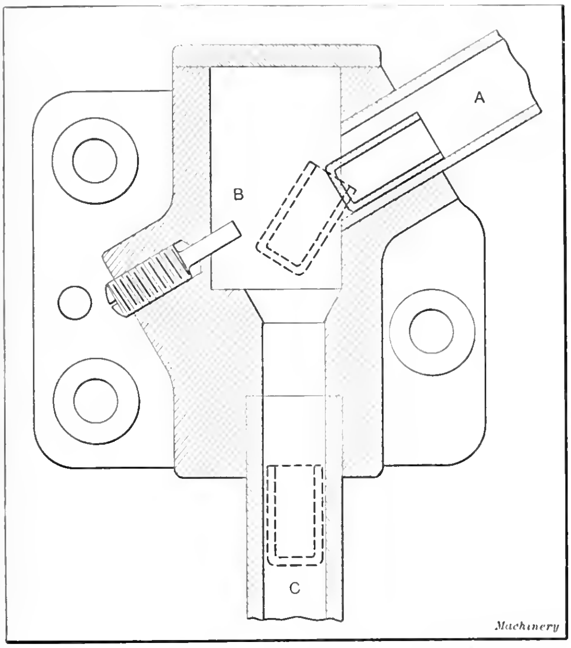


Fig. 1. Cup delivered to Feed Pipe C in Regular Way

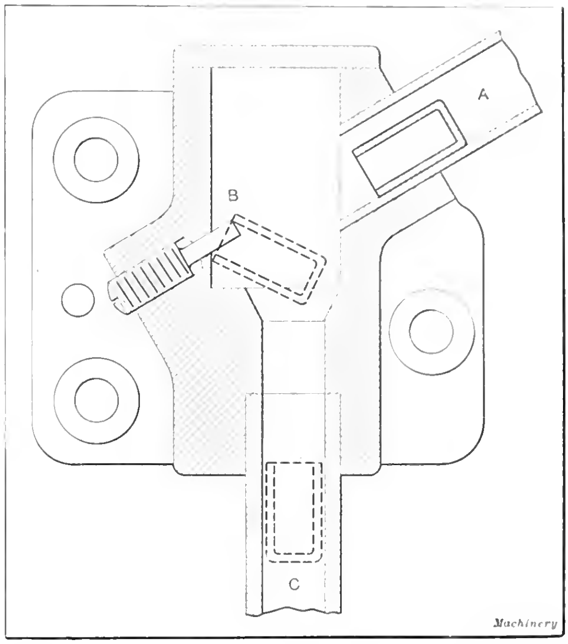


Fig. 2. Inverted Cup in Act of turning over before entering Feed Pipe

LAWRENCE FAY

BOOK AGENTS AND APPRENTICE BOYS

There are men calling themselves book agents who travel through the country visiting shops and factories. In reality, these men are nothing but "leeches" who prey upon the ignorance of the average shop hand or apprentice. I have had a good deal of experience with these so-called publisher's agents, and find that in most cases they pick apprentice boys for their victims and sell them several massive volumes full of old wood cuts and manufacturers' engravings. To do this they "hand out a line of talk" that throws the dust in the boys' eyes, with the result that they buy costly set of books that are probably never opened after a cursory inspection of the pictures is made. In most cases the books consist of from two to four volumes, costing \$15 to \$25 for the set. The binding is attractive, but the books are altogether too heavy for a shop man to carry in his tool chest to refer to when in need of information. There are few shops where shelves are available to keep such books and in most cases there would be a row if an employe was seen opening a book weighing from ten to twenty pounds during working hours.

The main objection that I have to the book agent is the method that he uses in making a sale. He usually starts in by telling his victim that Mr. Bank of Blank & Co. bought a set of these books when he was only making \$12 a week and that he is now earning \$5000 a year and owes it all to the information he obtained from his set of books. Mr. Blank is further quoted as having stated that he would not be without a set of these books at any price. This usually is the means of making a sale. In a certain case that came to the writer's attention, an apprentice boy happened to mention that his grandfather had bought a set of the first edition of a certain work. This was the agent's cue. He asked the grandfather's name and immediately said that he remembered having sold him the books in question but that the first edition was now entirely out of date and the apprentice should have books giving information concerning the most modern practice. This boy bought the books in question for \$25 and offered to sell them three weeks later for \$10. He was a boy of average intelligence, and if he had been given time to look into the matter he would have seen that he was paying an exorbitant price for something from which he would get little benefit. He was simply carried away by the agent's arguments and that is the way in which most valueless books are sold.

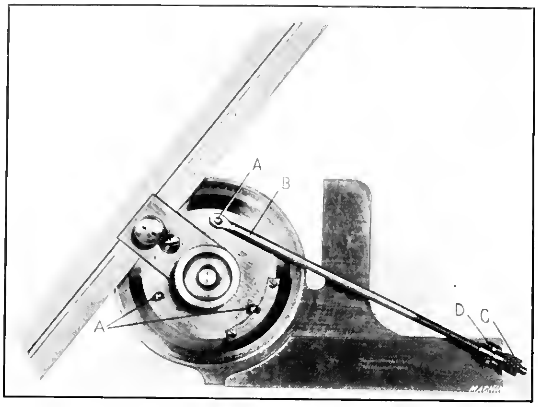
I think that a satisfactory remedy for this state of affairs would be to have the superintendent of a factory or some other man of sound judgment take a little more interest in the employes' welfare. If book agents were refused admission to a shop without first leaving copies of the books they wish to sell at the office to be looked over with the view of determining the value of the information contained in them and the fairness of the price, a lot of this trouble would be eliminated. It is generally quite easy for an agent to deceive an inexperienced apprentice boy, but it would be another matter if he had to convince an older man of the merit of the books he was selling. If such a course of action were followed, an agent could be granted admission to the shop after his book had been O. K'd. The foregoing must not be

regarded in the light of a criticism of shop agents of reputable publishers, as the books and magazines issued by such firms are certainly of the greatest value to every shop man.

Newark, N. J. G. W. Jager

BEVEL PROTRACTOR ADJUSTING BAR

The following describes an adjusting bar for use on the B. & S. bevel protractor. This bar can be easily made by any toolmaker to suit the protractor which he uses, and will be found of value in making accurate adjustments. When not in use, the adjusting bar can be taken off. Referring to the illustration it will be seen that three pins *A* are driven into the movable disk 120 degrees from each other. These pins are made of drill rod 3/32 inch in diameter and are located



Bevel Protractor fitted with Adjusting Bar for making Accurate Settings

¾ inch from the center of the disk. The adjusting bar *B* is also made of 3/32 drill rod, which is flattened at one end and drilled to receive one of the pins *A*. The opposite end of the adjusting bar is threaded to receive the adjusting nut *C*. A swivel-bracket *D* is attached to bar *B* by means of two lugs which are bent over the nut. This bracket can also be readily removed when the adjusting bar is not required.

Chicago, Ill. H. E. Thielberg

TAR CONCRETE FOR FACTORY FLOORS

At the last gas congress in Marseilles, France, a paper was read by Mons. D. Hedde on what he considered a new and very practical floor for machine shops and factories. This floor is not only proving resistant to the usual mechanical wear and tear in machine shops, but is also easily cleaned and not quickly soiled, and has the further merit that it is cheap to lay and to maintain in good condition. The mixture consists of 95 parts by weight of stone dust and 5 parts of tar, mixed by hand or by machine according to the amount to be made. Of course machine-mixing is cheaper and more thorough than hand mixing.

Care must be taken that the 5 per cent proportion of tar is not exceeded, as in such a case either the mixture would not harden sufficiently at ordinary temperatures, or it would get soft in hot weather or under the influence of artificial heating. In laying this floor-covering it is not necessary to see that the under-flooring is perfectly smooth or even perfectly level; only to be sure that there are no great bumps or hollows. The earth is first well tamped in order to give it sufficient resistance to enable it to support the tar and stone layer; then about two inches of the mixture is applied, tamped down firmly and made level.

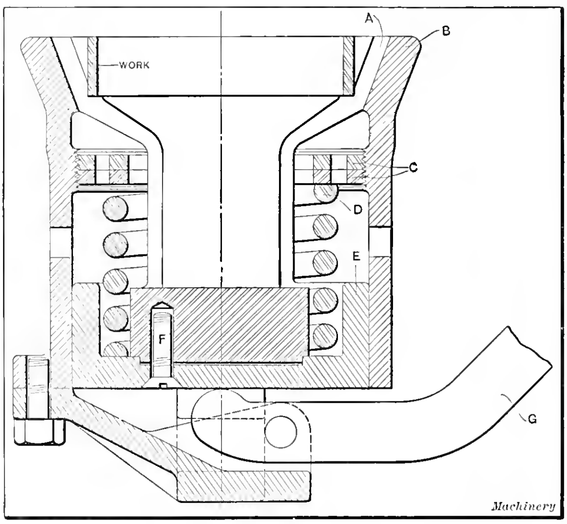
Mons. Hedde says that this floor-covering gets tougher and harder with time, but that during the first month it is desirable to protect it against very heavy weights on small areas. If it is necessary to hasten the hardening process, the floor can be strewn with powdered lime. As regards the cost, European figures have but little value for Americans; but for a floor five centimeters or say two inches thick, the cost is given as 8 centimes or 1.6 cent per square meter, which is about 1.38 cent per square yard. The amounts of material are, however, useful in calculating for American conditions. They are, respectively, 34 and 67.5 kilograms per square meter for the above named thickness; and this would come to nearly 64 pounds and 125 pounds, respectively, per square yard.

Dresden, Germany. Robert Grimshaw

FIXTURE FOR HARDENING STEEL RINGS

The accompanying illustration shows a fixture which has proved very successful in hardening steel rings of thin section. It is particularly important for these rings to be hardened without distortion, and it was to attain this end that the fixture was designed. Referring to the illustration it will be seen that the sliding member *A* is bored to exactly the required size to receive the work. This member is slotted to make it the equivalent of a spring chuck or collet, and then hardened and tempered. The body *B* of the fixture is made of cast iron and is threaded to receive the two adjusting nuts *C*. The function of these nuts is to regulate the tension under which the spring *D* works. It has been found that the best results are obtained by so adjusting the spring tension that it is proportional to the cross-section area of the work. The ring *E* serves as a bottom guide for the chuck, and also takes the thrust of the spring. Three screws *F* are used to hold the chuck *A* to the ring *E*.

The fixture is carried by a pivot on the edge of the tank containing the hardening bath, and is operated by the lever *G*. This lever compresses the spring *D* and opens the chuck so that the work may be put in place. When the lever is released the chuck is closed by the tension of the spring *D*, and the whole fixture is then turned on the pivot to immerse it in the bath. After the work has been quenched, the fixture is tilted back and unloaded by reversing the process. It will be



Fixture used in hardening Steel Rings to prevent Distortion

seen that recesses are cut in the chuck to provide space to get hold of the work when it is being removed. It must be clearly understood, however, that the chuck grips the work all the way to its upper edge except at the points where the recesses are cut. It will also be noticed that holes are drilled in the side of the body *B* of the fixture so that there will not be any air pressure to overcome.

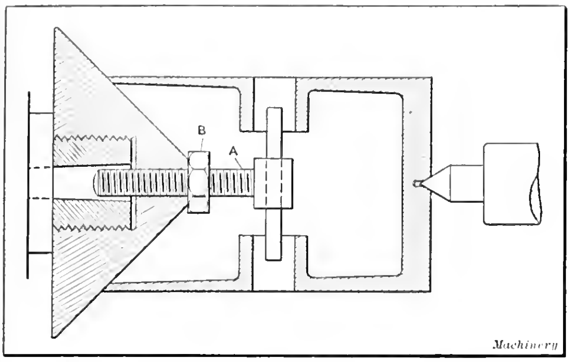
Bristol, Conn. Frederick A. Hotchkiss

METHOD OF HOLDING AND DRIVING GAS ENGINE PISTONS WHEN TURNING

The accompanying illustration shows a fixture that will be found useful, principally in repair shops, for turning gas engine pistons. The open end of the piston is supported by a cone having an included angle of about 90 degrees, which is

screwed onto the nose of the lathe spindle. The diameter of the cone base, in this instance, is 9 inches. The other end of the piston is held by the tailstock center. Screw *A*, which is $\frac{7}{8}$ inch in diameter, is screwed into the end of the cone. It is about $3\frac{1}{2}$ inches long and has a square head $1\frac{1}{4}$ inch wide with a $\frac{1}{2}$-inch hole drilled through it. A rod is driven through the head, which is long enough to engage the wrist-pin bosses inside the piston. The driver *A* is adjusted for pistons of different sizes by means of lock-nut *B*.

Before the piston is placed in this fixture, it should be chucked so that the end can be faced and chamfered where



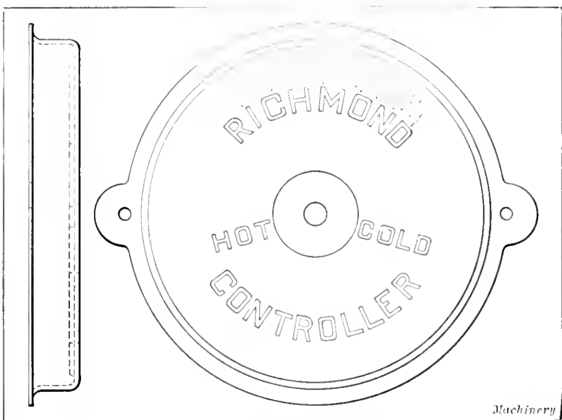
Method of holding and driving Gas Engine Pistons when turning

it bears on the cone. The center for the tailstock end can be put in on a drill press after the opposite end is faced square.

Dubuque, Iowa E. J. BUCHET

WHY THE BLANKS WRINKLED

In blanking and forming work in a combination cutting, forming and embossing die, trouble was experienced after about three thousand good blanks had been finished. At this point the work suddenly started to wrinkle badly at a point



Embossed Work that caused Trouble by wrinkling over Word "Richmond"

above the word "Richmond" and the metal in the letters of this word also seemed to be crushed. This state of affairs developed all of a sudden and without any perceptible cause. The die was taken off the machine and sent to the toolroom for repairs. It was thoroughly overhauled, and as everything appeared to be all right it was returned to the press department. The press was set up and started again but the work showed the same defect that it had before the die had been inspected.

About this time the assistant press foreman came along and the trouble was explained to him. He picked up one of the blanks, looked at it closely and then told the press operator to clean the stock thoroughly in order to remove oil and grease. This was done, and when the press was started on stock which had been carefully cleaned the work was found to be perfect. The foreman told us that the oil had caused the trouble by taking up sufficient space between the punch and die to cause a deformation of the work. This may be a matter that has come to the attention of some of MACHINERY'S readers, but I think that the majority of them have not been confronted by this particular problem.

New Britain, Conn. W. C. BETZ

GAGE FOR U. S. S. THREAD TOOLS

Away back in the days when the form of thread which we now call the U. S. standard was but little known, a machinist received instructions to design and make a gage for grinding the thread tools. To understand the difficulty of the task, we must remember that he had but one of the precision tools which now seem so indispensable, *viz.*, a one-inch micrometer of the old type with exposed thread and beveled points. The only machine tools available were a lathe and planer.

After much cogitation he decided to utilize the wedge principle and evolved the arrangement shown in Fig. 1. The upper edge of the movable scale *A* rests against the two buttons *B* which are adjusted to locate the lower edge of the scale at right angles to the axis of the 60 degree vee. The scale is tapered at such an angle that a movement of 1/32 inch corresponds to 0.001 inch in the width of the exposed edge representing the width of the thread tool flat.

Fortunately, the machinist referred to knew enough about

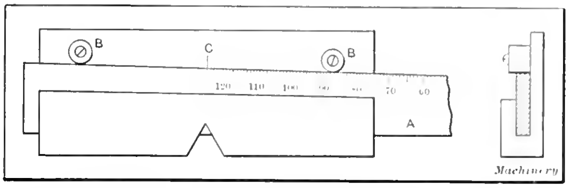


Fig. 1. Gage for U. S. Standard Thread Tools

trigonometry to know how this angle must be calculated, and he could use logarithms so that no lengthy figuring was necessary. He soon determined that the angle must be that whose logarithmic sine is 8.44268, for as $1/32 \sin a \; 2 \tan 30$ degrees $= 0.001$

$\sin a = 0.016 \cot 30$ degrees.

8.20412 Log 0.016
0.23856 Log cot 30 degrees

8.44268 Log sin *a*

The gage was now complete, *on paper*. The machine steel body was made on the planer. The sides of the vee were casehardened and lapped to fit a 60-degree center-gage, but how could the taper scale be ground in the lathe to the proper angle?

A piece of flat stock was lapped to 0.1875 inch thickness, to use as shown in Fig. 2. Dividing 0.1875 by the sine of *a*, gave 6.765 + or about 6 49/64 inches as the distance from the end of the straightedge to the point of contact with the 0.1875-inch block. By this means the compound rest of the

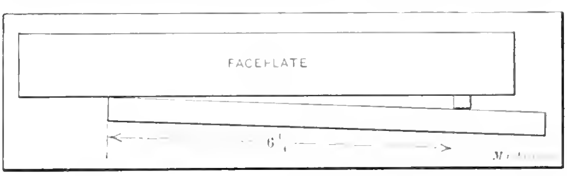


Fig. 2. Method of locating Scale for grinding One Side to Required Taper

lathe was set at the desired angle with the faceplate. The blank was clamped to the tool-block, parallel with the faceplate and was ground with an emery wheel carried by the live spindle.

The scale was easily graduated by a method in common use at that early date. The surface was first covered with asphaltum varnish. The scale was then clamped to the tool-block and the graduations were scratched by a scriber point held on a bar between the lathe centers, the necessary tra-

verse of 1/32 inch being obtained by turning the lead-screw to which a gear was attached to serve as an index plate. After the figures had been scratched with a scriber, the rest of the scale received a coat of asphaltum and it was then immersed in etching fluid.

The gage was then assembled and its zero point C determined. This could easily be done now, by using a size block, but nothing of the kind was then available. Even the 3/16-inch piece used to get the angle did not have square corners that were accurate; hence, the only way was to insert a round piece in the vee and determine by calculation what the reading of the gage should be when the scale was in contact with this size plug. A knurled head screw (not shown in Fig. 1) was used to lock the scale when desired.

This gage did excellent work, being as accurate and convenient as the well made and expensive tools we find in the shops at the present time. A similar gage can be made for Acme and worm thread tools, making the vee 29 degrees and tapering the scale to the angle whose logarithmic sine is 8.79146.

For either 60-degree or 29-degree tools, the gage can be designed to give 1/16-inch instead of 1/32-inch movement for 0.001 inch increase in width of tool point, the only objection being the greater length of scale required.

New London, N. H. GUY H. GARDNER

HOW A PIECE-WORK RATE WAS SMASHED

One of the methods of concave turning described in the article entitled "Machining Convex and Concave Surfaces" by Albert A. Dowd, which appeared in the January, 1914 number of MACHINERY, reminded me of an incident that occurred some six years ago in a certain manufacturing plant. This plant makes a great many cast-iron disks 8 or 10 inches in diameter, which are hollowed out "saucer fashion" on one side. The time-honored method of handling this work was to rough out the concave surface and then hand-tool it to fit a templet. One day a new man was hired and put on this job. He was anxious to speed up as much as possible, being paid by the piece; and after giving the matter a little thought, he sharpened the ends of a piece of drill rod of a length equal to the radius of the concave surface, and inserted the points in center punch marks in the cross-slide and tailstock. He then started the cross feed, keeping the carriage pressed against this radius rod, and proceeded to amass wealth.

In the afternoon caution somewhat over-balanced acquisitiveness, and he worked at less than his maximum rate; but when the whistle blew at closing time, he had finished six times as many pieces as his predecessor had ever turned out in a day. A little reckoning brought him to the happy conclusion that he had about $18 coming to him as the result of a day's work. He now virtuously resolved to do his utmost the next day, and being a dexterous youth, he saw from $20 to $24 almost within his grasp. But this, alas, is a world of disappointments; and before he could begin the day's work that was to add materially to his "bank roll," he received the disheartening tidings that the rate had been cut to one-eighth of its former enticing magnitude, and he had to hustle like a squirrel in a wheel to make $3 a day. Now this primitive method of working with a hand tool and templet was not used in "Lonelyville" but within three miles of MACHINERY'S office in New York City.

New London, N. H. GUY H. GARDNER

HIGH-SPEED STEEL JIG BUSHINGS

The inquiry of C. R. in the March number of MACHINERY, relative to the use of a high-speed steel jig bushing, calls attention to the prevalent misunderstanding regarding the degree of hardness of heat-treated high-speed steel as compared with heat-treated carbon tool steel. It is generally admitted by those who have tested the relative hardness of the two steels, that carbon steel can be heat-treated to give a considerably harder surface than any heat-treatment will give to high-speed steels. Carbon steel would, therefore, appear to be the better material to use in all places where wearing hardness is desired. The reason that high-speed steel is so desirable for cutting tools is that it retains its hardness under a service that develops considerable heat. A cutting tool of high-speed steel used in a lathe, for example, may be run continuously under a service which may generate sufficient heat to raise the temperature of the tool to a dull red heat. In other words, the cutting tool retains its hardness for effective cutting purposes even at a dull red. A carbon steel tool would, under these conditions, lose its hardness at once.

To recapitulate, high-speed steel, while relatively softer, retains its hardness under temperatures that are considerably in excess of those allowable for carbon steel. If this is clearly understood, it will do away with misunderstanding regarding its use. Tests with the Shore scleroscope as well as wearing tests made with cutting tools bear out the statement that high-speed steel is less hard after heat-treatment than is carbon steel. In resharpening carbon steel cutting tools great care had to be taken to prevent heating the cutting edge sufficiently to blue it. This led to the use of water grinding machines for resharpening cutting tools. With the advent of high-speed steel cutting tools, wet grinding was at first considered necessary. Repeated experiments have shown, however, that it is not necessary for the life of the tool, and that it is in most cases positively injurious to water-cool the tool when resharpening it. As C. R. desires hardness in his jig bushings for the sake of wearing qualities, and as the bushings are, while in use, relatively cool, carbon steel is the best for his purpose. CASE

As regards the question of the practicability of using high-speed steel for jig bushings there can be no possible advantage in its use for this purpose, unless there is an unusual heat developed by friction. The cost of high-speed steel is prohibitive and its resistance to wear is no greater than that of hardened high-carbon steel. The principal advantage in the use of high-speed steel for any purpose is that it will not lose its hardness at a low red heat—hence its value in the cutting of metal at high peripheral speeds.

To illustrate the above assertions regarding the wearing qualities of high-speed steel, the writer's experience along this line may be of some value to readers of MACHINERY. In the drilling of holes in hard carbon, we found that high-speed steel did not wear as long as glass-hard high-carbon drills when operated at low speeds, but when operated at high speeds with heavy feeds, the carbon steel drill points became blued very rapidly, losing their hardness, and consequently were short-lived. The high-speed drills operated in like manner would wear about five times as long, although the points become blue the same as on the carbon steel drills.

Cleveland, Ohio J. E. WASHBURN

SELECTING DIAMONDS

In reply to J. Towler's query in the January number of MACHINERY concerning the selection of diamonds, I would say that he is not alone in his experience of having apparently good stones crumble to dust almost immediately after they are put in use. Diamonds are a product of nature and their composition and temper were thus placed beyond human control. No dealer is justified in guaranteeing them. From the time they leave the hands of the diamond syndicate at the mines, and in passing from the cutter to the importer, and from the importer to the dealer, each man buys without a guarantee. Naturally the user is expected to do the same.

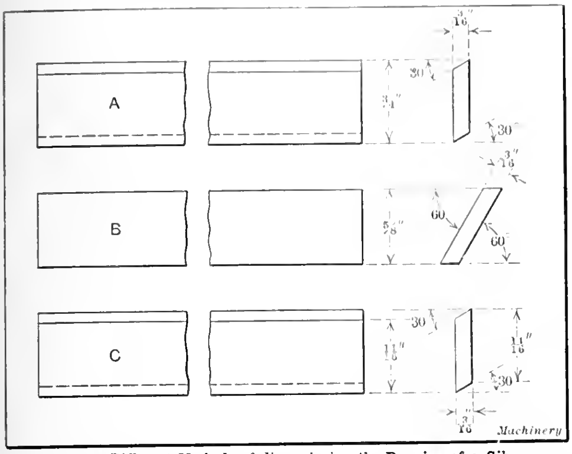
The firm with which the writer is connected is a large user of diamonds, but after fifteen years' experience in their selection we still have stones that "look good" go wrong. Permit me to suggest that those who are still using black diamonds investigate what are known as the Brazilian bortz or brown stones. These are sometimes called South African "premiers" and by other trade names. For truing up grinding wheels they are just as satisfactory as the black diamonds, and for $15 you can buy a brown bortz stone equal in size and weight to a black diamond costing $70 or $75. By way of conclusion, I would say that in selecting stones, the best plan is to avoid those which appear to have seams, as such stones are likely to crack along these seams,

while the smooth skinned stone is the most likely to prove satisfactory. Of course, the more points a stone has the better.

GRINDING WHEEL MANUFACTURER

DIFFERENT METHODS OF DRAWING A GIB

The accompanying illustration shows three different methods of drawing a gib. In making a gib the first thing a milling machine or planer operator wants to know is what size of stock is needed to produce the piece without wasting time or material. It appears to the writer that the method illustrated at *A* enables anyone to see at a glance just the size of stock that is required. This illustration shows the thickness and the full width so that all that is necessary is to machine the gib to the required angle.



Three Different Methods of dimensioning the Drawing of a Gib

The illustration *B* shows the width of the gib after it has been machined to the proper angle; but how much stock is required to obtain this size? Illustration *C* shows the width of the gib from one edge to the other. In illustrations *B* and *C* the operator must either stop to figure out the size of stock that is required or else resort to guesswork. These drawings made by different draftsmen started an argument in regard to the best method of illustration. The writer claims that the method shown at *A* is the correct one, while another man advocates that shown at *B*, and still another claims that the one shown at *C* is the best. Who is right?

Pearl River, N. Y. W. BUTZ

CUTTING A SPIRAL ON A LODGE & SHIPLEY LATHE

A spiral is a very difficult thing to machine and a special lathe is generally required for this purpose. The accompanying illustration shows a Lodge & Shipley lathe cutting a 4-pitch spiral in a plate 6 inches in diameter, and it is the purpose of this article to describe the fixture used for this

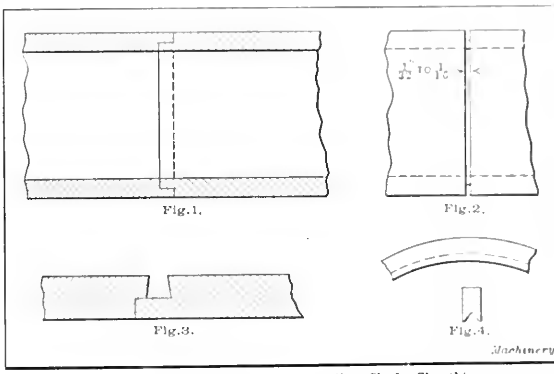
Lathe Fixture used for cutting a Spiral

operation. After the blank was turned it was chucked as shown in the illustration. The feed is regulated by a screw with a pitch equal to the desired pitch of the spiral. This screw is driven by a miter gear which meshes with a gear fastened to a mandrel supported between centers. The screw works in a nut mounted at the rear end of the carriage, and the feed clutch on the apron may be disengaged to allow the carriage to be moved. This attachment is simple and may be constructed from odd pieces found around the shop. The gears are not necessarily miter gears, although these are preferable, as they simplify the calculation of the pitch of the screw.

Chattanooga, Tenn. RUSSELL K. ANNIS

BRONZE SHEATHING OF PROPELLER SHAFTS

The tail-shafts of ships, that is, the length of the propeller shafting which passes through the hull of the ship and on which the propeller is carried, is fitted with bronze sheaths or liners to prevent corrosion due to the action of the sea water. These liners are usually made in lengths of from five to six feet and are arranged so that when in position on the shaft a male and female joint come together as shown in Fig. 1. The method of securing them on the shaft is by shrinking. The liners are bored out smaller in diameter than the shaft, the usual allowance being 0.001 inch per inch of diameter of the shaft. Heat is applied either by means of a steam jet or by a gas or oil burner, until the liners have expanded sufficiently to allow them to be slipped over the shaft. Provided the shaft has been turned parallel and there has been little variation in the bore of the liner, a perfectly



Joints between Sections of Propeller Shaft Sheathing

solid contact should result. The solidity can readily be tested by lightly tapping the liner with a hammer

Great difficulty has been experienced in getting the liners to butt closely at the joints when cold. This, of course, is due to shrinkage. Local cooling with water at the joints has been tried, but fails to obtain the desired result and invariably we find that there is a space of 1/32 to 1/16 inch between the ends, as shown in Fig. 2. Such a condition is not acceptable in cases where rigid inspection obtains. To close this gap electric welding often is used. The joints are welded and the surplus metal is afterward removed in the lathe. With this method great difficulty was experienced in obtaining a homogeneous weld.

To overcome the annoyance and expense incurred by faulty welds, the following method has been devised. The liners are shrunk onto the shaft and the outside is finished as before. The space between the liners is enlarged until a groove 1/4 inch wide and just deep enough to reach the outside of the male joint is obtained between each pair of liners. The sides of the grooves are then cut away slightly to form a dovetail. (See Fig. 3.) Into these grooves are driven segments of material having a cross-section similar to that shown in Fig. 4, until the circle has almost been completed. In fitting the last segment a space must be left around the circumference to allow for the expansion of the metal when all the segments are forced into the groove. This amount, of course, depends on the circumference of the groove.

To fasten the segments securely into the groove, the tail-shaft is revolved in a lathe and a knurling tool is pressed against the outside of the segments until they are completely flattened. A light cut is then taken with a finishing tool, to remove all surplus metal. The material used for the segments should be a soft combination brass such as is used for calking pieces in turbine work.

Sparrow's Point, Md. JOHN GRAHAM

WORK SPEEDS IN GRINDING

I hope your editorial in the December number entitled "A Question for the Grinding Expert" will bring forth a friendly discussion among grinding machine makers and users. It would certainly redound to the benefit of all. Grinding is no longer the "hit or miss" machine shop practice it used to be, but is becoming one of the leading shop operations. Yet no one has a monopoly of the knowledge of it.

Unfortunately many of those who are in a position to write authoritatively and entertainingly on grinding practice have not yet been "moved by the spirit." Charles H. Norton of the Norton Grinding Co. and J. H. Hollinger of the Landis Tool Co. have both, in times past, contributed to MACHINERY'S columns. I hope they will both continue and that we shall hear from some of the others as well. J. Kenyon, of the Brown & Sharpe Mfg. Co.; H. T. Shearer, of the Landis Tool Co.; B. M. W. Hanson, of the Pratt & Whitney Co.; H. K. Spencer, of the Blanchard Machine Co., and Mr. Wight, of the Diamond Machine Co., all could contribute funds of information regarding grinding operations.

To return to the subject suggested by your editorial, the satisfactory working of any grinding wheel (I refer now to automatic grinding operations) depends upon the question of feeds and speeds. Of course, in manufacturing grinding operations where similar pieces are constantly being ground, the wheel maker can supply a suitable grain and grade of wheel to meet whatever conditions of speeds and feeds the user may have established. But, when a grinding machine is used for all sorts of work—the "run of the shop"— it is manifestly impossible to change the wheel for every new job, and here is the importance of knowing how to change the feeds and speeds to do the various jobs quickly and efficiently.

The larger the surface of contact between work and wheel, the softer should be the wheel. The effect of a soft wheel can often be obtained by reducing the wheel speed. Inversely, if a wheel is wearing too rapidly, increasing the wheel speed will overcome the difficulty. I question your statement that "comparatively soft wheels are conceded to be the most efficient for roughing." Consider two specific operations, *viz.*, roughing cams and roughing crankshafts. For the former, very satisfactory results are being obtained on Landis and Norton grinders with 24-O corundum wheels, some (The Maxwell Motor Co.) preferring even coarser and harder wheels, *viz.*, 16-P corundum. Many operators may be surprised to know that such coarse hard wheels can be used for any automatic grinding operations, but they can and with excellent results. For finishing the cams, 46-K or 46-L corundum wheels are used.

For crank grinding, there are a variety of preferences as to grade, but none of the grades used could be considered "comparatively soft." No. 24 combination N is a favorite wheel for crank grinding, and from this up to grade Q, the latter being used by one of the largest auto manufacturers in the country. In crank grinding the usual practice is to use a wheel just as thick as the width of the pin to be ground, and to feed heavily right in without traverse. The wheel is then dressed true with a diamond, and the same wheel used for finishing, the finish cut being a light one.

Again I question your statement that the work speed is reduced for finishing. As a general rule, I believe that increasing the work speed, with a very light cut and a slow traverse, will improve the finish. One mistaken impression exists in many minds that a fine wheel must be used for finishing. A good commercial finish can be obtained with a wheel as coarse as 36, if it is kept true. For surface grinding, wheels *finer* than 30 or 36 are rarely used.

The above grains and grades referred to are those of the American Emery Wheel Works.

Providence, R. I. JAMES O. SMITH

CHART OF EXPERIENCE AND WAGES

The accompanying illustration shows a chart that can be conveniently used by a man in applying for work. The horizontal base line of the chart is laid off in years, while the left-hand vertical lines are laid off to represent wages. In the left-hand chart, the writer's experience between the years 1899 and 1908 is shown, the wages being expressed in Swedish crowns per month. In 1908 the writer moved to America, and at this point of his career a new chart was started on which the wages are shown in dollars per week. Where such a chart is sent to a prospective employer, it shows at a glance just what experience the applicant has had and the wages he has received. Such a method could be extensively used to the mutual advantage of the employer and employe.

Duluth, Minn. R. POITZEL

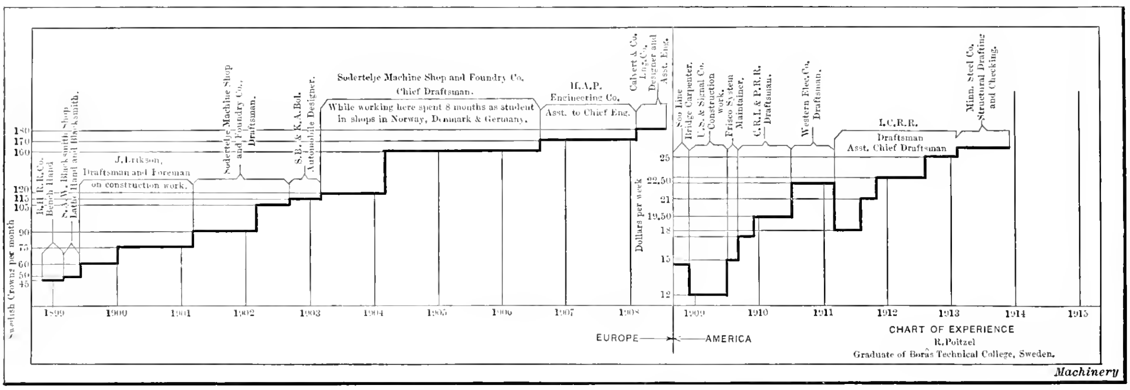


Chart of Experience and Wages used in applying for a Position

LUBRICATING STICK

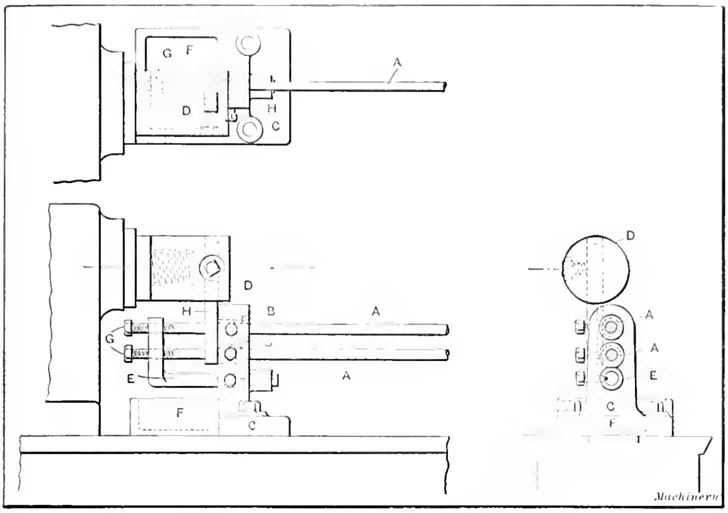
When sawing or drilling small copper, brass, or German-silver pieces, with small saws or drills, a fine lubricant is prepared as follows: (1) Make a solution of two parts of camphor in four parts of turpentine. (2) Melt together two parts of pure mutton tallow and one part of beeswax. To this melted mixture add about 5 per cent by volume of solution No. 1 and also a few drops of oil of lavender to offset any offensive odor. This mixture, while hot, is poured into paper tubes about one-half an inch in diameter and four inches long. These are made by winding typewriter paper around an arbor, gluing the layers together, and shellacking the outside when dry. When cold, these sticks should be quite hard, and may be handled without soiling the hands;

they are as convenient as a piece of beeswax and give better results. This stick has the end exposed by removing a narrow ring of the paper and is touched to the revolving cutter; the heat generated by cutting melts that which sticks to the cutter and lubricates thoroughly. In cases where cleanliness is a primary factor, this method is giving perfect satisfaction.

Southbridge, Mass. WARREN E. THOMPSON

LATHE ATTACHMENT FOR CUTTING OFF PINS

In setting up machines a great many pins for use in collars, dowel pins, etc., are required. It is the purpose of this article to describe an attachment for use on a lathe which provides for cutting off pins of various lengths from wire of different diameters. Referring to the illustration, it will be seen that the fixture provides for cutting off two pins at a time, the wires *A* from which the pins are cut passing through the bushings *B*, which are supported in a bracket *C*. This bracket is screwed to the bed of the lathe. The bushings are made interchangeable so that a number of sizes may be used for cutting pins from wire of different diameters. The cutter *D* is held in the tool-holder by means of a set-screw, the tool-holder being threaded to fit the lathe spindle. The bracket *E* acts as an adjustable stop, being fastened in any required position to suit the length of pins to be cut off by means of a set-screw. In operating the attachment, the wires are pushed through the bushings until they come in contact with the stops; the cutter then comes around and shears them off. Immediately after two pins have been cut off, the wires are pushed up against the stops in position for the next cut. As the pins are cut off they fall into the trough *F* which is an integral part of the bracket that supports the attachment.



Lathe Attachment for cutting off Two Pins simultaneously

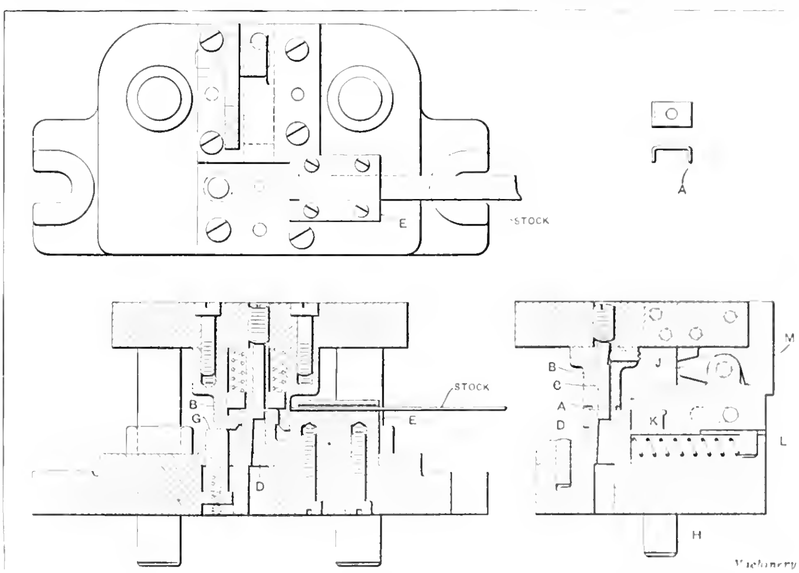
It is possible that the cutter could be made longer and that a greater number of bushings could be used, in which case more pins could be cut off at each revolution of the cutter. The possibility of development along this line would depend upon the operator's ability to push more than two wires up to the stop before the cutter comes around for the next cut. By using different sized bushings and setting the stop-screws *G* in different positions, it is possible to cut off pins of different lengths and diameters at the same time. In operating this attachment, it is important to have the bracket *C* adjusted to such a position that the cutter slips over the surface *H* so as to give a good shearing action.

If it is desired to cut off long lengths of wire, the shearing cutter *D* could be fastened to a bar carried on centers and driven by a driving dog. In this case the bracket *C* would be placed on the bed of the lathe near the cutter, and a separate bracket with adjustable stops would be employed to control the length of the work. The second bracket would be fastened to the bed of the lathe. The attachment shown in the illustration is self-contained and when it is not in use it can be easily removed from the lathe. W. R. O.

A NOVEL PUNCH AND DIE

The punch and die illustrated herewith is used for cutting off, forming and piercing pieces of the form shown in detail at *A*. These pieces are parts of an electrical switch and are made of 1/16-inch sheet brass. The interesting feature of the punch and die used in producing them is that an ejecting mechanism is provided to remove the finished pieces from the die, thus making it unnecessary for the operator to put his hands under the punch. After all, this is the surest method of preventing punch press accidents. The use of an automatic ejecting mechanism also permits the punch to run continuously instead of making it necessary to stop after each stroke to remove the work. In the illustration, *B* is the forming punch, *C* the piercing punch and *D* the die.

It will be seen that ribbon stock is used which is fed through a guide *E* until it comes up against the stop *G*. The punch is shown at the end of the down stroke. On the up stroke the hardened cam *H* engages the lever *J* which pushes the slide *K* forward and knocks the finished piece of work *A* off the die. The spring *L* returns the slide and the



Combination Cutting-off Forming and Piercing Die provided with a Novel Ejecting Mechanism

cam is so timed that it advances the slide before the stock can be fed forward for the next operation. The plate *M* is held in the punch-block to return the lever to the working position should it fail to return after the cam passes it on the down stroke. The work is cut off against the face of the

guide E, and the arrangement of the strippers is evident from the illustration without requiring further description.

LAWRENCE FAY

SYSTEMATIC CALCULATIONS

The use of systematic methods of calculation is a subject which seems to have been neglected by the technical press. The writer's experience has been that the majority of draftsmen do not try to systematize their notes and computations. On the contrary, most of them use the loose and shiftless method of scratching upon a scrap of paper, marks and figures arranged in haphazard form, that are disconnected and incomplete. Such a habit is of no profit to either the draftsmen or their employers. In case a question arises in regard to the strength of a certain part of a machine, the draftsman would save himself and his employer much time and trouble if he had made his computations in such a manner as to make reference to them both intelligible and accurate.

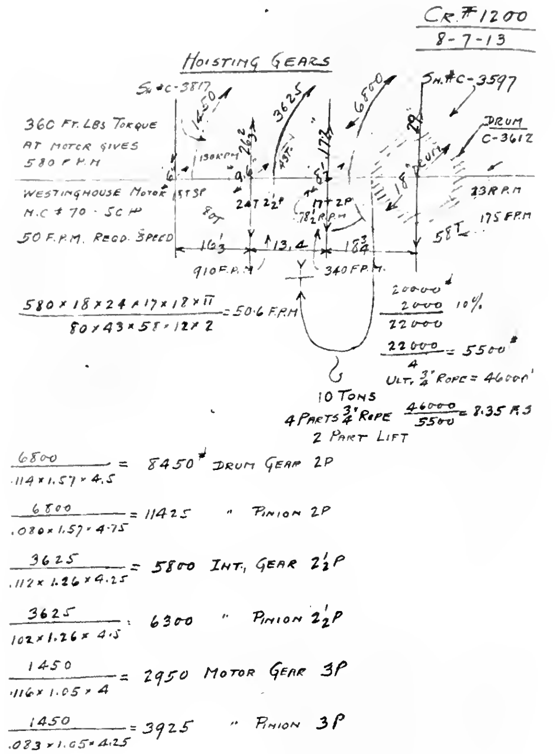


Fig. 1. Computation Sheet for Hoisting Gears—kept for Reference Purposes

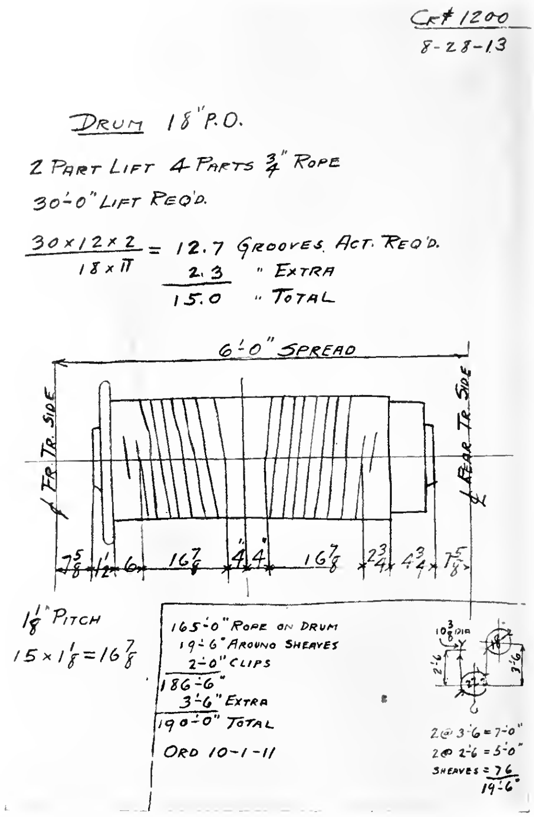


Fig. 2. Calculations for Hoisting Drum Grooves and Rope Length

To begin with, all the data regarding the calculations for a certain part of a machine should be put down. This is advisable because, while the designer knows exactly all the conditions of the case under consideration, a year or more afterward he will have forgotten them or, perchance, will have changed his position. If a mistake is made, instead of destroying the sheet of figures it is better to mark it void, because oftentimes computations which were thought to be wrong are found to be right. A "new" machine is seldom entirely new, but is generally an adaptation and modification of some other design. In this event carefully made and preserved notes and calculations of the old design are often useful. Then, too, proposals, estimates and bids which are generally required in a minimum length of time can be made up more quickly by the aid of such records.

Fig. 1 shows a computation sheet for hoisting gears. A careful perusal of this sheet will show that all the necessary and important data are given. The contract or machine number should appear on all such sheets, as well as the date of computing. It is often found necessary to use certain parts called for on different drawings, as for instance, in a train of gears it is desirable to use gears detailed on different drawings; in that case the number of each drawing should be noted upon the computation sheet with arrows clearly indicating just what gears are covered by that particular drawing. Such practice will prove of value in designing because, when the details are to be made, the designer knows just exactly what parts he intended to use. The gear centers are put down on this sheet and are found useful in laying out the general arrangement of the mechanism.

A method for figuring drum grooves and the length of rope required is shown in Fig. 2, together with an illustration of the drum giving the necessary dimensions for making a drawing. Many designers prefer to make their notes and calculations in a permanently bound blank book. The writer has found it convenient to use loose sheets held together with a spring paper clip, until the design for a machine is completed; the sheets are then riveted together for future reference.

The habit of making all notes, sketches and calculations clear, intelligent and complete, cannot be emphasized too strongly. The faithful and conscientious use of the aforementioned hints will, the writer believes, prove to be a great help to any draftsman and designer.

Toledo, Ohio CARL E. SCHIRMER

* * *

A successful engineer must build a man below him to take his place. He must do this with his eyes open to the fact that in time of grave financial crisis he may be discharged, so that the work can be carried on with a reduced pay roll, but this contingency is, after all, very remote. The 99-per-cent-certain result is that he, himself, is the logical candidate for advancement, because he will leave no aching void when he steps higher.—*J. M. Eaton in the Journal of the Worcester Polytechnic Institute.*

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

HOW TO COOL STEEL WITHOUT HARDENING IT

Very often a mechanic is working with a piece of tool steel and wants to cool it off without hardening it. Very simple you say. Lay the piece on the floor behind the forge and you will be able to handle it in fifteen minutes. When the piece is wanted for immediate use, however, it can be cooled quickly by plunging it into a pail of soapy water. When this practice is followed the steel will be soft enough to cut with a tool.

Middletown, N. Y. DONALD A. HAMPSON

FOR LAPPING SMALL HOLES

The most convenient method of handling emery or other cutting powder is in combination with ordinary non-fluid engine grease. Make a mixture by adding a small percentage of emery to the grease and stirring thoroughly. Care must be taken not to add enough powder to destroy the sticking properties of the grease. This may be applied to the lap by a stick and will not fly off as oil will. This mixture will also cut much faster than emery and oil.

Southbridge, Mass. WARREN E. THOMPSON

LUBRICATION OF SCREW MACHINE CUTTING TOOLS

After having had considerable trouble with oil gumming the movements of small automatic screw machines, all the oil was washed out of the machine and clean kerosene used in its place. For cutting screws from soft steel, German silver, and copper alloy wire, no better lubricant can be desired and the machines are never gummed or disagreeable to work on. The ordinary geared pumps handle kerosene satisfactorily if speeded a little higher than for heavier oil.

Southbridge, Mass. WARREN E. THOMPSON

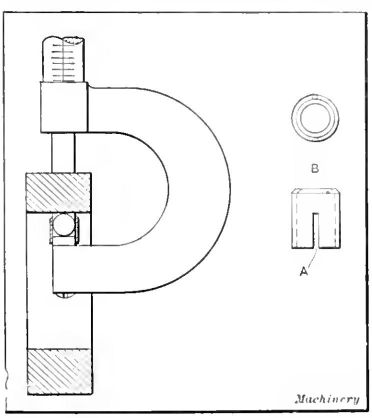
ENLARGING THE PILOT OF A COUNTERBORE

Experience has shown me that a very quick way of enlarging the pilot of a counterbore for counterboring an odd sized hole for which you do not wish to make a bushing is to cover the pilot with solder and then turn the solder down to the exact size of the hole. If care is taken to cover the pilot all over with solder and not to turn into the cutting edge of the counterbore when turning down to the required size, this method will be found very satisfactory for handling an emergency job.

Providence, R. I. JOHN W. HIRD

MEASURING THE BORE OF RINGS AND CYLINDERS

The following describes a rapid and accurate method of measuring the bore of rings or cylinders which have been machined on the outside. The first step is to measure the outside diameter of the work. The diameter of the bore that it is required to machine is then deducted from the measurement of the outside diameter, which leaves twice the thickness of the wall of the ring or cylinder. An outside micrometer is fitted with a steel ball 1/4 inch in diameter, the ball being held in place by a short piece of 1/4-inch tubing. This piece of tubing is split at *A* and spun over at *B*, thus forming a retainer which holds the ball in place on the anvil. After boring the hole to within 1/32 inch of the required size, the thickness of the wall is measured with the micrometer, as shown in the accompanying illustration. Then 0.250 inch is deducted from the micrometer reading to correct for the diameter of the ball. The thickness of the wall, as determined by calculation, is then subtracted from the corrected reading, which gives the amount of metal that still has to be removed. By this method holes can be bored or ground more accurately than when measurements are made with an inside micrometer. To obtain satisfactory results it is evident that the outside of the work must run perfectly true. To accomplish this, an accurate indicator may be used or the work may be held in a special spring chuck or on a magnetic chuck.



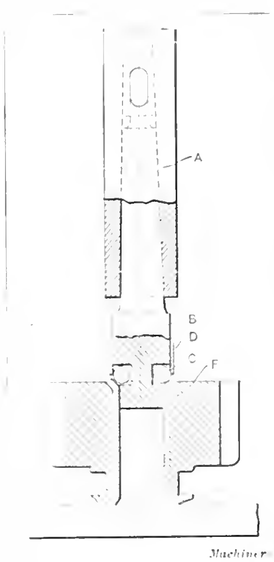
Measuring Bore of Ring with Outside Micrometer

New Britain, Conn. W. C. BETZ

A BEADING TOOL

The tool shown herewith was designed to rapidly bead over the ends of small bronze bushings such as are used extensively in motor car manufacture. In this way, the bushings are held securely in the bore of the sliding gears to which they are fitted. The beading was formerly done by hand but required too much time and the work was irregular. With the tool now used, the work is done rapidly as well as more uniformly.

This tool is used in a sensitive drilling machine. In the illustration, *A* represents the drill spindle and *B* the shank of the tool. The latter is made from steel and is hardened at its lower end where there is a groove carrying the balls *C*. These balls, which are kept in position by ring *D*, press against the upper rim of the bushing *F* while rotating and bead over the ends as the illustration indicates.



Ball Beading Tool for Gear Bushings

Turin, Italy. C. BOELLA

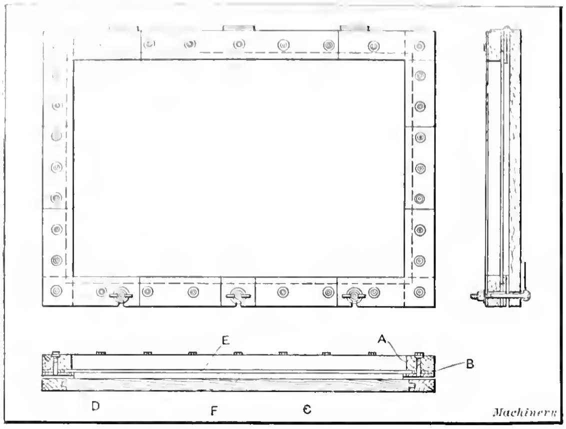
BLUEPRINTING FRAME

A frame for blueprinting by sunlight, in which a good contact between the glass and paper is secured is described by the following: The frame is made of hard wood and a sheet of glass is selected which is quite clear and free from bubbles. The glass must be of sufficient thickness to support the pressure and a sheet of 1/4-inch plate glass will be found satisfactory for the purpose. The frame is mounted on a carriage that enables it to be placed in a convenient position for taking advantage of the best sunlight. It will be seen that this is not a "turn-over" frame but that the blueprint paper and tracing are inserted by lifting the cover in which the glass is set. The pressure is applied by means of three wing nuts carried by bolts which slip into slots in the cover.

The use of a frame of this kind is particularly convenient when it is desired to blot out any section of a tracing on the blueprint. As the tracing is always right side up and in plain view, it is unnecessary to turn the frame over in order to see whether the shield over the part to be blotted out is properly located, and ready to be exposed to the sunlight.

Although the first cost of a frame of this kind is a little more than that of a stock frame, the rapidity with which blueprinting can be done will soon make up for the difference.

Referring to the cross-sectional view, *A* represents the hardwood top strip, *B* the separating strip and *C* the base of the frame. Strips *D* are employed to hold the plate glass *E* in



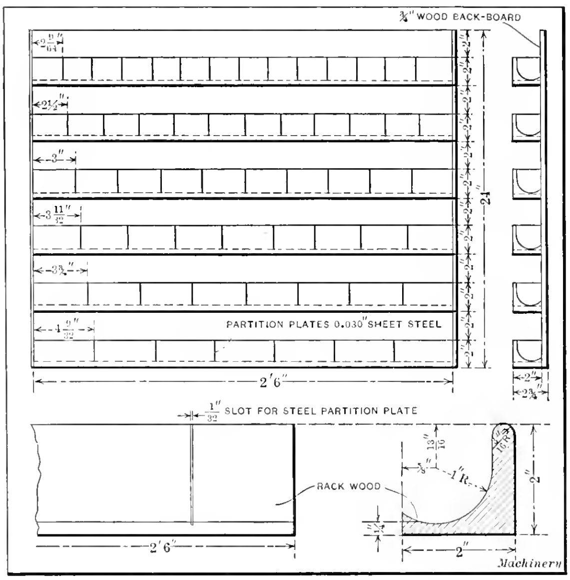
Frame for blueprinting that gives Good Contact between Paper and Glass

the frame. A sheet of felt *F* ½ inch in thickness is used to form a pad which takes up any inequalities in the pressure and insures having the blueprint and tracing held firmly against the glass at all points.

Philadelphia, Pa. C. W. CARRIGAN

RACK FOR SMALL DRILLS

The accompanying illustration shows what has proved to be a very handy as well as space-saving drill rack for small drills varying from No. 1 to No. 60. A rack of the same general construction could be used equally well for small taps. The tills are made from 2-inch square stock, planed in the carpenter shop to the shape shown in the sectional view. Care



Rack for Small Drills or Taps

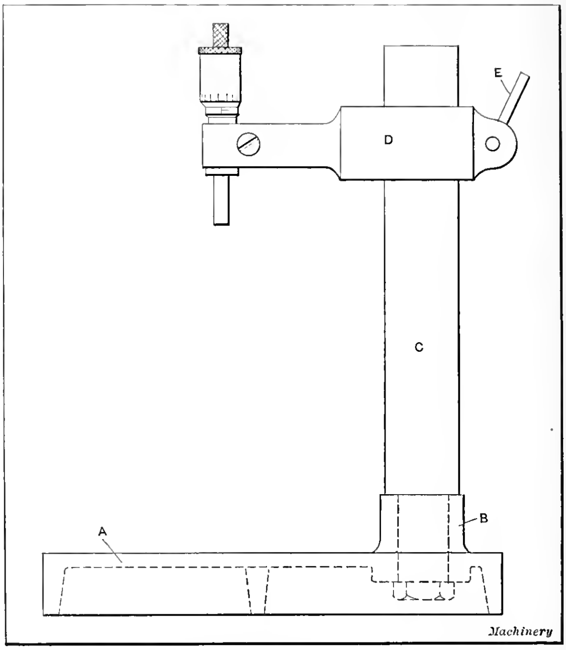
should be taken to form the tills so that there are no sharp corners into which the drills can roll.

The strips are cut 2 feet 6 inches long and are sawed for the steel partition plates, the spacing varying from 4 9/32 inches for No. 1 drills to 2 9/64 inches for No. 60 drills. The partition plates are made of sheet steel. These are assembled after the tills have been fastened to the back-board. Sheet metal end plates are used to close the outer ends and help support the tills. The cost of this rack is very small as compared with the drill cabinets often used. It should be placed on the wall within easy reach of the store-room window and will save the attendant many steps. There is ample space on the front of each till for marking the size of the drill and inserting a hook for the workman's check.

Pittsfield, Mass. C. E. PORTER

ADJUSTABLE MICROMETER HEIGHT GAGE

The adjustable micrometer height gage illustrated herewith was made to meet certain requirements in inspection work that were not fulfilled by standard gages; this special gage has also been found useful for a variety of purposes, other than in the inspection department, and will doubtless be of interest to readers of MACHINERY. It consists of two castings, a piece of turned steel and a micrometer head. The base casting *A* is of rather light section and is provided with a boss *B* in which the post *C* is carefully fitted. It will be seen that the post is turned to form a shoulder which abuts against the face of the boss *B*. The casting *D* carries a standard micrometer head in a hole bored for the purpose, while a hole is bored at its opposite end to fit over the post *C*. Both ends of the casting *D* are split in to the bored holes. The micrometer head is permanently secured by means of a screw which tightens the arm onto it. The position of the arm on the post may be adjusted by means of the binding screw *E*, which tightens it in any desired position.



Adjustable Micrometer Height Gage for use in Inspection Department

It is evident that a gage of this nature must be very accurately made to give satisfactory results. The upper face of the base casting *A* must be finished so that it is exactly perpendicular to the axis of the micrometer screw for all positions of the arm *D* on the post *C*. The micrometer head is set by means of an accurate standard. With the zero point determined in this way, pieces of work may be measured with the standard as the basis of comparison. The provision of the swinging arm, which can be adjusted to different heights, and the broad base of the gage has made it possible to measure many classes of work that cannot be handled with an ordinary micrometer or snap gage. This tool has found favor with all who have had occasion to use it.

Middletown, N. Y. DONALD A. HAMPSON

* * *

It is not so bad to build castles in the air as some people may think, provided, of course, that we go to work right away to put a solid foundation beneath them.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

COPIES OF FOREIGN PATENT SPECIFICATIONS

W. F. W.—To whom should I apply for copies of British and German patent specifications?

A.—Printed copies of British patents can be obtained from the Comptroller of Patents, 25 Southampton Bldg., London, England, and German patents, of Kaiserliches Patentamt, Gitschinerstrasse 97/103, Berlin, S. W. 61, Germany. Photographic copies of specifications and drawings of foreign patents can be obtained from the U. S. Patent Office, Washington, D. C. The cost of copies on paper 7 by 11½ inches, single page only, is 15 cents per print. Copies on paper 11½ by 14 inches, composing single or double pages, are 25 cents per print.

MAKING MICROMETER CALIPER SCREWS

H. G.—How are the screws of micrometer calipers cut? Are they afterwards lapped or not? Are they tested for pitch, and if so by what method?

A.—The practice of the different makers of micrometer calipers differs widely. One well-known maker cuts the screws on small special screw-cutting lathes in essentially the same manner as screws are chased on the ordinary engine lathe. Another well-known maker is said to cut micrometer screws in the automatic screw machine, using special chasing dies for the purpose. Another rolls the threads with thread rolling dies. All the makers test the screws for accuracy and some of them compensate for inaccuracies by inclining the datum line on the barrel to the axis of the barrel. The datum line is inclined to the right or left, depending on whether the screw is long or short in the lead. Contributions on the subject are invited from readers.

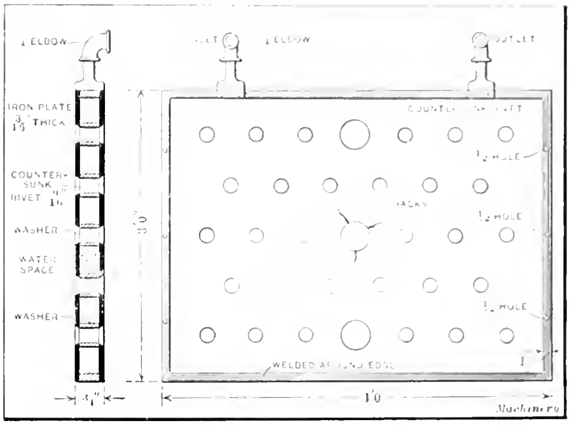
THE FOX LATHE

E. R. R.—I am running a Fox lathe. A friend asked me why it was called a Fox lathe, and I am unable to answer the question. Any information on the origin and history of this machine tool will be appreciated.

A.—The Fox lathe was first built by George H. Fox, who started in business with a partner as a machinist in Boston, Mass., in 1843. The lathe was developed some time between this date and 1859, when it was first advertised as the product of George H. Fox & Co., 45 Kingston St., Boston. The business was incorporated in 1864 as the American Machine & Tool Co., with Mr. Fox president, and this company has built it as a small side line ever since. Distinguishing features of the Fox lathe are a compound slide rest which in later years was usually surmounted by a tool turret and a screw chasing attachment, advertised by Fox as "Nason's patent screw chasing apparatus." This consists of a tool-holder clamped to a longitudinal round bar which is mounted in bearings so that it can both oscillate and slide endways. A half-nut, fixed to the bar, is brought into engagement with a short lead-screw when the operator pulls the chasing tool against the work. To change the pitch of the screw chased, it is necessary to change the lead-screw. Some improved forms of the Fox lathe have several lead-screws mounted on a revolving frame so that any one can be brought into use by turning a handle. The Fox lathe was also built many years ago by the Exeter Machine Works, Exeter, N. H. It is and always was primarily a brass-working lathe, and is widely used in the manufacture of brass valves, gas fixtures, plumbing supplies and other brass goods.

TO PREVENT RIVETS LEAKING IN STEAM PLATES

A. E. D.—We are using the oxy-acetylene welding process for welding rivets in steam plates of the form shown in the accompanying illustration with poor results and would like suggestions for overcoming the troubles. The steam plates are made of two iron plates three feet wide, four feet long laid on each side of a welded rectangular frame and are held together by rivet stays. The over-all thickness of the assembled plate is ¾ inch. The plates are 3/16 inch thick and ¾ inch space is provided between them for steam and water. The rivets are 9/16 inch diameter and are spaced at intervals of about six inches each way; washers are provided between the plates to support them when riveting. These plates are used in the manufacture of underwear, about twenty of them being piled up on a press with the goods between them. A pressure of about sixty tons is applied in a hydraulic press, and, through pipe connections provided, steam is turned on for a certain time and then shut off and cold water is circulated through the plates. The result is that the expansion and contraction stresses are very severe and the rivets soon begin to leak. We have used the oxy-acetylene apparatus for welding the rivets to the plates but the plates crack around the heads. It then becomes necessary to put in



Steam Plate for treating Textile Fabrics that leaks at the Rivets

larger rivets, some of them now being as large as two inches diameter, bnt still the plates crack around the holes. They seem to crack worse since we started riveting them than before.

A.—The expansion and contraction stresses are very severe as you say, and unless the design of the plate is changed so as to reduce the severity of these stresses, cracking of the plates and leakage around the rivets will be unavoidable. We advise making the steam plates of uniform thickness throughout, as far as possible. The rivets should be discarded in favor of hollow screwed ferrules of the same wall thickness as the plates. These ferrules may be applied the same as staybolts, being threaded on the outside and screwed through tapped holes in the plates. When they are in place they should be cut off smoothly with the face of the plates and then they may be welded with the oxy-acetylene process. In this way you will obtain a steam plate which will expand and contract without setting up as severe stresses as when thick, solid rivets are employed. Suggestions from readers are invited.

* * *

NEW ELECTRIC GENERATOR SET!

A French inventor has produced a very practical (?) device for taking the requisite exercise in the home and incidentally producing the electric energy required for lighting a small house. He has combined a so-called "exerciser" made in the form of a bicycle (without wheels) with a dynamo and storage battery so that after taking the required exercise in the morning or evening, as the case may be, enough electric energy is stored up for several lamps for domestic lighting. It is pointed out that an important factor in favor of this device is the fact that generating the electric current gives stimulus to the use of the machine, and is intended to prevent neglect of the daily exercise, which becomes a necessity, or darkness prevails. The machine is designed to provide energy for a number of lamps after an hour's pedaling. When there are several members of the family the number of lamps may be increased indefinitely!

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GLEASON SPIRAL TYPE BEVEL GEAR GENERATOR

The machine which forms the subject of this article has been designed and built by the Gleason Works, Rochester, N. Y., for the purpose of cutting spiral bevel gears and pinions. This machine is of the generating type and is fully automatic. Fig. 1 shows the first of this type to be built, which is now in operation at the Gleason Works. Perhaps the easiest way to gain a clear idea of this machine is by comparison with the bevel gear generating machine built by the same firm for cutting straight tooth gears. The only essential difference in principle is that the new machine passes the tool through the blank in a curved path instead of in a straight path going to the cone center. The method of forming the tooth profile is the same in both cases, being the well known generating principle in which a tool representing the tooth of a crown gear is made to roll with the gear blank without slipping, cutting at the same time so as to roll out the tooth profile. The method of applying this principle in the new machine has been changed, as well as numerous details of design, some of which will be noted later. The curved tooth is obtained by building the cutter in the form of a face mill, as shown in Figs. 3 and 5, the curve being the arc of a circle whose diameter is the diameter of the mill. Fig. 3 shows the cutter as it is now being made, and Fig. 5 shows the original cutter. The average diameter of the cutter is 12 inches, and there are twenty blades, ten cutting on the outside and ten cutting on the inside, the alternate blades having shear angles in opposite directions. The cutting side of each blade is ground to the pressure angle, and the other side is given a clearance. The cutting sides and the points of the blades are finished with a grinding attachment on a relieving lathe, so that in order to sharpen them it is only necessary to grind back on the face, and the cutting edge has the correct angle all the way back, the same as on a rotary cutter.

The wedge behind each blade is used in making the necessary adjustment after sharpening. All the cutting edges on each side of the cutter must work on exactly the same radius from the center of the cutter within a fraction of a thousandth of an inch. Otherwise the profile of a gear or pinion tooth would be a series of decided flats. It is practically impossible to remove the cutter from the spindle, mount it on a grinder and sharpen the blades, and then remount it on the cutter spindle and have the blades run true. With the wedge adjustment the cutter can be sharpened on a grinder, paying only a reasonable amount of attention to having the blades true; then, when the cutter is replaced on the spindle, the blades can be trued up by means of the wedges, one blade being set to a gage to maintain the proper diameter, and the rest of the blades being set to exactly the same reading on an indicator. This method has proved to be very successful. This adjustment was not provided in the first cutter, and is not shown in Fig. 5. The cutter head fits the spindle on a taper, and is held with four cap-screws. The same cutter is used for cutting both sides of a tooth, and for both the pinion and gear. It is necessary to remove it only for sharpening, and this is not often, on account of the large number of blades in action.

The shaft shown squared for a crank in Fig. 5 is a worm-shaft. The worm-wheel with which it meshes (seen in Fig. 2) is internally threaded, and adjusts the cutter spindle lengthwise, so that the plane of the points of the cutter blades contains the cone center of the gear or pinion to be cut. The cutter is supported by a column which stands on a large cradle; and it is through this cradle that the generating motion is applied to the cutter. The cutter and work are rolled together by means of a geared drive, instead of the crown gear and segment used in the straight tooth generators. A reversing mechanism (not shown) drives this generating roll, and it is applied to the cradle by a worm and worm-wheel segment, shown under the center of the cradle in Fig. 5. The same reversing drive is carried up through the center of the machine by means of a sleeve (Fig. 2), and back along the side of the head to a worm under the rear head bearing, which meshes with a worm-wheel segment fastened to the inside of a fantail hanging down from the spindle-carrying sleeve. The connection between this sleeve and the work-carrying spindle is through the index mechanism on the outside of the fantail, which is the same as the mechanism used in earlier designs, making the machine fully automatic.

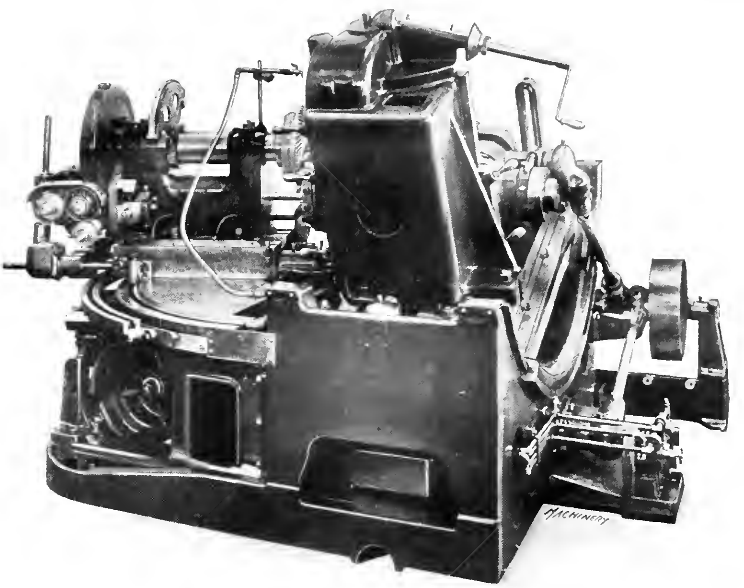


Fig. 1. Gleason Generator for machining the Spiral Type of Bevel Gears

The reversing mechanism has a fixed number of turns in each direction, and the amount of roll of the cutter-carrying cradle is controlled by a set of change gears, giving a small roll of the cradle for a pinion tooth and a large roll for a gear tooth. The relative roll between the cutter and the work is governed by a set of compound change gears on the drive going to the work-head. This ratio depends on the pitch angle of the gear or pinion that is being cut, according to the formula:

$$\frac{\text{Angle of roll of cradle}}{\text{Angle of roll of gear}} = \text{sine pitch angle of gear.}$$

A graduation in half degrees on the side of the cradle and a graduated plate with a vernier attachment on the work sleeve afford a means of testing this roll as a check. For example, in cutting the gear of a forty-nine- and thirteen-tooth combination, the pitch angle of the gear is 75 degrees 8 minutes. The compound gearing controlling the relative roll of the cutter and work must be such that taking into

consideration the constant of the fixed gears of the train, it will give:

$$\frac{\text{Angle of roll of cradle}}{\text{Angle of roll of work}} = \text{sine } 75 \text{ degrees } 8 \text{ minutes} = 0.96653.$$

To check this on the machine, assume any angle of roll of the cradle—say 30 degrees. Then the work must roll:

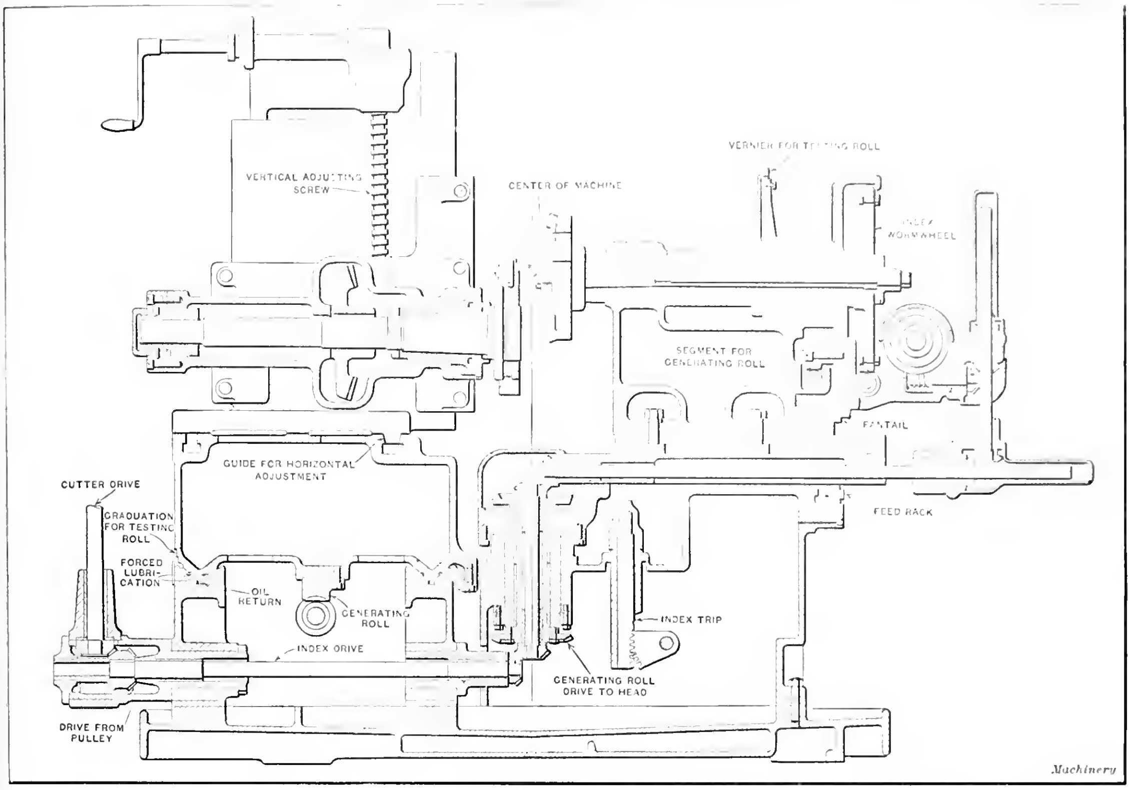


Fig. 2. Vertical Section through the Center Line of the Machine with the Work Head swung around to an Angle of 90 Degrees

$$\frac{30}{0.96653} = 31.038 \text{ degrees.}$$

By rolling the cradle through the 30 degrees and reading the roll of the work on the vernier, this result can be checked within a minute, which is quite accurate enough for producing the correct tooth profile. When the machine was built, a differential mechanism was used on the reversing drive in addition to the compound gears in order to get the relative roll of work and cutter exactly. This was found in actual use to be an unnecessary refinement and has been discarded, a single set of compound gears giving the correct roll within a minute. The reversing mechanism is timed with the feed cam. The cut takes place during the up-roll of the cutter and work. During the down-roll, the work is swung away from the cutter by the feed cam, is indexed, and returned to the cutting position. The position of the cutter with relation to the cone center of the machine can be adjusted both vertically and horizontally. The vertical adjustment is obtained by raising or lowering the cutter spindle saddle on the ways of the vertical column by means of the lifting screw shown in Fig. 2. A horizontal screw adjusts the whole vertical column transversely on the top of the cradle. For each adjustment, a scale is provided for even inches, and a graduated dial for thousandths. One side of a tooth is cut at a time and in changing from one side to the other, it is necessary to give the cutter a slight adjustment, and set the blank over to a position that gives the correct tooth thickness. In changing from a gear to a pinion it is necessary to adjust the cutter vertically so that its center is above the cone center of the machine instead of below it. This is done to give the opposite hand of spiral on the pinion from that on the gear. The same horizontal setting answers for both sides of the gear and pinion teeth so that only the vertical setting needs to be changed when a job is once started. This machine has been built primarily for finish cutting, but by changing the feed cam and throwing out the generating roll, gears can also be stocked out. The stocking cutter is the same as the

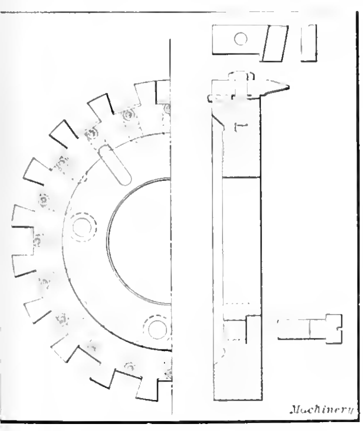


Fig. 3. Elevation and Sectional Views showing Construction of the Cutter

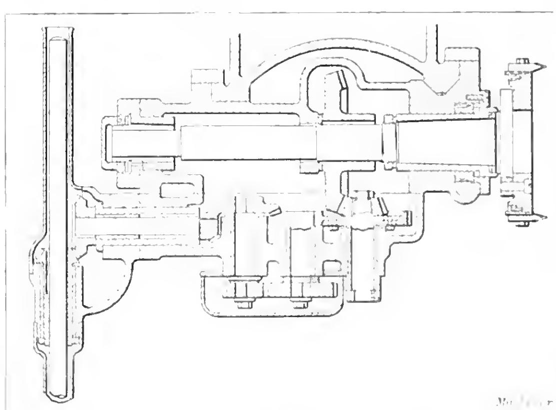


Fig. 4. Horizontal Sectional View of the Cutter-slide

finishing cutter except that there is no wedge adjustment for the blades, and the blades are ground with top rake. The stocking out is being done on a milling machine at the present time at the Gleason Works.

Fig. 1 shows the machine as it now appears. As this is the first machine built, there are several features which will be changed in the next machines. The new design of the cutter has already been described. Among other changes the universal joints in the cutter drive will be done away with, and the position of the oil pumps and piping will be changed.

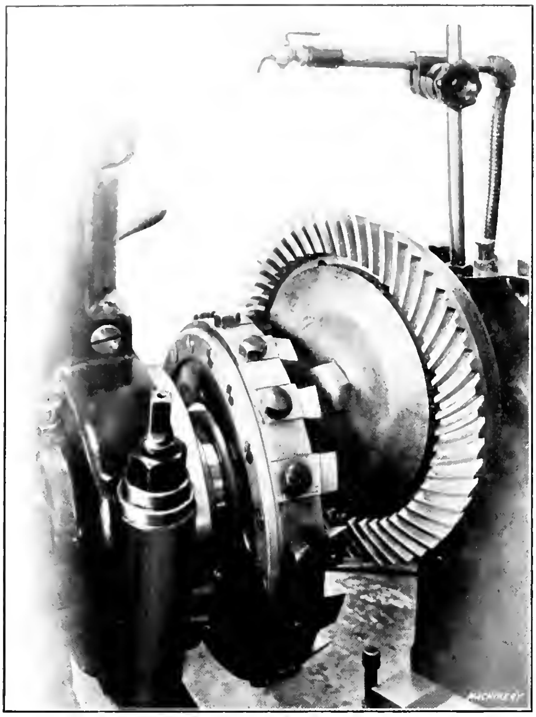


Fig. 5. Close View of the Cutter generating the Teeth in a Gear

The cutting time of spiral type gears compares very favorably with the time for cutting straight tooth gears. After stocking out a spiral gear it is necessary to cut each side of the teeth once, making two cuts around in generating. In straight tooth gears of high grade, it is usually necessary to make two generating cuts after the stocking out. Some gears and pinions at the Gleason Works have been cut with spiral teeth in the same time per set as the straight tooth gears. The average time for the spirals, however, would be a little longer than for straight tooth gears—from one to one and a quarter times as long.

Fig. 6 shows a few of the spiral bevel gears and pinions that have been cut at the Gleason Works, and Fig. 7 shows a single spiral bevel gear and pinion in mesh. Gears of a wide variety of combinations and pitches have been cut and have been subjected to severe tests by a number of automobile and axle manufacturers. In all cases the results have been very satisfactory. Trials of gear testing machines show that the pinion is capable of a wide range of adjustment with relation to the cone center of the gear, and this feature is a great advantage. It has been suggested that there is more sliding between the tooth faces of these spiral bevel gears than in the case of straight tooth gears, but this does not appear to be the case. Considering any section of a spiral gear tooth taken normal to a cone line, and a corresponding section of the pinion tooth,

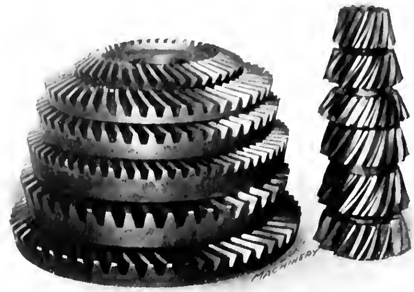


Fig. 6. Spiral Bevel Gears cut on the Gleason Generator

the shapes would be the same as corresponding sections for straight bevel teeth of the same pitch and combination, and the rolling action would be the same. Either the straight tooth or the spiral tooth may be considered as made up of an infinite number of such sections, and the fact that in the spiral tooth the sections are lined up with each other on a curve instead of on a straight line would not change the rolling contact. The angle of spiral used thus far has been such as to give a lead of about $1\frac{1}{4}$ to $1\frac{1}{2}$ the circular pitch in the width of face, and this has shown very good results in quiet running.

Fig. 7. Spiral Bevel Gear and Pinion in Mesh

The same cutter is used for both sides of the tooth, and for both pinion and gear. The outside of the cutter cuts the concave side of the tooth, and the inside cuts the convex side. The gear and pinion tooth faces in contact are thus cut on slightly different diameters of the cutter, and this results in the bearing being heavy at the center of the tooth. The amount of this difference of curvature is very slight, however, and in the average automobile gear the bearing can just be seen to fade away at each end of the tooth.

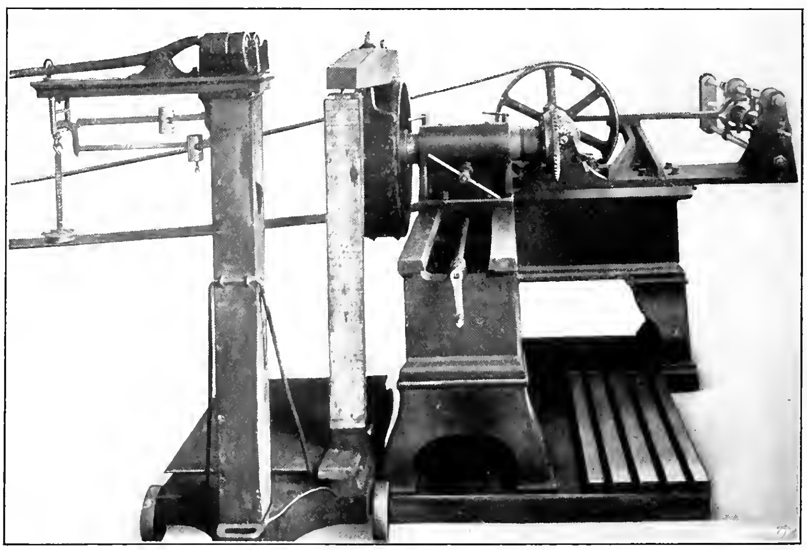


Fig. 8. Machine used for testing End Thrust of Spiral Bevel Pinions

One of the first questions that arose in connection with the use of these gears was as to the end thrust of the pinion caused by the spiral angle. The apparatus shown in Fig. 8 was used in tests made to determine the amount of this thrust. Power was applied to the pinion shaft, and the load transmitted was measured by a Prony brake on the gear shaft. The pinion shaft was free to float endwise, within certain limits, and within this range was held by a lever seen at the back on the right of the drive pulley. The other end of the lever was connected with a spring in compression (at the extreme right) so that any tendency of the pinion to thrust back brought the load on the spring. By means of a threaded handwheel the position of the spring could be adjusted endwise so as to bring the pinion back to the correct running position with each change of load on the gear. The amount of thrust could then be read by means of graduations on the spring-carrying bar, the spring having been calibrated before the tests were made.

Tests of the end thrusts were made with four pairs of bevel driving gears and pinions. The first test was made with the usual straight tooth type of bevel gear; the second and third tests were made with spiral bevel gears of different spiral angles; and the fourth test was conducted with skew bevel gears. All four pairs of gears used for these tests were cut on generating machines. For the first test the usual straight tooth gear generator was used; the gears for the second and third tests were cut on the Gleason spiral type bevel gear generator, the elements of the teeth being curved; and the gears for the fourth test were cut on a generating planer, so that the elements of the teeth are straight, but do not pass through the cone center, the tools being offset so as to pass above the center in cutting the gear and below the center in cutting the pinion. The direction of the spiral on the gears for tests No. 2 and No. 3, and of the skew for test No. 4 was the same—right-hand on the pinion. This results in a tendency to pull the pinion in toward the cone center in the forward drive, and to thrust it back against its bearings in the reverse. The straight tooth gears used for test No. 1 show a backward thrust, and the spiral and skew gears have this backward thrust combined with the pull or thrust due to the angle of the spiral or skew. The results presented in the table show the net values of these two forces—the pull due to the spiral minus the backward thrust of the straight tooth gears in the case of the forward drive; and the thrust of the spiral plus the backward thrust of straight tooth gears in the reverse drive. This accounts in a large measure for the results on the reverse being so much greater than on the forward drive.

In tests No. 2 and No. 3 the angle of the spiral is measured midway between the two ends of the tooth—this being the point at which the pressure is heaviest in this style of gear. In test No. 4 the angle of skew is measured at the large end of the tooth. If the angle of the spiral of the gears used in tests No. 2 and No. 3 were measured at the large end of the tooth, it would be greater than at the mid point, and the thrust would be less in proportion to the angle. Similarly, if the angle of skew of the gears used in test No. 4 were measured at the center of the tooth, it would be greater than at the large end, and the thrust would again be less in proportion to the angle. The method of measuring the angle, therefore, seems fair to both types of gear. The results given in the table show that the amount of end thrust or pull varies with the angle, and does not depend on whether the gears are of the spiral or skew type—the spiral type of pinion of greatest spiral angle showing the greatest thrust, the skew with a less angle showing less thrust, and the spiral

RESULTS OF TESTS OF THE END THRUST OF DIFFERENT TYPES OF PINIONS

Straight Bevel Gears — 15 and 53 teeth; 0.7032 inch circular pitch; 1 5/8 inch face width

Drive: Tooth Load in Pounds	Drive: Average End Thrust on Pinion in Pounds	Drive: Thrust per 100-pound Tooth Load	Reverse: Tooth Load in Pounds	Reverse: Average End Thrust on Pinion in Pounds	Reverse: Thrust per 100-pound Tooth Load
163.9	9.86	6.01	163.9	9.86	6.00
328.0	19.75	6.02	328.0	19.75	6.02
493.0	34.70	7.04	493.0	29.60	6.00
659.0	47.33	7.18	659.0	47.33	7.19
815.0	62.50	7.67	815.0	65.80	8.08
986.0	77.60	7.86	986.0	87.46	8.86
1152.0	97.40	6.72	1152.0	96.76	8.38
1312.0	108.60	8.28	1312.0	111.76	8.50
1480.0	121.73	8.23	1480.0	126.83	8.56
1648.0	138.30	8.40	1618.0	141.46	8.60
		Average, 7.341			Average, 7.619

Spiral Type Bevel Gears — Spiral angle, 31 degrees 21 minutes; 15 and 53 teeth, 0.7032 inch circular pitch, 1 5/8 inch face width

Drive: Tooth Load in Pounds	Drive: Average End Thrust on Pinion in Pounds	Drive: Thrust per 100-pound Tooth Load	Reverse: Tooth Load in Pounds	Reverse: Average End Thrust on Pinion in Pounds	Reverse: Thrust per 100-pound Tooth Load
.....	....	......	163.8	118.6	72.2
286.0	−138.3	−48.3	329.0	237.0	72.0
451.0	−217.0	−48.1	492.0	358.3	72.8
615.0	−306.0	−49.8	658.0	477.3	72.4
782.0	−381.6	−48.9	816.0	608.6	74.6
941.0	−457.3	−48.4	989.0	740.0	74.8
1110.0	−559.6	−50.4	1150.0	858.0	74.7
1275.0	−641.0	−50.2	1315.0	979.6	74.5
1439.0	−730.0	−50.6	1482.0	1119.6	75.3
1609.0	−813.3	−50.6	1645.0	1231.0	74.9
		Average, −49.5			Average, 73.82

Spiral Type Bevel Gears — Spiral angle, 19 degrees 45 minutes; 14 and 53 teeth; 0.681 inch circular pitch; 1 1/2 inch face width

Drive: Tooth Load in Pounds	Drive: Average End Thrust on Pinion in Pounds	Drive: Thrust per 100-pound Tooth Load	Reverse: Tooth Load in Pounds	Reverse: Average End Thrust on Pinion in Pounds	Reverse: Thrust per 100-pound Tooth Load
......	....	....	.....	.....	...
374.0	− 98.8	−26.40	366.0	148.1	41.6
558.0	−150.8	−27.00	554.0	242.0	43.7
732.0	−207.0	−28.30	740.0	336.0	45.4
929.0	−276.0	−29.70	858.0	390.0	45.4
1115.0	−325.5	−29.20	1045.0	474.0	45.3
1305.0	−384.5	−29.45	1228.0	563.0	45.9
1495.0	−440.0	−29.45	1416.0	642.0	45.4
1675.0	−493.0	−29.40	1602.0	746.0	46.5
1885.0	−555.3	−29.45	1810.0	830.0	45.8
		Average, −28.70			Average, 45.00

Skew Bevel Gears — Skew angle, 23 degrees 46 minutes; 18 and 57 teeth; 0.6803 inch circular pitch; 1 1/4 inch face width

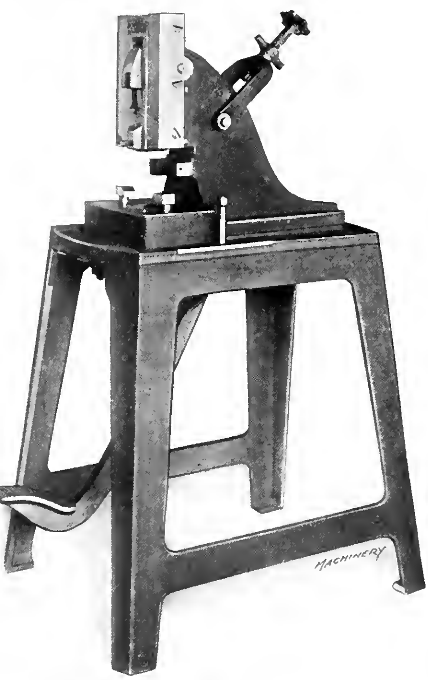
Drive: Tooth Load in Pounds	Drive: Average End Thrust on Pinion in Pounds	Drive: Thrust per 100-pound Tooth Load	Reverse: Tooth Load in Pounds	Reverse: Average End Thrust on Pinion in Pounds	Reverse: Thrust per 100-pound Tooth Load
131.7	− 39.5	−30.1	131.7	65.6	49.8
262.0	− 79.0	−30.1	262.0	138.0	52.7
390.5	−121.7	−31.15	390.5	194.0	49.6
521.0	−164.5	−31.55	521.0	266.5	51.2
649.0	−204.0	−31.45	649.0	332.2	51.1
778.0	−237.0	30.50	778.0	391.5	50.7
909.0	−279.5	−30.65	909.0	461.0	50.7
1042.0	−312.5	−30.00	1042.0	533.0	51.1
1169.0	−352.5	−30.10	1169.0	592.0	50.6
1291.0	−385.0	−29.80	1291.0	652.0	50.4
		Average, 30.51			Average, 50.79

with the smallest angle showing the least thrust. The load has been given in pounds instead of in horsepower, since a given horsepower would put different loads on the teeth of pinions of different diameters. The load has been figured for the mid point of the tooth, *i. e.*, on the mean pitch radius of the pinion. The speed of the pinion in all runs reported was constant at about 260 R. P. M. A series of runs made at different speeds up to as high as 360 R. P. M. of the pinion showed the same thrust per 100 pounds of tooth load. Negative results indicate pull in toward the cone center; positive results indicate thrust away from the cone center. In each run the gear was loaded up to about 10 horsepower. Three independent sets of readings were taken in each case, and the results given are the averages of these sets of readings.

NOBLE & HUNT FOOT PRESS

Noble & Hunt, Newark, N. J., have recently developed a foot press of improved design which is shown in the accompanying illustration. This machine is intended for use in the manufacture of jewelry, metal novelties and other work of relatively small size. The features of the press are strength, extreme accuracy of the stroke and improved facilities for setting the die. It will be noticed that while the design follows the established lines of machines of this type, it is exceptionally heavy at the throat. The press is mounted on an iron stand and the slide has unusually long bearings which insure adequate support and reduce the possibility of deflection of the punch.

Ample leverage is provided. The motion from the end of the lever is transmitted to the ram by means of a link which

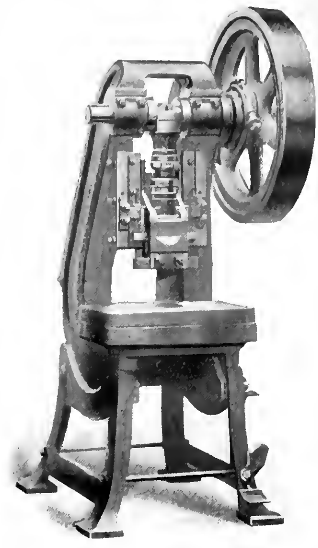


Noble & Hunt Foot Press with Improved Device for clamping the Die

is so designed that it obviates the danger of throwing the slide out of line while it is descending. This feature, in connection with the long slide bearings, increases the accuracy with which the machine operates. The usual stop or bumper is supplied at the back of the press to limit the backward stroke of the lever. The automatic clamping of the die plate is effected by means of the lever at the right-hand side of the machine. Trouble is often experienced in die setting because unequal tightening of the nuts causes the die to creep to one side, thereby throwing it out of line with the punch. With this press, the die plate is put in an approximate position and after the punch has located the die correctly on the die bed, the hand lever is thrown over, thus setting the clamps down firmly without requiring the use of a hand wrench. The lever for actuating the clamps works in conjunction with an eccentric motion. This clamping feature is one that will be readily appreciated by users of small dies. The press and stand have a total weight of 750 pounds.

WATERBURY FARREL INCLINABLE PRESSES

The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has recently brought out a line of inclinable open-back presses which are known as the standard Series E. These machines have an exceptionally large tool space and are of unusually heavy construction. They are adapted for a great variety of press work, the construction being such that various types of automatic feeding attachments can be readily applied. The housings are tied together at the back to increase the rigidity and the slide has bearing surfaces of ample proportions. The overhanging type of construction for the crankshaft and slide gives the maximum amount of tool space in all directions as well as permitting the attachment of the knock-out shown in the illustration.



Waterbury Farrel Series E Inclinable Open-back Presses

The crankshaft is made of high carbon machine steel, and runs in capped bearings. The Waterbury Farrel improved Johnson clutch is used, which has a particularly efficient friction. These machines can be built with back gears to meet the requirements of heavy work handled at a moderately slow speed. In addition to the floor type of machine illustrated, presses of this type are made in a small size for bench work. The machines are particularly adapted for use in the manufacture of tin boxes and similar classes of work.

WHEELOCK FLEXIBLE CUTTING LUBRICANT TUBE

Fig. 1 shows a flexible metallic tube for use in supplying the lubricant to the cutters of machine tools, which is a recent product of the Wheelock Mfg. Co., Wheelock, Vt. No

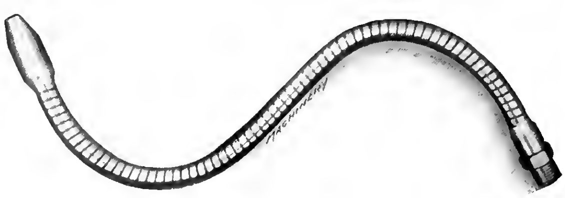


Fig. 1. Wheelock Flexible Cutting Lubricant Tube

packing of any kind is used in this tube; it consists of two steel wires which are wound together in such a way that a perfectly tight tube is produced. A cross-sectional view of the tube is shown in Fig. 2, from which the construction will be readily understood. The tube can be easily bent to any desired curve, and is sufficiently rigid to stay in the position to which it is bent. Owing to its flexibility, one end of the tube may be attached to the traveling carriage or other moving part of a machine. This feature is the chief advantage

of the Wheelock tubing over solid piping, which, if attached to such a moving part, must be provided with swinging joints or telescoping joints which are very apt to give trouble through leaking. In addition, such piping is more expensive and cumbersome.

The brass fittings used at either end of the Wheelock tubes are provided with standard pipe threads, and any special form of fittings or nozzles may be provided. This tubing is made in three sizes which have bores $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ inch in diameter, and the tubing may be made of any desired length.

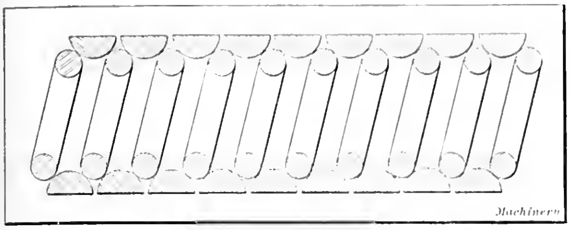


Fig. 2. Sectional View of Wheelock Lubricant Tubo showing Construction

MOTOR DRIVE FOR SPRINGFIELD SHAPER

Motor drive applied to a 15-inch crank shaper built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, is illustrated in Fig. 1; and Fig. 2 shows the gear box which, in connection with the constant-speed motor drive, provides four changes of speed. The changes of speed may be instantly obtained. The drive is connected by means of a friction controlled by a lever, and the operator can select the desired speed and engage the power without being required to make any adjustment of the motor. This motor-drive equipment has been put on the Springfield shaper to adapt it for manual training school service, where it is used to illustrate the individual motor application.

Fig. 1. Motor Drive applied to a Springfield Shaper

The rawhide pinion through which power is delivered to the friction gear is entirely encased and a box attached to the shaper contains the starting switch, fuses, etc. The current is controlled by a push button which is shown in Fig. 1, and it will be noticed that the motor is mounted directly on the machine base. Any type of motor may be employed. Referring to the view of the gear box shown in Fig. 2, it will be seen that sliding spur gears are used which are controlled by levers shown in Fig. 1. The arrangement is such that it is impossible to engage more than one speed at a time. Both the machine and motor drive are of rigid construction and constitute an excellent equipment for either demonstrating purposes or shop work. Aside from the feature of motor drive, the shaper is the regular 15-inch Springfield crank shaper which has been on the market for a number of years.

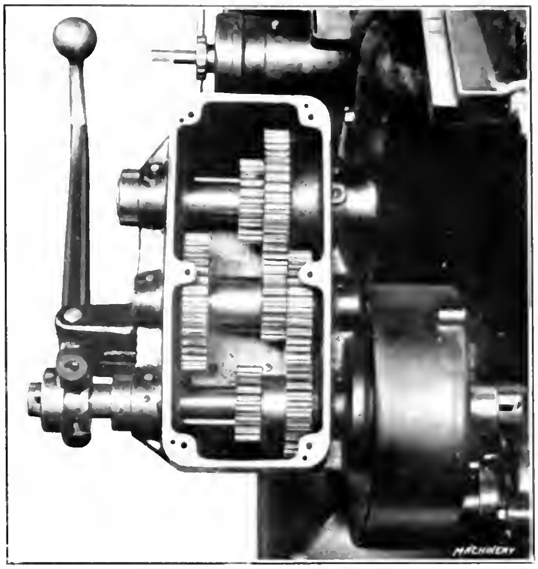
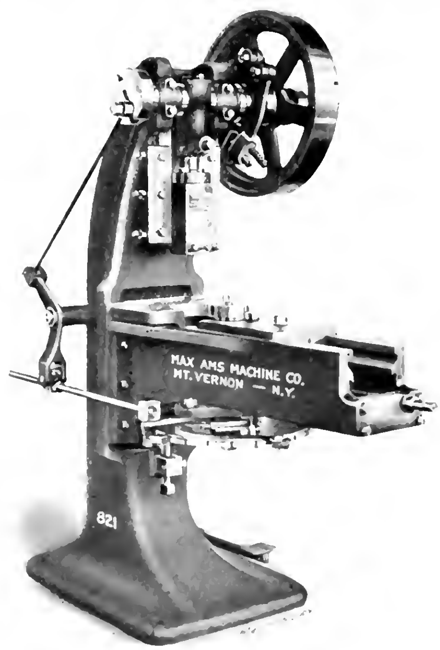


Fig. 2. Interior View of the Gear Box

MAX AMS NOTCHING PRESS

The accompanying illustration shows a machine for notching armature disks from 4 to 30 inches in diameter, which is a recent product of the Max Ams Machine Co., Mount Vernon, N. Y. The design has been worked out along lines which adapt the machine for doing accurate work at a speed ranging from 250 to 325 revolutions per minute. A clutch is provided which grips the wheel centrally at several points. The



Max Ams Press for notching Armature Disks from 4 to 30 Inches in Diameter

indexing is obtained by an index ring that is fed and locked positively, and so arranged that wear on the teeth of the index wheel is reduced to a minimum. Other features of the machine consist of the adjustment of both the slide and the die bed by means of screws, thus providing for variations in the height of the punches and dies. The adjustment for disks of different diameters is made by a screw conveniently located at the front of the machine. When notching disks which have no keyways, a clamping arm can be used to hold the work. Depressing the treadle starts the machine and it stops automatically as soon as the disk is finished.

SPRINGFIELD 24-INCH QUICK CHANGE GEAR LATHE

For a number of years the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, has been building "Ideal" rapid change gear lathes, but the change gear device has never been applied to machines of more than twenty inches swing. To meet the demand for a larger quick change gear lathe, this company has recently added the quick change gear device to its twenty-four-inch machine, the first lathe to be equipped in this way being shown in Figs. 1 and 2.

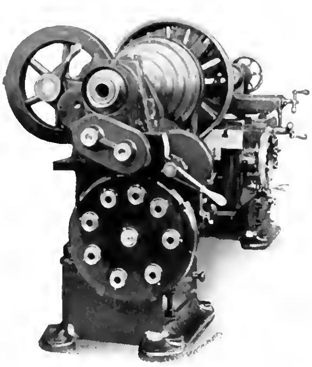


Fig. 1. End View of Springfield Lathe

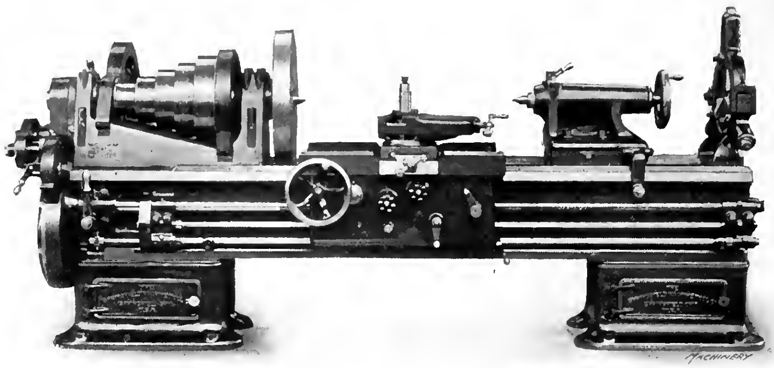


Fig. 2. Springfield 24-inch Quick Change Gear Lathe

The quick change gear device furnished on this lathe is of simple and efficient construction. Only seven gears are used when chasing right-hand threads and eight gears when chasing left-hand threads. The lead-screw is not splined. Feeds are transmitted to the apron by the regular feed-rod and the automatic stop operates in either direction. The reverse mechanism which is controlled at the apron operates both the lead-screw and feed-rod and is actuated by means of spur gears at the rear of the headstock. Particular care is taken in cutting the lead-screw and its accuracy is guaranteed.

The other features of the lathe may be briefly referred to as follows: It is equipped with a five-step cone pulley, single back gears, compound and steadyrests, large and small face-plates and a double friction counter-shaft with self-oiling bearings. The spindle is made of 60-point carbon steel, and lumen bearing metal or phosphor-bronze is used for the journal linings. The spindle journals are adjustable and ring oiled, the thrust being taken on the rear housing by means of cast-iron and hardened steel collars. The apron is of the double plate type, providing support at both the front and back of all shafts. Longitudinal and cross feeds are engaged by means of frictions and no tumbler gears are used. The tailstock is recessed and can be set over for turning a taper. Aside from the application of the quick change gear mechanism, the lathe is not new, so that a detailed description is unnecessary at this time.

RAHN-LARMON LATHE

The 16-inch engine lathe illustrated in Fig. 1 is being manufactured by the Rahn-Larmon Co., Cincinnati, Ohio. The design has been worked out with the view of meeting the requirements of modern manufacturing practice, being simple, accurate and providing ease of operation. The bed is of heavy construction and firmly braced for its entire length with box girders to provide for absorbing the vibration of the heaviest cuts. The headstock is bolted to the bed. The spindle is hollow; it is made of high carbon steel and ground perfectly cylindrical. The centers are No. 4 Morse taper hardened and ground to run accurately. The bearings are bushed with gun metal and provided with means of compensating for wear. The driving cone is of large diameter and designed to carry a wide belt; either single or double back gears, and a three, four or five step cone pulley may be used. The tailstock is of the off-set type, which allows the compound rest to be placed parallel with the bed; and the tailstock may be set over for turning tapers.

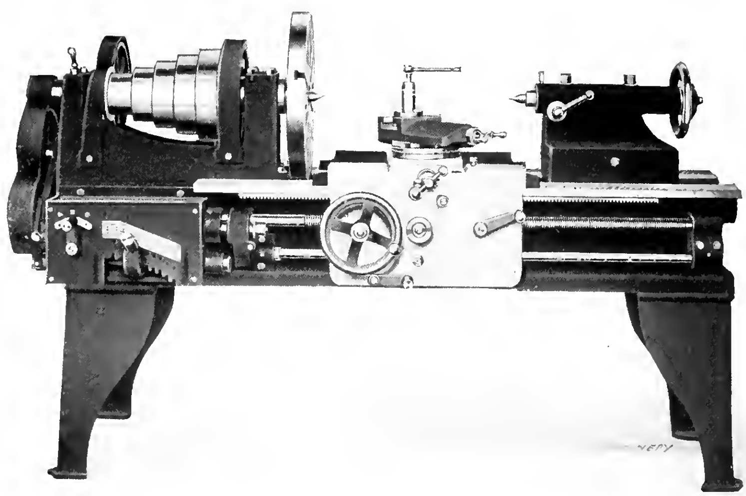


Fig. 1. Rahn-Larmon 16-inch Lathe with Quick Change Gear

The carriage is gibbed to the bed at both the front and back and is provided with a broad bearing for the compound rest. It has a long continuous bearing on the bed and can be firmly locked in place. The compound rest is provided with taper gibs for taking up wear, and the swivel section is so constructed that a long bearing for the tool rest is

provided. The apron is of simple design and all feeds are conveniently controlled. The machine shown in Fig. 1 is equipped with a quick-change gear, and a better illustration of the change gear is shown in Fig. 2. The quick-change screw cutting and feed mechanism is of very simple and substantial construction. Thirty changes of feed are obtained by shifting only two levers and these changes can

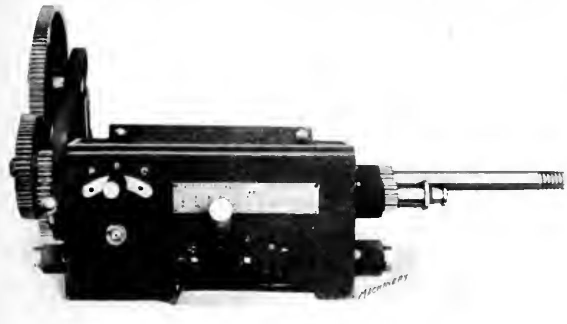


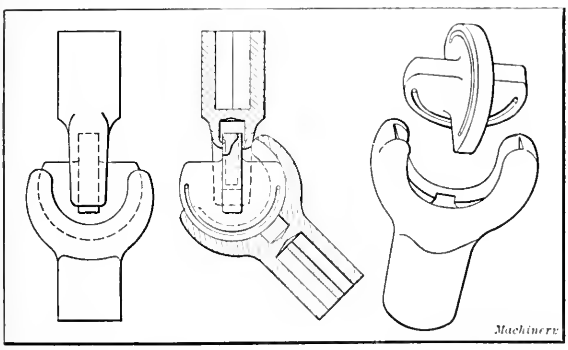
Fig. 2. Quick Change Gear Unit for Rahn-Larmon Lathe

be made instantly while the lathe is running. The gears are steel, the shafts are accurately ground and all bearings are bronze bushed. The gearing at the end of the headstock is so arranged that metric or special feeds can be cut by the substitution of the proper gears. Screw chasing dials are provided which obviate the necessity of reversing the spindle when chasing threads.

Thé regular equipment of the lathe includes a countershaft, steadyrest, follow-rest, large and small faceplates, wrenches and a screw cutting dial. A taper attachment, a turret for the carriage, a turret for the bed, cabinet legs, chucks, chuck plates and special tool rests can also be obtained. In addition to the form shown in Fig. 1, the lathe is also built without the quick-change gear device.

PLANK UNIVERSAL JOINT

A universal joint of simple but strong construction is a recent product of the Plank Flexible Shaft Machine Co., 234 Ionia St., N. W., Grand Rapids, Mich. This universal joint is



Plank Universal Joint and Details of the Yoke and Center

composed of three parts—two yokes and the center. It interlocks and disengages at 45 degrees and can be disconnected at two points. The bearing surface is said to be from 300 to 400 per cent greater than that of any other universal joint now on the market and the use of screws, pins or rivets is eliminated.

The center block, as shown in the accompanying illustration, consists of one piece of chrome-nickel steel, drop-forged and machined to accurate dimensions and then heat-treated and polished. The yokes are made of high-carbon steel and they are also drop-forged before machining. The simplicity and rigidity of the construction of this universal joint make it particularly well adapted for use on automobile propeller shafts, multiple spindle drilling machines and a variety of other uses where a universal joint is required to transmit motion under severe conditions of service.

BRISTOL PNEUMATIC RECORDING TACHOMETER

In many lines of industrial work it is desirable to keep machinery running at a specified rate of rotation, and in other cases it may be necessary for stops to be made periodically. Recording tachometers are used to furnish the superintendent or manager of the plant with information concerning the way in which the machines have been operated. A case in point is the blowing engines which supply the draft to blast furnaces; these engines are driven at a predetermined number of revolutions per minute, but they are

Fig. 1. The Bristol Pneumatic Recording Tachometer

usually slowed up once every twenty-four hours when the casting is done.

The Bristol Co., Waterbury, Conn., is now manufacturing the pneumatic type of recording tachometer illustrated in Fig. 1, which has been developed to afford a means of keep-

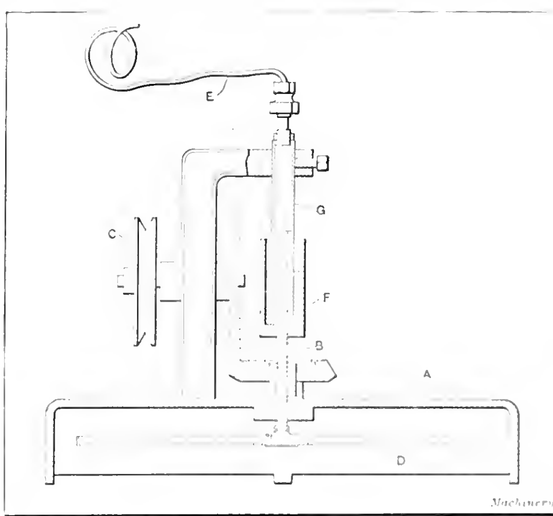


Fig. 2. Diagram showing how the Tachometer operates

ing a record of the rotative speed at which machines are operated, as outlined in the preceding paragraph. These tachometers are used extensively in connection with blast furnace blowing engines, for recording the speed of paper machines, and for similar purposes. In many cases it is not

convenient to have a self-contained recording tachometer located near the revolving shaft, and one of the important features of the new Bristol instrument is that the flexible connecting tube may be twenty-five feet in length or longer, thus allowing plenty of room between the revolving mechanism and the recording instrument. The recorder may be mounted in any convenient position, as, for instance, on a switchboard or the wall of the engine room. The pneumatic principle of operation depends on the centrifugal action of air in a revolving tube which is connected to the recording instrument through an oil sealed flexible connecting tube. Fig. 2 illustrates the construction of the revolving mechanism and shows how the tachometer operates. In this diagram *A* is the base which supports a bearing on its upper surface for the hollow shaft *B*. This shaft is rotated from the member whose angular speed is to be measured by means of the pulley *C* and bevel gears as shown in the illustration. In practice, it is generally found more convenient to drive the tachometer by means of a special form of sprocket and chain in place of the pulley *C* and a belt running over it to the shaft whose revolutions are to be counted.

At the lower end of the hollow shaft *B* there is a horizontal tube *D* which is open at the ends; the tube *D* connects with the recording instrument through the hollow shaft *B* and the flexible tube *E*. The upper end of the shaft *B* is surrounded by a casing *F*; this casing is partially filled with oil, and the free end of a second casing *G* dips into it. The casing *G* remains stationary and the flexible tube *E* leading to the recording instrument is connected with it. The recording instrument is a special low range Bristol recording vacuum gage. When the tube *D* revolves in the casing *A*, the action of centrifugal force tends to throw the air out of the ends of the tube *D*, thus creating a vacuum which actuates the gage. As the magnitude of centrifugal force is dependent upon the rate of rotation, it will be evident that the gage can be graduated to show the number of revolutions per minute.

DETRICK & HARVEY HORIZONTAL DRILLING MACHINE

The accompanying illustrations show a machine designed for heavy drilling operations with high-speed drills, which is a recent product of the Detrick & Harvey Machine Co., Baltimore, Md. The general design follows the lines of a horizontal boring and drilling machine of the traversing column type having a fixed work table, a column traversing horizontally on the runway and a saddle traveling vertically on the column.

The spindle of the machine is made of hammered high-carbon steel with a tapered front bearing 7⅞ inches in diameter, the bearing being bushed with phosphor-bronze and provided with means for compensating for wear. The thrust is taken by a dust-proof roller thrust bearing and the spindle has a standard taper socket. The main body of the spindle is 4 inches in diameter. Power is provided by a 4 to 1 variable-speed, 20-horsepower motor which is mounted at the top of the column. All driving gears are of cast steel or manganese bronze and the pinions are of high-carbon steel. The range of spindle speeds is from 60 to 240 revolutions per minute and no belts or chains are used in driving the spindle or feed mechanism. The power feed is driven from the spindle sleeve gear; and the feed mechanism is equipped with all-steel gears and clutches, with a steel pinion engaging a rack cut from solid steel on the feed quill. Four changes of feed ranging from 0.004 to 0.090 inch per revolution are provided.

The vertical movement of the saddle and the horizontal movement of the column are obtained through handwheels conveniently located within reach of the operating platform. The column is mounted on rollers to reduce friction on the runway to a minimum. Both the saddle and column may be easily changed to any required position and have gibs for taking up wear. The controller for the motor is also mounted on the operating platform, thus providing complete control of the machine from a single position. An oil jet is provided for the drill, the oil being delivered by a rotary pump driven by a small auxiliary motor. The work table is provided with a channel around all four sides, by means of which the oil is returned to the supply tank of the pump, thus eliminating all waste. The high table provided on this machine enables the spindle to be brought down within 3 inches of its surface; the vertical adjustment of the head on the column is 12 inches and horizontal adjustment of the column on the bed is 6 feet. The machine can be made in various sizes to meet the requirements of individual cases.

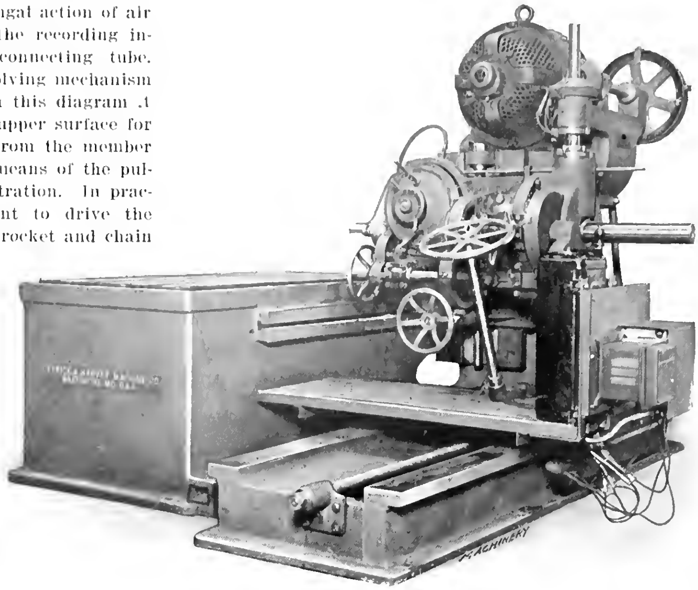


Fig. 1. Operating Side of the Detrick & Harvey Horizontal Drilling Machine

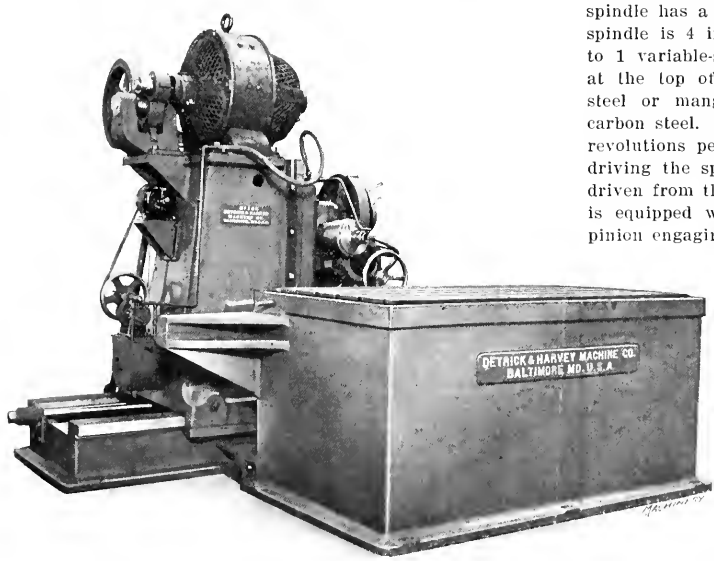


Fig. 2. Detrick & Harvey Drilling Machine showing Table, Spindle, etc.

PRATT & WHITNEY DIE-SINKING MACHINE

The duplex die-sinking machine shown in Fig. 1 has recently been developed by the Pratt & Whitney Co., Hartford, Conn., to supplement its smaller sizes of die-sinking machines. The present machine differs from the smaller sizes in that the head is made the movable member. The reason for this change in design is that the weight of the dies for which this machine will generally be used is so great that it was considered inadvisable to adopt a construction that would make it necessary to elevate the table and work. The machine has a wide range and is of unusually heavy construction. The design includes several new features, among which may be mentioned the duplex spindle construction, the method of feed control and other points which will be referred to in detail in subsequent paragraphs. These features add greatly to the efficiency of the machine and make it particularly well adapted for finishing large forging dies in an economical manner. The bearing surface on the column, on which the head is mounted, is of liberal proportions, tapered gib adjustments being provided to compensate for wear. The head is accurately counterbalanced, and is raised or lowered by a handwheel *A*, which is connected with the elevating screw *B* by means of bevel gears. A micrometer dial enables the travel to be accurately controlled, and, in addition, a positive vertical stop *C* is provided. A powerful binding device controlled through the handle *D* permits the head to be clamped at any desired point.

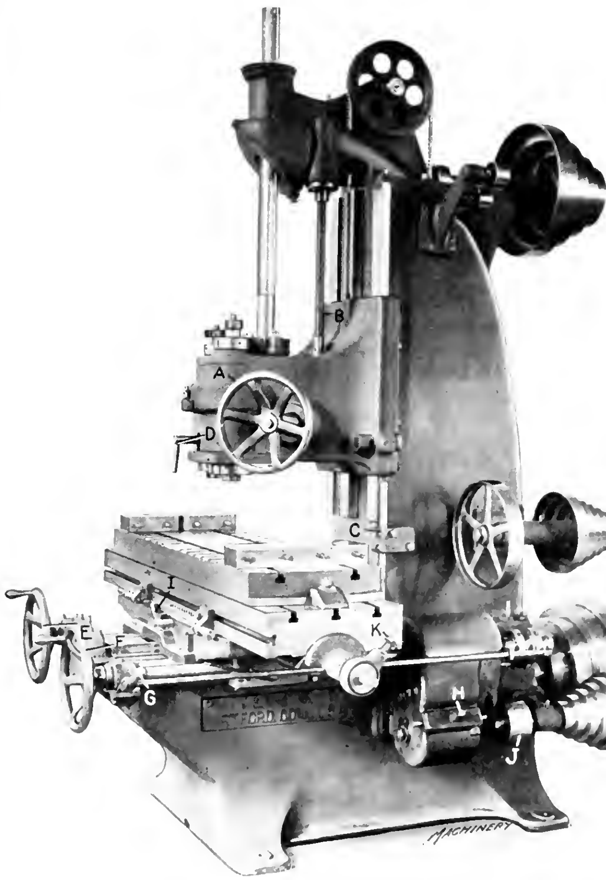


Fig. 1. Pratt & Whitney No. 4 Duplex Die-sinking Machine

It will be seen that the machine is provided with two spindles, one of which is considerably larger than the other. The value of this construction lies in the fact that on large die work it is frequently necessary to take finishing cuts with cutters of small diameter, requiring a high spindle speed. It was found that a spindle of sufficient size to stand up under the heavier cuts which are required of this machine could not be provided with a sufficient range of speeds to drive small cutters satisfactorily. With the two spindles, speeds ranging from 11 to 610 revolutions per minute are obtainable, which makes the machine equally efficient on both light and heavy cuts. The spindles are made of special steel and mounted in bronze bushed cylindrical bearings, which have conical seats in the heads and means for compensating for wear. Both the spindles are located in the same plane and are not adjustable vertically. The large spindle is provided with a tapered hole of the same dimensions as that of the spindle of the No. 3 die-sinking machine built by the Pratt & Whitney Co., and the small spindle corresponds to the spindle of the No. 2 die-sinking machine of this company's manufacture. Both spindles are provided with pull-back rods for holding the cutters securely in place. A simple but efficient spindle locking device is also provided for holding the spindles stationary while tightening the cutter chucks. Each spindle is provided with eight speeds by means of a four-step cone pulley and a two-speed countershaft. A vertical shaft driven from the cone by means of bevel gearing transmits the power directly to the larger spindle through spur gearing. The small spindle is driven through gearing from the large spindle and the drive may be engaged or disengaged at will.

Both the saddle and table are of unusually heavy construction, liberal bearing surfaces being provided, with tapered gibs for making the necessary adjustments. Either the saddle or the table may be positively clamped at any point by means of binders provided for this purpose. The table has hand transverse feed, and both hand and power longitudinal feeds. The transverse feed is controlled through the handwheel *E*, the hand longitudinal feed through the handwheel *F*, and the power longitudinal feed through the lever *G*. The handwheels on the front of the machine are widely separated with a view of enabling the operator to get near to the work when necessary. Micrometer dials are provided to enable the adjustments to be accurately gaged. The power feed is operative in either direction, the lever *G* being pushed in or pulled out, according to the direction in which the table is to travel. In order to meet the diversified requirements of the machine, a liberal range of feeds has been provided. The feed mechanism is contained in a compact unit located at the right-hand side of the machine and is so constructed that two gear ratios are obtainable by means of sliding gears which act in conjunction with the six-step feed cones to give twelve changes of feed. The sliding gears are operated by the handle *H*.

The travel of the table is controlled by means of positive stops, this method being preferable to the ordinary automatic knock-outs, due to the fact that in sinking forging dies the operator always works to a line. It can readily be seen that it would be quite impossible to provide an automatic device which would be sufficiently accurate for this purpose. The stops are carried on the side of the table, suitable locating places being provided which act in conjunction with ordinary binders to prevent the stops from slipping. Furthermore, micrometer screws are provided which make it possible to obtain very delicate adjustments. Should the operator neglect to disengage the feed, the stop will engage the abutment *I* on the saddle, thus stopping the table. The friction through which the feed is controlled will slip under these conditions, preventing damage to the machine. Ordinarily, the operator would disengage the feed a trifle before the cutter reaches the line on the work, and then bring the table up to the micrometer stop by hand. The feed friction referred to is enclosed in a case *J* and is sufficiently powerful to provide adequate feed under all working conditions. In addition to the regular feeds, the table is provided with a quick hand return. This movement is obtained by releasing the lock-bolt *K* and rotating the feed-screw by means of a crank, the end of the screw being squared for this purpose. In the operation of the regular feeds, the screw remains

stationary and the nut rotates, which makes it possible to obtain a very rapid return by rotating the screw.

The plain vise which forms a part of the regular equipment of this machine extends practically the full length of the table. The top of the vise is provided with suitable locating places for the accommodation of the jaws; and the vise is pivoted at the center, allowing it to be swung to an angle of 15 degrees in either direction from the center. The machine may also be provided with a circular vise which is mounted directly upon the table. The rotary hand feed is transmitted through a worm and worm-wheel. Fig. 2 shows the cherrying attachment set up in the operating position, and Fig. 3 shows a larger view. It will be seen that the attachment is

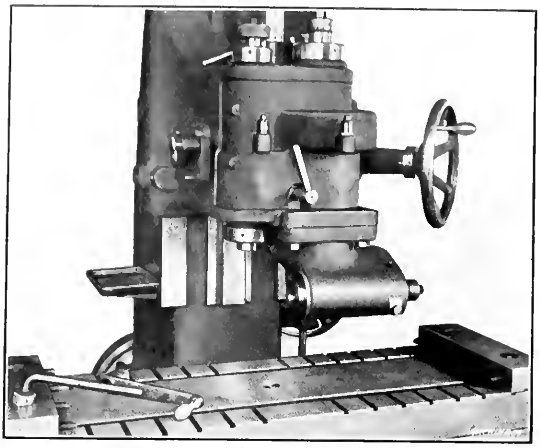


Fig. 2. Cherrying Attachment set up on Pratt & Whitney Die-sinking Machine

clamped to the under side of the head, being located by and driven from the large spindle. It may be swiveled and securely clamped in four different positions, *i. e.*, the horizontal spindle can be located in the most desirable position to operate upon the die that is being machined. The spindle of the attachment is provided with the same taper as the large spindle of the machine. Chucks for straight shank cutters are provided for use on this machine. These chucks are of rugged construction, being made of hardened steel and finished by grinding. They are made in sizes suitable for use in either the large or the small spindle.

The machine described in the preceding paragraphs is known as the No. 4 size, and its capacity is as follows: size of top of table, 18 by 72 inches; longitudinal travel, 30 inches;

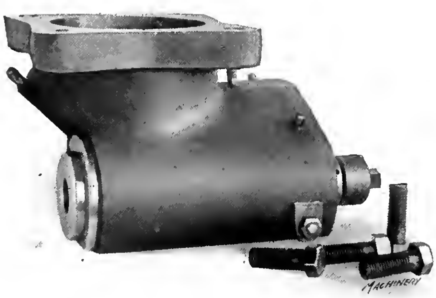


Fig. 3. Cherrying Attachment shown in Fig. 2

transverse travel, 16 inches; maximum distance from table to spindle, 28 inches; vertical movement of head, 20 inches, and maximum opening of plain vise, 52½ inches.

WATSON-STILLMAN HYDRAULIC STRAIGHTENING PRESS

The Watson-Stillman Co., 192 Fulton St., New York City, has recently added to its line the hydraulic straightening press shown in the accompanying illustrations. This machine has a capacity of 325 tons, which is sufficient for straightening steel shafts up to 10 inches in diameter; and the only limit to the length of the shaft is the extent of the foundations provided. By referring to Fig. 1, it will be seen

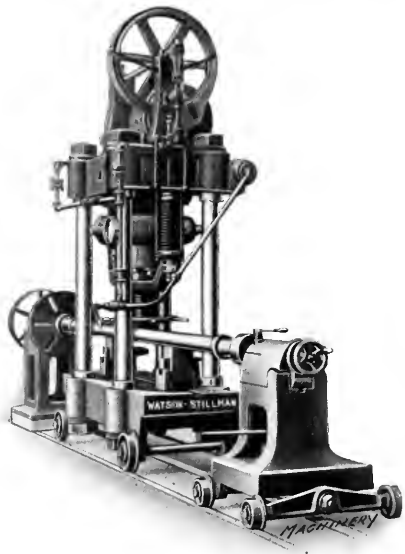


Fig. 1. Watson-Stillman Hydraulic Straightening Press in Operation

that the press is a motor-driven self-contained unit requiring no outside air or hydraulic system. There are three independent parts to the equipment—the headstock, which is stationary, and the press and tailstock, which are mounted on rollers to permit of their adjustment for straightening

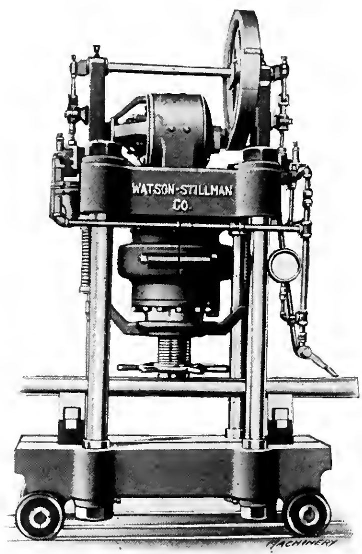


Fig. 2. Front View of the Watson-Stillman Press

shafts of various lengths. The bed rails are set flush with the floor so that when the movable parts are not in use, they can be rolled to one side, leaving the floor clear of obstructions. The head and tailstock are similar to those of a lathe except that the centers are hinged to follow the movement of the ends of the shaft while the shaft is bending.

The shaft is rotated from the headstock and the high point noted. The press is then moved to that point and the bending blocks adjusted. The ram has a maximum movement of 2 inches, and a square thread adjusting screw is mounted concentrically in it, as shown in Fig. 2. This provides for making adjustment for the different diameters of shafts

straightened in the machine, and also enables the operator to predetermine the flexure desired. In this way, all danger of over-bending is eliminated. The entire hydraulic power plant, including a five-horsepower motor, pump, reservoir, etc., is mounted on the top of the platen of the press. The floor space required is 3 feet 6 inches wide by the length of the shaft to be straightened plus six feet. The total weight of the press is 19,300 pounds.

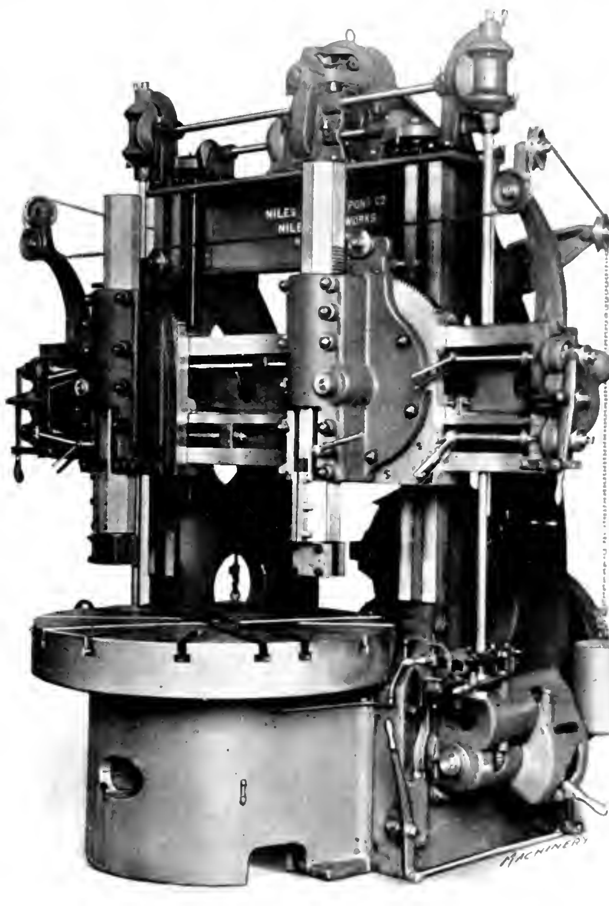
NILES BORING AND TURNING MILLS

The accompanying illustration shows the 53-inch size of a line of boring and turning mills which has recently been placed upon the market by the Niles-Bement-Pond Co., 111 Broadway, New York City. In the design of these machines, particular care has been paid to the development of features which add to the convenience of operation, thus increasing the output of the machine and operator. The levers for all changes of feed and reversal, rapid power traverse or hand adjustment of the saddles and bars, cross-rail adjustment and table control are within easy reach of the operating position. One lever disengages the feed, engages the fine and coarse feed and operates the rapid traverse in either direction. Rapid power traverse to the saddles and bars in either direction is provided and also hand adjustment of the saddles and bars by automatic releasing ratchets located at the sides of the saddles. The machine is entirely self-contained, no part extending below the floor line and no special foundation being required.

The housings are of the box girder form with broad faces which have no openings in the front of them. The cross-rail elevating screws are located between the housings. The table is strongly ribbed and supported by an annular bearing which is kept flooded with oil. The table is driven by a coarse pitch bevel gear, which is accurately cut and of wide face. The surface of the table has two pairs of parallel and eight radial T-slots. The table is maintained in strict alignment by an upper and lower bearing. The upper bearing is bored from the solid bed and fitted with an adjustable taper bushing to compensate for wear. The lower bearing is bronze bushed and there is an adjustable threaded collar on the end of the spindle to prevent lifting.

The cross-rail is of the three-track type. It has a narrow guide at the bottom with the saddle traversing screw located between the guiding surfaces. The cross-rail is of the box girder form and made of exceptional depth to enable it to resist the strains resulting from heavy cutting. It may be readily clamped to the housings in any desired position, and power adjustment is provided. The saddles have wide bearings on the cross-rail, which are accurately scraped and provided with tapered gibs to compensate for wear. A clamping bolt provides for clamping each saddle while the bar is feeding. The bars are octagon shaped steel forgings which are scraped to a bearing on four sides. Eight changes of positive feed are available; the feeds are reversible and independent for each head, both in amount and direction. The tool-holders are steel forgings provided with means for readily clamping the tools for boring, turning and facing operations. The tool-holders have straight shanks and are readily removed to provide for the insertion of special boring bars. Counterweights for each bar are attached to the same chain, but act independently of each other, and will not pull the swings over nor interfere with the movement of the saddles. The counterweight chain is placed at the rear of the bars to prevent interference with an overhead crane when moving work on or off the table of the machine. Safety friction clutches located on the vertical spline shafts insure against accidents in case the heads or bars meet with an obstruction while feeding or traversing.

Where direct current motor drive is employed, a four to one variable speed motor carried on the plate located between the housings at the rear of the machine is employed. Power is transmitted through a double run of clutch gears giving two mechanical changes of speed, which, in connection with the sixteen or more speeds in the controller, affords thirty-two or more speeds to the table. The motor is fitted with a push button control and a dynamic brake for the table. An auxiliary motor located on the top brace of the mill is furnished for elevating the cross-rail and operating the rapid power traverse for the bars and saddles. Belt drive through a single pulley or alternating current motor drive from a constant speed motor may also be employed. In this case, the drive is through a speed-box and back gear located at the rear of the mill, twelve changes of speed being provided. The speed-box is fitted with a hand operated friction clutch for starting or stopping the table, and a brake is provided that is controlled by the same hand lever which operates the clutch. Belt driven machines are built on the convertible plan and may be readily changed over for motor drive, if so required. This line of boring and turning mills is made in four sizes which have actual swings of $41\frac{1}{2}$, 54, 63 and $74\frac{1}{2}$ inches.



Fifty-three-inch Niles Boring and Turning Mill

KELSEY DRAFTING TABLE

A great deal of attention is now being paid to the development of convenient methods of controlling machinery and other factory equipments, so as to reduce the effort required of the operator and increase his efficiency. In the case of the draftsman, improved methods of control of this kind are particularly valuable, as the reduction of fatigue means that he is at his best both mentally and physically, which is particularly important in striving for the best results in drafting. The Kelsey drafting table illustrated in this connection is equipped with a special form of ruling

edge, which is more convenient to use than the regular form of T-square, thus reducing fatigue and increasing the draftsman's efficiency.

The design of the table may be briefly described as follows: a drawing-board holder, consisting of two castings mounted on a rocker shaft, has the drawing-board clamped between wooden front and back pieces by means of thumbscrews. The ruling edge or blade works independently of the edges of the board, and the way in which it is supported

Fig. 1. Kelsey Drafting Table with Blade in Operating Position

allows the draftsman to work with greater ease and rapidity than he could with an ordinary T-square. The blade is carried by a pivoted support which is almost counterbalanced by springs at either end of the table, the slight excess of weight being carried by a finger bar secured to the blade. The support is hung from a rocker shaft and so adjusted that a slight lift raises the blade a considerable distance

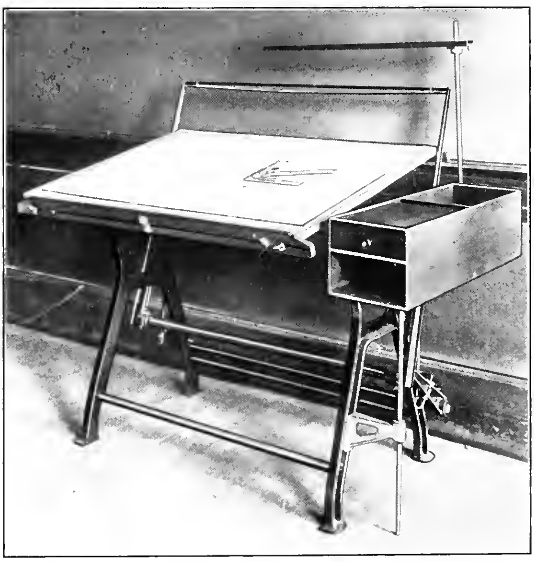


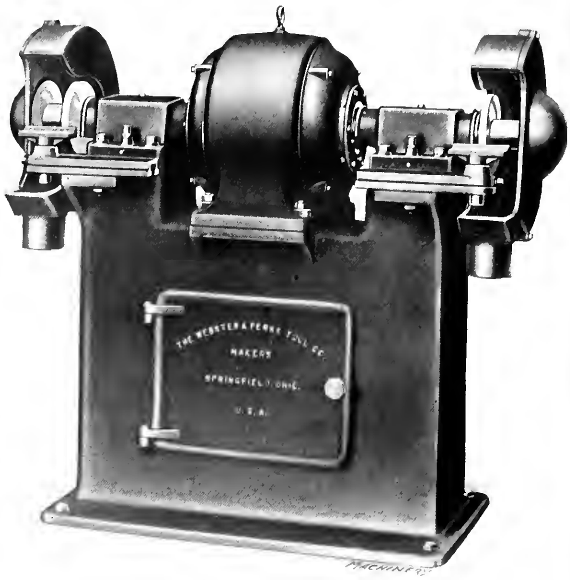
Fig. 2. Kelsey Table with Blade lifted up from the Paper

above the drawing-board, where it is held stationary until it is again wanted. This feature is particularly convenient when applying tracing cloth or changing drawings on the board. As the blade is practically balanced and can be moved into any desired position over the board by means of the finger bar, the convenience of the arrangement will be apparent. This device can be supplied as an attachment for use on any substantial table, in which case the support for the blade is mounted above the table.

The illustrations show the draftsman's universal square and protractor, which is a product of the same maker, in place on the table. This instrument affords a particularly efficient means of drawing horizontal, vertical and angular lines. The instrument is made in various sizes. It will also be seen that a cabinet is attached to the table. This cabinet has a drawer 7½ by 13 by 1¾ inch in size, a pocket 8 by 12 by 3 inches in size and a pigeon hole for holding rolled up tracings, which is 8 by 4 by 27½ inches in size. An upright for holding a light is also shown in the illustration. This drawing-board is a recent product of D. J. Kelsey, 77 Livingston St., New Haven, Conn.

WEBSTER & PERKS FLOOR TYPE GRINDER

The floor type grinder illustrated herewith is a recent product of the Webster & Perks Tool Co., Springfield, Ohio. The machine is driven by a five-horsepower alternating-current motor which is adapted for use on a sixty-cycle circuit and runs at 1150 revolutions per minute. The rotor is wound on a hollow steel shaft mounted in ball bearings, and the arbor of the machine passes through this hollow shaft, from which it is driven by a pair of dovetail steel keys. As the



Webster & Perks Motor-driven Floor-type Grinder

arbor is of smaller diameter than the hole in the rotor shaft, any ordinary deflection of the arbor cannot throw the rotor out of alignment and cause it to strike the fields. The arbor may be removed from the machine without in any way disturbing the motor. The arbor bearings are independent of the rotor bearings, being babbitted and provided with the self-oiling feature applied in the bearings of other machines of this company's manufacture.

The principal dimensions of this grinder are as follows: capacity for handling wheels, 16 or 18 inches in diameter by 3 inches face width; height from floor to center of arbor, 33 inches; size of base, 22 by 38 inches; and net weight of machine with motor, 1550 pounds. The machine is shown equipped with the exhaust type of wheel-guards which may be removed if necessary.

WOOD STOCK CONTROL CHUCK

The Wood Turret Machine Co., Brazil, Ind., is now equipping all its tilted turret screw machines and turret lathes with a new chuck; a machine equipped in this manner is illustrated in Fig. 1, and Fig. 2 shows a cross-sectional view of one of the chucks, from which the construction will be better understood. Referring to this illustration, it will be seen

that three grooves *A* are provided to keep the cutting compound from working into the spindle bearings. The holes *B* are provided to receive a spanner used in adjusting the chuck; *C* is the collet master or collet closing ring, and *D* is the collet. The spindle is recessed at the end to receive the collet closing ring *C*, this recess being ground to size by the use of a special fixture which is employed after the spindle is assembled in the bearings. This insures a more perfect and concentric bearing for the ring than could otherwise be obtained. The ring is hardened and ground both internally and externally, the internal opening being tapered to fit the nose of the collet.

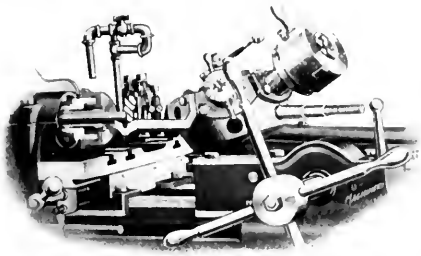


Fig. 1. Machine equipped with the Wood Improved Stock Control Chuck

In the old form of chuck in which the holder is screwed onto the spindle, the rear face of the chuck is so far removed from the point where the work is held that any slight variation between the chuck and spindle causes the work to be thrown materially off center. The necessity of frequently detaching the chuck from the threaded spindle causes the thread to become worn, with the result that lost motion develops between the chuck and spindle which causes a corresponding inaccuracy in the work. Furthermore, it was necessary to heat-treat a chuck of this style which resulted in distortion of the thread with a corresponding inaccuracy in the alignment of the work held in the chuck.

These objectionable features are entirely eliminated in the new Wood stock control chuck by simply mounting the collet in the spindle and centering it by means of the collet master *C*, which is hardened and then accurately ground. The master, in turn, is controlled by the hood on the end of the spindle, the hood keeping it from being pushed forward. With this construction the engagement of the hood with the spindle may be out of alignment without in any way affecting the alignment of the collet master and the collet. The collet master remains stationary when the chuck is in operation in chucking or unchucking the work. All wearing parts are hardened and ground.

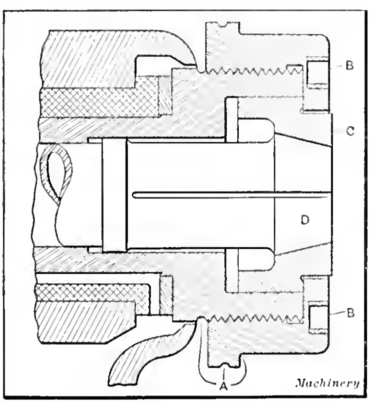
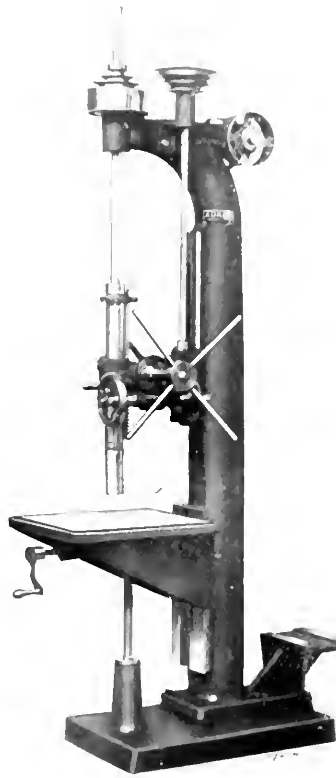


Fig. 2. Cross-sectional View of the Chuck

AURORA HIGH-SPEED DRILL

The high-speed drill equipped with both hand and power feed, an adjustment of 14 inches for the slide, 14 inches travel for the head and 11 inches adjustment for the table has recently been brought out by the Aurora Tool Works, Aurora, Ind. A number of these drills were built for use in the plant of the Fort Wayne Electric Works of the General Electric Co., according to specifications furnished by the mechanical superintendent. The machines are designed for heavy work in driving multiple spindle drill heads of the Langelier and similar types in which as many as eight 3/8-inch drills are working simultaneously.

The drive is provided by a direct current Fort Wayne motor mounted on a bracket on the base of the machine. The illustration shows the bracket provided for this purpose, but it will be seen that the motor is not in place on the machine. For the particular class of work for which these drills were built, a constant speed motor is used, driving the spindles at 1800 revolutions per minute. If a range of speeds was required, however, a variable speed motor could be employed or the motor bracket could be replaced by a bracket supporting a cone pulley. Three changes of feed are secured through the feed cone pulleys at the top of the machine,



Aurora Ball Bearing High-speed Drill

the available feeds being 0.0035, 0.007 and 0.010 inch per revolution. The pulleys are mounted in ball bearings and the spindle is equipped with a ball thrust bearing, which reduces friction losses to a minimum.

G. E. CONTINUOUS CURRENT GENERATORS

A new line of engine type, commutating pole, continuous current generators has been recently placed on the market by the General Electric Co., Schenectady, N. Y. These machines embody all the advanced refinements in the electrical and mechanical design of this class of apparatus, which enables them to meet the most exacting service requirements modern applications demand. The generators are offered in the usual complete line of standard sizes ranging from 25 K.W. to 400 K.W., inclusive. They are manufactured in both the two-wire, designated Form LD, and three-wire, known as Form LDS, types, with either shunt or compound field windings and with armatures wound to deliver the rated kilowatt output at any voltage from 115 to 125 volts or 230 to 250 volts. Larger sizes of both types and wound for 250 volts only are built on specification.

The speeds of these generators are in conformity with modern engine practice, and were selected after a careful consideration of the recommendations and requirements of leading engine builders. Compound wound machines auto-

matically compensating for line drop in the distribution system are built for any desired degree of compounding from no load to full load, although 1 to 5 per cent is usually sufficient for average conditions, and standard field windings provide for this amount. The frame is designed for installing on the engine bed plate or masonry foundations, and the armature is bored for mounting on the engine shaft. The utilization of commutating poles in these generators is one of the distinctive features of the new design, and permits operation over an extremely wide range of load and voltage with a fixed brush position and sparkless commutation. The commutating winding produces a magnetic field flowing in a direction that assists the reversal of current in the coil undergoing commutation, and is also directly opposed to the field generated by armature reaction tending to retard the reversal of current in this coil.

The commutating field thus completely nullifies the distortive effect of armature reaction on the main field flux in the commutating zone, and generates an electromotive force that helps the brush to commutate the current without sparking and with a consequent increased life of the commutator and brushes. Inasmuch as the commutating windings are directly in series with the armature, their strength varies directly with the armature current and provides the correct rectifying effect for proper reversal of current in the

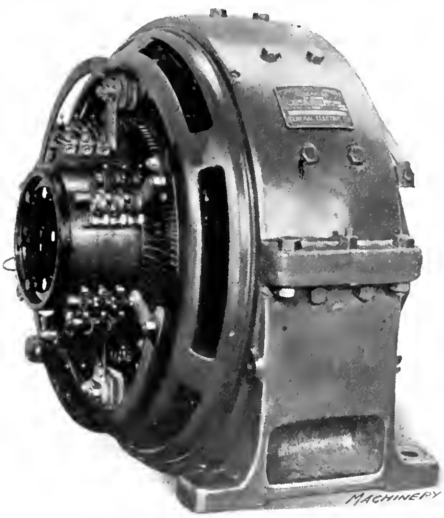


Fig. 1. Two-wire Form LD Engine Type Generator of 35 K. W. Capacity

coils at all loads. Hence it is unnecessary to shift the brushes as the load changes. A new and very important feature of this line of generators is the development of the three-wire machines with a special type of revolving compensator. The advantages of the three-wire system for the distribution of electrical energy at low voltages are well understood. The principal advantage is the fact that a 125/250 volt three-wire system requires about one-third the amount of copper in the distribution system required by a 125-volt two-wire system. Thus the adoption of the three-wire system for a combined lighting and power load saves about two-thirds the investment in copper.

The adoption of the revolving compensator with one collector ring for obtaining the neutral connection with three-wire operation is somewhat of a radical departure from previous designs. This design supersedes the familiar separate stationary compensator and two collector ring arrangement. The revolving compensator consists of a circular magnetic core upon which are mounted suitable exciting coils, the core with its coils being assembled on a cast bracket bolted directly to the back end of the armature spider. The compensator fits under the overhanging end windings of the armature, projecting but a short distance beyond the main winding, and requires no additional allowance in floor space. The compensator windings are connected to the main armature winding at proper points, and the neutral connection is taken through the armature spider to a single collector ring mounted on the outer end of the commutator shell. The neutral brushes bearing on this ring are supported by and insulated from the main brush-holder studs. The simplicity of this design, self-contained with the armature, eliminates floor space taken by the stationary compensator, requires fewer collector rings and brushes, and reduces the number of cable leads to the switchboard.

Revolving compensators may be applied and connected to standard Form LD two-wire armatures. Aside from the

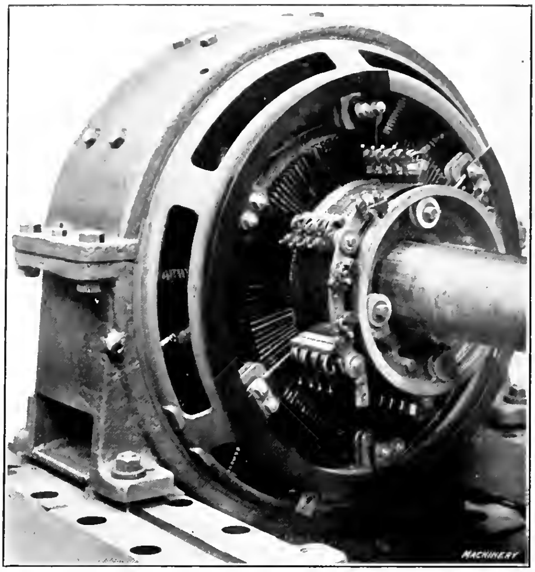
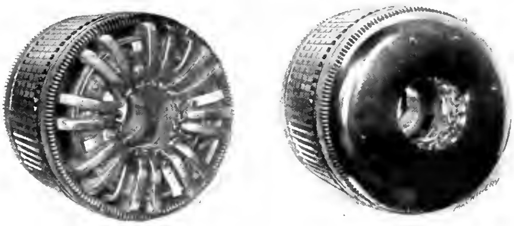


Fig. 2. Three-wire Form LDS Engine Type Generator of 100 K. W. Capacity

armature construction, the only important difference between a two-wire Form LD and a three-wire Form LDS generator is in the field connections. In the three-wire generator the series and commutating fields are equally divided between the two sides (positive and negative) of the armature, insuring exact compounding for all load conditions whether balanced or unbalanced. Three-wire generators are designed to carry on unbalanced current of 25 per cent of the rated full load current in the neutral. Particular attention has been given to the ventilation of these machines. Armature cores, windings, spiders and flanges, commutator shells and all field coils are of the open construction, allowing a free circulation of air through and around all component parts, which insures low temperatures, good efficiency and durability of the insulation. The magnet frame is cast steel split horizontally above the center line, so that the generator can be taken apart for cleaning, inspection or repair without removing any of the field poles.



Figs. 3 and 4. Armature with Revolving Compensator for Three-wire Machine

The main poles are of laminated steel, punched to suit the finished frame and held in place by bolts. The main field is constructed with the series coil mounted outside the shunt coil, and is separated a sufficient distance to permit thorough ventilation and insure easy access to either coil. The shunt coil is thoroughly insulated on a sheet metal body and is supported by heavy insulating collars. The commutating poles are of rolled steel held in place by bolts, and carry a

helical winding of edgewise-wound copper strip, insuring effective radiation of heat. Either the main or commutating poles with their coils are readily removed without interfering with the magnet frame or brush rigging. The armature windings, either multiple or series as best suits the design, are formed from bar stock in coils of endless type, without joints or clips on the back end; and the design of the coil is such that an exceptionally free circulation of air is obtained around and through the end windings. An improved wrapped type of insulation supersedes the trough type used on previous designs. The windings are held in the slots by hardwood wedges dovetailed in the punchings, and on the ends by binding bands, which do not, however, extend over the core. The end connections are supported by flanges bolted to the armature spider. Suitable equalizer connections are provided on all multiple wound armatures to prevent any difference in voltage due to variation in the air gap, and also to equalize the magnetic pull on the shaft.

The commutator segments are made of liberal depth, from hard drawn copper, insulated from the shell and from one another by mica gaged to uniform thickness and of such hardness as to wear evenly with the copper. On the smaller sizes the back clamping rings are cast integral with the commutator shell, the outer clamp ring being a separate casting. On the larger sizes both clamping rings are separate castings. The commutator segments are of sufficient length to permit staggering the brushes, which insures even wear of the entire commutator surface. The commutator is supported independently of the shaft, being mounted on an extension of the armature spider. The segments are connected to the armature winding by copper strips soldered into the segments and to the armature conductors. The armature core is built up of thin laminations thoroughly annealed, assembled and keyed to a finished seat on the armature spider. Through bolts hold the assembled core in place between two cast-iron flanges, one of which is cast integral with the spider. These bolts are located within the inner periphery of the punchings and do not pass through the core. A liberal number of radial air ducts is provided to insure good ventilation.

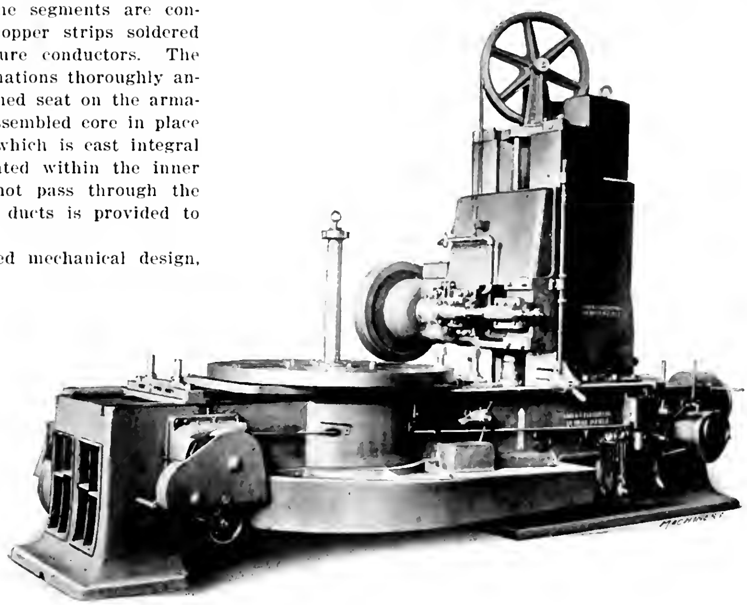
The brush rigging is of an improved mechanical design, the yoke fitting closely in a groove turned in the magnet frame. The brush-holder brackets are firmly attached to the yoke and are made adjustable to allow for natural wear of the commutator. The brush-holder studs are riveted in the brackets and are supplied with a liberal number of brush-holders. No shifting device is furnished nor required. After the brushes are once adjusted in their proper position, the yoke is locked in place and no further brush shift is necessary. The design of the brush-holder embodies distinctive features. The brush-holder body is a single-piece brass casting bored for the stud fit, while the broached box offers a long bearing surface that eliminates grooving of the brush. The punched steel lever is rigid and maintains its relation to the brush irrespective of wear. Tension is obtained by a steel wire spring, the design allowing a wide range of adjustment for brush pressure. A metal cap riveted to the brush avoids wear at the point of contact with the spring lever. A flexible copper connection with ample contact surface is supplied for carrying the current to avoid deterioration of the brush-holder spring.

Connection blocks are bolted to the under side of the magnet frame. To these are fastened the machine leads, which are fitted with suitable terminals for receiving the line cables. While commutating pole generators are superior to non-commutating pole generators for any character of service, these machines with their many additional improvements in design will operate in a thoroughly satisfactory and reliable manner under the most severe service conditions, where fluctuating motor loads frequently predominate, such as for lighting and power service in office buildings, industrial plants, mines, and other classes of service.

GOULD & EBERHARDT AUTOMATIC GEAR-CUTTING MACHINE

Gould & Eberhardt, Newark, N. J., have recently built the automatic gear-cutting machine which forms the subject of this article for Foote Bros., Chicago, Ill. The machine is of exceptionally large size, having a capacity for cutting spur gears up to 144 inches in diameter by 24 inches face width. Steel gears up to 4 inches circular pitch can be handled by the machine. This automatic gear-cutting machine is of the vertical cutting type, and owing to the exceptionally heavy gears for which it is designed, the indexing worm-wheel is mounted in a fixed position and the stanchion carrying the cutter-slide is adjustable by hand or power to accommodate gears of various diameters and also for setting the machine for the required depth of cut.

The cutter spindle is driven by a powerful worm and worm-wheel, and a heavy flywheel is mounted at the end of the main spindle to compensate for any inequality in the work or any other cause which might tend to make the speed of the cutter fluctuate. The cutter spindle is 3 inches in diameter and will take cutters up to 14 inches in diameter. An auxiliary cutter spindle is also provided which is driven through hardened helical gears from the main spindle. This auxiliary spindle makes it possible to use cutters of ordinary sizes, thus adapting the machine for cutting smaller gears. The use of these two spindles enables this machine to handle a great variety of sizes of gears ranging from small pinions up to the large size gears referred to in the preceding paragraph.



Gould & Eberhardt Automatic Gear-cutting Machine of Unusually Large Size

The machine is entirely automatic in operation and is equipped with many of the features of the Gould & Eberhardt gear-cutting machine of smaller size. A wide range of cutter speeds is provided and the cutter feeds, which are independent of the speeds, may be conveniently changed through an improved type of gear box. The indexing worm-wheel is of the split rim type and exceptional care has been taken to hob it accurately. The index and feed mechanisms are connected through a system of inter-locking levers which are so arranged that it is impossible for the feed clutches to be engaged until the indexing operation has been completed. A system of oil pans completely covers the worm-wheel and prevents oil from splashing onto the floor. An

oil pump of generous proportions supplies a liberal flow of cutting compound to the cutters.

In addition to being used in its regular capacity, the machine is so arranged that worm wheels can be hobbed automatically without previously gashing the teeth. The cutter spindle is geared in unison with the indexing worm and single or multiple thread hobs may be used with equal facility. The speed of the indexing wheel may be varied to suit the different sizes of gears. The cutter spindle may be locked in any desired position for hobbing and an automatic mechanism gradually feeds the hob into the wheel. The weight of the machine is about 35,000 pounds.

MARTELL ALIGNING REAMER

A garage engaged in handling a general line of repair work finds that the bearings constitute the greatest element of uncertainty in making an estimate on the price to be charged for overhauling a car. This is due to the great variation in the amount of wear which may be found in the bearings of different cars. With the view of overcoming this difficulty, the Martell Motor Co., 1928 Columbus Ave., Boston, Mass., has brought out an aligning reamer which is shown in operation in Fig. 1. When this reamer is used, badly worn bearings may be refinished with practically the same rapidity as those which have very little wear so that the repair man is able to estimate intelligently on this part of the work.

The reamer shaft is supported by a number of temporary bearings which engage directly with the holes to be reamed, thus making the device entirely independent of the form of the supporting members of the bearings. The fact that it is not necessary to bolt the crank-case down rigidly is also a feature which adds to the assurance of perfect bearing alignment. The reamer shaft is easily adjusted in relation to any given points, as, for instance, paralleling a surface or providing for the proper mesh of gears. An ample range of adjustment of the reamer blades is also provided. The reamer heads are secured to the shaft in such a manner that they may be rigidly clamped to the shaft in any desired position.

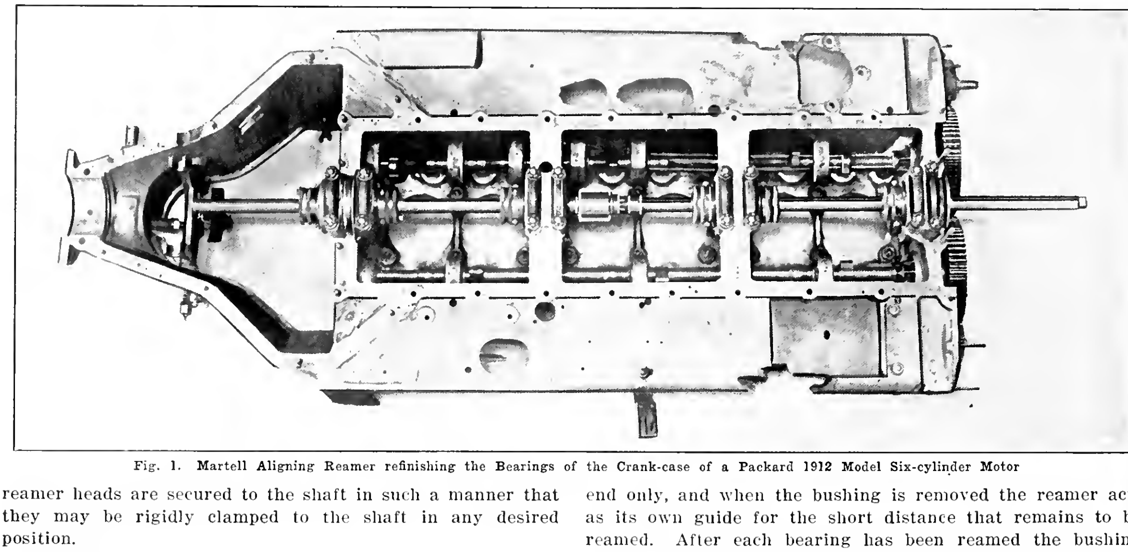


Fig. 1. Martell Aligning Reamer refinishing the Bearings of the Crank-case of a Packard 1912 Model Six-cylinder Motor

An eccentric flanged bushing that is mounted directly on the reamer shaft has the flanged portion provided with a radial slot concentric to the surface engaging with the bore of a second bushing. This second bushing is also of the eccentric flanged type and is an easy fit over the first bushing. The flanged portion of the second bushing is provided with six tapped holes which are located on a circle that is concentric with the bore; and a cap-screw passing through the radial slot serves to lock the two bushings together in any desired position. The edges of the flanges of these bushings are graduated, one bushing having nineteen divisions and the other twenty, thus affording a vernier which shows the eccentricity of the two bushings in thousandths of an inch. The range of variation is from zero to 0.095 inch. A conical bushing with the taper portion threaded with seventy threads per inch is screwed firmly into the end of the bearing or hole to be reamed. The bore of this conical bushing is ground to receive the larger of the two bushings previously referred to and is provided with four clamping screws to lock the position of the bushing when the desired adjustment has been obtained.

It has already been mentioned that the reamer is equipped with two heads, each of which carries six blades which are assembled in suitable slots. There are wedges at each end of these slots which engage the inclined surfaces of the blades and allow them to be moved toward or away from

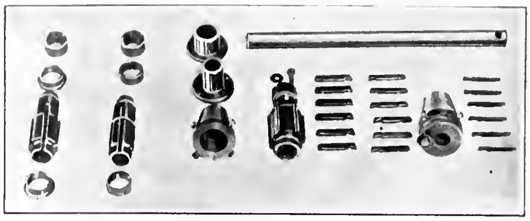


Fig. 2. Parts of the Martell Aligning Reamer

the center through the action of adjusting nuts. The reamer heads are held in any desired position on the shaft by means of locking nuts. The reamer blades are oil tempered and ground and provided with a 6-degree angle on the cutting edge.

The reamer is shown in Fig. 1 refinishing the crankshaft bearings of a 1912 Packard six-cylinder motor. The crankshaft gear is mounted directly on the reamer shaft by means of a special bushing, and the proper mesh of the gears is obtained by means of eccentric bushings. The rear end of the shaft is next aligned to bring it parallel to the top of the crank-case. In order to ream all the way through the bearings, the bushings at the back end must be removed. The reamer blades are provided with a cutting edge on the front end only, and when the bushing is removed the reamer acts as its own guide for the short distance that remains to be reamed. After each bearing has been reamed the bushing that was removed for the purpose is replaced in its former position. In this manner the work is easily and accurately handled. This reamer was designed for reaming automobile crankshaft bearings, the idea being to provide the repair man with a means of accurately aligning such bearings and saving time in the operation. An idea of the rate at which the tool works may be gathered from the fact that the job shown in Fig. 1 was completed in eleven hours without any attempt having been made to establish a record.

GARDNER MOTOR-DRIVEN POLISHING LATHES

The motor-driven polishing lathe shown in the accompanying illustration is a recent product of the Gardner Machine

Co., Beloit, Wis. The notable features of this machine are the application of motor drive, the motor starter and the way in which the spindle construction has been worked out. The fully enclosed direct-current motor is of the commutating pole type and runs without any sign of sparking. It has a continuous rating of 4 horsepower and a two-hour rating of 6 horsepower. The compound starter is mounted within the base of the machine and is accessible by opening the hinged door at the front. A speed variation of from 2000 to 3000 revolutions per minute may be obtained.

The spindle is of unusual size and mounted in ball bearings. In the No. 3 size machine shown in this connection, the spindle is 49 inches in length; its maximum diameter is 2¼ inches and the diameter between the flanges is 1¼ inch. The complete weight of the No. 3 machine is 850 pounds. The same type of machine is made in two smaller sizes, known as the No. 2 and No. 1 Gardner polishing lathes. The No. 2 machine has a spindle 42½ inches long, the diameter between the flanges being 1 inch; the No. 1 machine is equipped with a spindle 32 inches long and the diameter between the flanges is ¾ inch. The preceding spindle lengths are standard, but special spindles of different lengths may be supplied to meet the requirements of different classes of work.

No. 3. Gardner Ball Bearing Motor-driven Polishing Lathe

DETROIT SEMI-AUTOMATIC DRILLING MACHINE

The semi-automatic horizontal drilling machines which form the subject of this article were designed by the Detroit Tool Co., Detroit, Mich., for drilling small holes in small work. Drilling of this nature requires precision, speed and rapid handling, and these machines meet the requirements in a very satisfactory manner. The horizontal spindles permit the work to be held in fixtures of simple design, in which the work can be located without moving the fixture or risking interference by the drill. Both the work and drill are constantly visible. The working parts are all enclosed, thus protecting both the mechanism and operator from injury. On most classes of work, the capacity is governed entirely by the speed with which the operator can handle the work. The drills are fed automatically by cams, and as the feeds are entirely independent of the operator, it is necessary for him to maintain a steady rate of production or fall behind the machine. These drilling machines are made in two sizes, known as the No. 1 and No. 2. The principal features of both machines are identical and the following description applies to either machine. The No. 1 machine is designed particularly for drilling very small work at high speed, while the No. 2 machine is adapted for handling work of a more general character, and to adapt it for this purpose it has a wider range.

As previously stated, the operator is merely required to look after placing the blanks in the work-holding fixtures

Fig. 1. Detroit Semi-automatic Horizontal Drilling Machine

and removing the finished product. The drills advance automatically at the proper rate of feed so that they enter the work without breaking. If desired, the cams may be so formed that the feed increases automatically after the drills have started, and when so desired the drills may also be backed out to clear the chips out of deep holes. When a hole is finished, the drill is withdrawn and remains back long enough for the finished piece to be removed from the fixture and a fresh blank mounted in its place. In the meantime, a steady flow of cutting lubricant has washed away

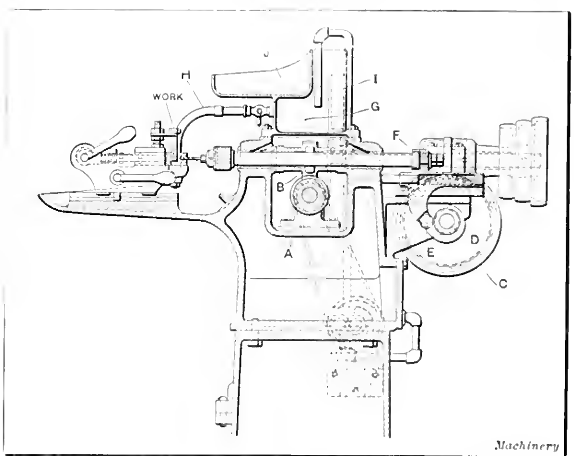


Fig. 2. Cross-section through Machine showing Feed Mechanism

the chips so that the work and fixture are clean. The cams for feeding each drill are so timed that the holes are drilled in rotation. In this way the operator is able to divide his time between the five work-holding fixtures, and by the time he has placed a blank in the fifth fixture, the hole has been finished in the piece held in the first fixture and he can go

back and replace this piece by a fresh blank. He then begins changing the finished product for fresh blanks in each fixture in turn, performing this cycle over and over. Fig. 2 shows a cross-sectional view of the machine, from which the design will be readily understood. The main driving shaft *A* extends through the bed at right angles to the spindles, which are driven from this shaft by means of spiral gears *B*. Between the first and second, and the fourth and fifth spindles and parallel to them, there are two shafts, one of which is driven by spiral gears from the main driving shaft *A* and the other connected to the cam-shaft *D* through a worm and gear *C*. These two shafts are connected at the rear of

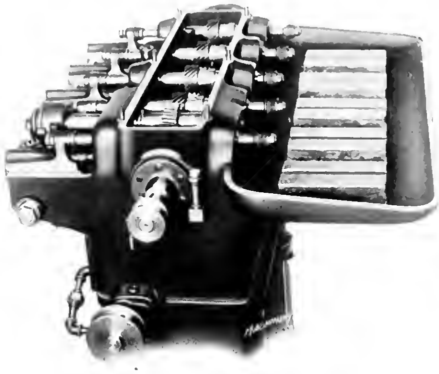


Fig. 3. Arrangement of Spiral Gears connecting Driving Shaft and Spindles

the machine by a belt running over three-step cone pulleys, thus providing three different spindle feeds for each spindle speed. The feed of the spindles is obtained by cams carried on the cam-shaft *D*, which operate against rollers *E* attached to slides carried on the rear end of the spindles. The cams force the spindles forward, thus feeding the drills into the work, and the spindles are withdrawn by springs.

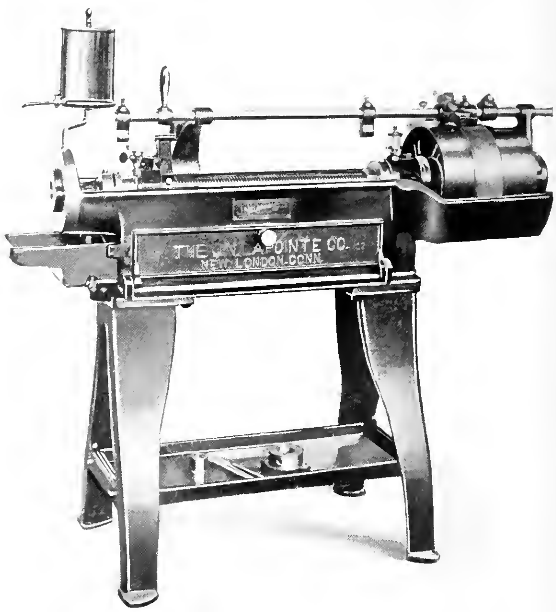
Spiral and worm gears are used throughout the machine. All of the gears are located in a compartment in the bed at the rear of the pan as shown in Fig. 3. The construction forms an oil-tight compartment which completely encloses the gears, and when supplied with oil constitutes a self-oiling system. Both the gears and the spindle bearings and main shaft bearings are lubricated from this source. The spindles are made of hardened alloy steel, and are ground to the required finish and carefully balanced. On the No. 1 machines the spindles are $\frac{3}{4}$ inch in diameter, and have a taper of 0.9 inch per foot to fit a standard No. 1 chuck. On the No. 2 machine, the spindles are 1 inch in diameter, and have a taper of 0.96 inch per foot to fit a standard No. 2 chuck. On both machines, the end-thrust of the spindles is taken on ball bearings at the rear, which are shown at *F* in Fig. 2. Each spindle is carried in two bearings of ample size, which are lined with bronze. The main driving shaft bearings and the bearings of the two shafts controlling the cam-shaft are also bronze bushed. All of the bearings are line reamed.

Cutting lubricant is supplied to the drills from the tank *G*, from which it is conveyed by curved pipes *H*. A uniform flow at a constant pressure is insured as the surplus oil is pumped into the upper tank where a uniform level is maintained by means of the overflow *I*. The oil is drained from the chip pan through a strainer into a settling pan in the base of the machine. From there it passes to a reservoir in the base, from which it is pumped back to the upper tank *G*.

The saving of drills effected by the automatic feed employed on this machine is an important feature. Where drills are fed by hand, the rate of feed and strain on the tool varies considerably and results in a serious breakage of drills. With the cam mechanism employed on the Detroit drilling machines, however, the most suitable feed may be determined and this feed constantly employed. Where the drill enters a piece at an angle, or where other conditions exist which make it difficult to start the hole, the feed cams may be so shaped that the feed is slow at the start and accelerates automatically after the drill has entered the work. On deep holes it is frequently good practice to form the cams in such a way that the drills are withdrawn after the hole has been drilled to about one-half the required depth, thus clearing the chips from the hole. The machine is of compact design, and this feature, together with its high rate of production, means a considerable saving of floor space, which is at a decided premium in many factories. This feature is further enhanced by having a work-pan shown at *J* in Fig. 2 provided at the top of the machine. This does away with the necessity of using a table or some other space consuming equipment to hold the supply of work.

J. N. LAPOINTE NO. 0 BROACHING MACHINE

The broaching machine, illustrated herewith, was designed by the J. N. Lapointe Co., New London, Conn., to meet the requirements of a manufacturer who had work to be broached that was too small to be handled conveniently on a larger sized broaching machine. The machine proved so successful in operation that it is now being built for the market. The driving mechanism is of the simple planer type used on other J. N. Lapointe broaching machines and an automatic brake is provided. A belt shifting rod is located at the top of the machine which extends for its entire length. The automatic adjustable stop dogs are mounted on this rod and they may be set at any desired position according to the length of the broach that is to be used. A handle is also mounted on this rod which provides for operating the shifting mechanism by hand. This feature is particularly convenient in allowing the machine to be stopped instantly—regardless of the position of the automatic stops—in case the broaching tool fails to operate satisfactorily. The sliding head is arranged with vertical adjustment to provide



J. N. Lapointe No. 0 Broaching Machine for Small Sized Work

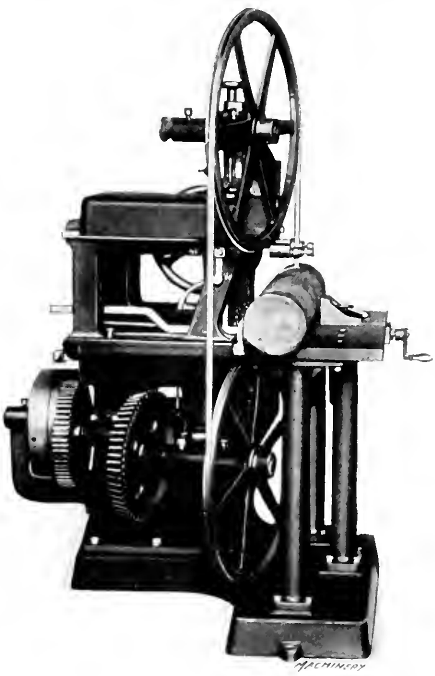
for regulating the position of the broaching tool to the desired height.

An oil pot at the top of the machine supplies lubricant to the broach and an oil pan is provided to catch the lubricant. This pan is detachable, permitting it to be removed and emptied when necessary. A small cupboard of sufficient length to hold the broaching tools when not in use is provided. The machine is made with legs and a pan as shown in the illustration; or it may be used without legs, in which case it is set up on a bench. The principal dimensions are as follows: Length of stroke, 21 inches; diameter of driving pulley on machine, 10 inches; width of driving belt, $1\frac{1}{2}$ inch; width of return belt, 1 inch; weight of machine with legs, 445 pounds and without legs, 325 pounds. The capacity

of the machine is for cutting a keyway up to 1/4 inch wide and of any reasonable length; holes up to 1/2 inch square by 1 inch long may be broached.

HOUGHTON & RICHARDS METAL CUTTING BAND SAW

In the August, 1913, number of MACHINERY, the drop-arm type of metal cutting band saw built by Houghton & Richards, 1394 W. 3rd St., Cleveland, Ohio, was illustrated and described. Since that time, the company has developed a straight-line metal cutting machine which is illustrated herewith. This machine is designed to cut to any required depth



Houghton & Richards Metal Cutting Band Saw

in irregular sections of all kinds, such as bar stock, piping, beams, etc.; in fact, any shaped wooden piece that can be cut on an ordinary wood band saw can be cut in metal on this machine. The construction is exceptionally heavy, and an automatic stopping device is provided in conjunction with an adjustable stop for regulating the depth of cut from zero to 6 inches. The feed is controlled by a weight located inside the standard which carries the sliding carriage. This weight is entirely covered but is easily accessible and provides a constant pressure of the saw against the work. The arrangement of the weight and cable is in the form of a Chinese windlass.

The sliding carriage which carries the wheels over which the band saw runs has large bearing surfaces with V-slides on the bottom and flat slides on the top. The adjustable stop is regulated by means of a small lever at the side of the sliding carriage; this lever is connected with a radius rod which slides the square rod that carries the stop either in or out, traveling with the carriage and controlling the depth of cut. When the small lever is set for any required depth of cut and the sliding carriage has traveled the required distance, the stop on the square bar comes into contact with the lever which holds the belt shifter on the tight pulley. The engagement of the stop and lever causes the shifter to be released and a spiral spring then throws the shifter over, moving the belt onto the loose pulley and stopping the machine. The sliding carriage is returned by means of a handwheel which is connected with a small steel pinion and steel rack on the sliding carriage. The carriage is held in place by a self-acting lock which must be released by hand before it can advance for another cut.

The guide rollers are of tool steel, hardened and ground, and hold the band saw in line for making the cut. An adjustment for alignment of the band wheels is furnished on the upper arm at the tension side of the saw and when once set, the wheels are set for all bands. The band saw used on the machine is 5/8 inch wide by 0.0312 inch thick, and for the machine having a capacity for cutting work up to 6 inches in diameter the saw is 12 feet 6 inches long. The heavy construction adapts the machine for standing up under hard usage. The illustration shows a machine equipped for belt drive, but if so desired, motor drive through a silent chain or direct gearing may be employed. An idea of the capacity may be gathered from the fact that the time required to cut through a 6-inch bar of tungsten steel is about 24 minutes and the disk will be within 0.001 inch of parallel. Operating at this rate, the capacity of a band saw will be to cut from 1200 to 1500 square inches of steel, depending on the speed and the material. The floor space occupied by the machine is about 9½ square feet.

Since the preceding type of drop-arm band saw built by Houghton & Richards was described in MACHINERY a number of important improvements have been made, among which the following may be mentioned: A positive worm geared feed has been provided for use when the saw is engaged in cutting work of large diameter. This mechanism applies exactly the same pressure on the saw all the way through the cut and adds to the life of the blade on this account. The friction feed can be used on work up to 3 inches in diameter but the use of the positive feed mechanism for all sizes of work is recommended. When the positive feed is used the machine requires absolutely no attention after it has been started. Using the friction feed, it is possible to cut a 3-inch bar in seven minutes, but operating at such a speed the life of the band saw blade is relatively short. When the positive feed is used, the life of the saw is considerably increased, as the pressure on the saw is constant. A band saw blade 5/8 inch wide by 0.031 inch thick will cut from 1000 to 1500 square inches of steel when running at a speed of 135 feet per minute. This improved drop-arm saw has a capacity for cutting stock from zero to 8 inches in diameter

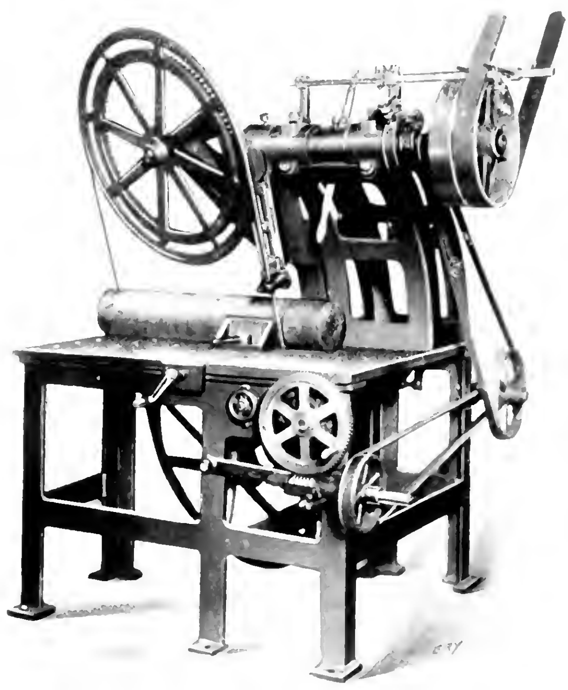


Fig. 2. Improved Type of Houghton & Richards Drop-arm Saw

and it will cut off 8-inch tungsten or carbon steel disks so that the two faces will not be more than 0.002 inch out of parallel.

CORBIN SAFEGUARD FOR PRESSES AND DROP HAMMERS

The Corbin Cabinet Lock Co., New Britain, Conn., is now manufacturing a safeguard to protect the operators of power presses and drop hammers from injury. A power press equipped with one of these guards is illustrated in Fig. 1, and Fig. 2 shows one of the guards in place on the drop hammer. The number of accidents which occur to the operators of power presses and similar machines has led to the development of a great variety of safeguards to provide for the safety of the operators of such machines. In a great many cases, however, these guards have proved inefficient because they hinder the operator in the performance of his work.

The important feature of the Corbin safeguard is that the view of the work is unobstructed at all times and the guard affords adequate protection to the operator without hindering his work in any way. The principle on which this guard operates can best be explained by referring to Fig. 1. It will be seen that a bracket is attached to the frame of the press, from which a horizontal bamboo stick is suspended in such a way that it is free to swing. This stick rests against the operator's arms at a point a little above the elbows. When he reaches forward to adjust a piece of work in the die, the stick is pushed forward. A thin metal rod is attached to one end of the bamboo stick, and when the stick is pushed forward this rod slides a stop into place, which locks the treadle rod in such a way that it is impossible to trip the press. When the operator has adjusted the work and draws his hands back from the die, the bamboo stick drops back to its former position and the stop is drawn back so that the press can be tripped. From this description it will be evident that the operator is not required to pay any attention to the safeguard, and it works so smoothly that he is not conscious of it. Consequently, it does not reduce his efficiency in any way.

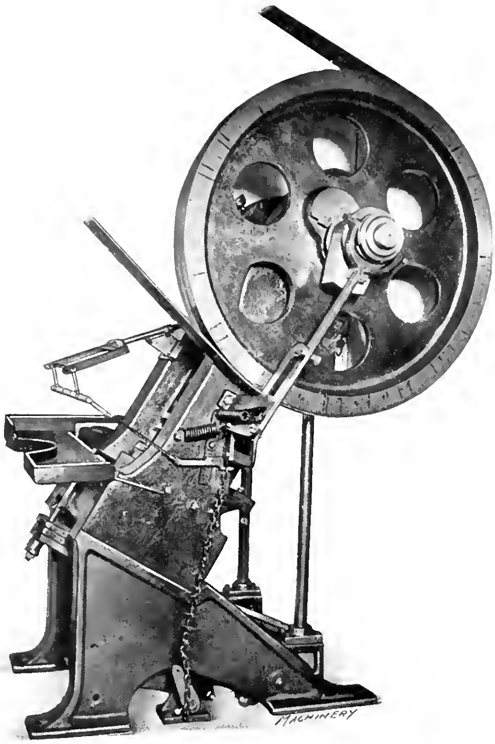


Fig. 1. Power Press equipped with Corbin Safeguard

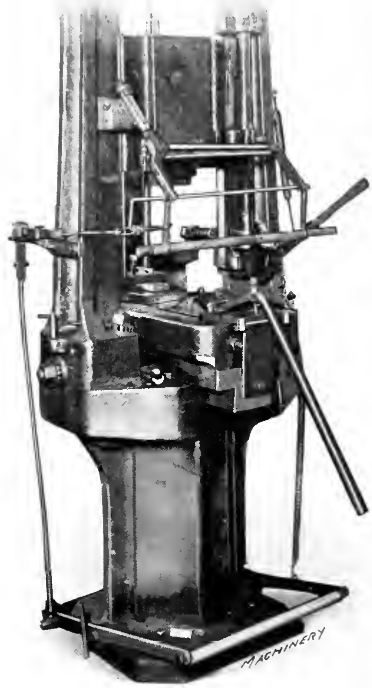


Fig. 2. Corbin Safeguard in Place on a Drop Hammer

LANGELIER SEMI-AUTOMATIC TAPPING MACHINE

The accompanying illustration shows a vertical semi-automatic multiple spindle tapping machine equipped with a stationary head and movable work table which is built by the Langelier Mfg. Co., Providence, R. I. This machine is designed to tap a large number of holes in a single operation and in practically the same time that it would ordinarily take to tap one hole with a single spindle tapping machine. With the new Langelier machine, the duties of the operator are reduced to merely placing the blanks on a simple work-holding fixture and taking off the tapped parts. The cycle of operations is so rapid and exact that as many as fourteen brass plates 1/16 inch in thickness, with seven holes tapped in each plate, have been turned out by this machine in a minute. The machine is especially adapted for use in plants making large quantities of similar parts—such as factories engaged in the manufacture of automobile parts, clocks, typewriters, electrical instruments, camera shutters, telephones and a great variety of other products.

The operator starts the machine by tripping a knee lever or by lowering the opposite end of this lever by hand. This operates the belt shipper and moves the belt to the forward driving pulley. In so doing, an upright shaft whose main function is to drive the main spindle of the multiple tapping head is set in operation, thus starting the multiple spindle tapping head. The tapping spindles in this head are crank driven; they are machined from steel bars, heat-treated and carefully finished by grinding. All of the spindles are accurately located on fixed centers and run in phosphor-bronze bearings. The head can be quickly removed from the machine to provide for the substitution of another head having a different spindle layout. In this way various parts can be tapped with the same machine by using different tapping heads interchangeably.

The spindles can be arranged in practically any desired way over a circle 5 inches in diameter. Each spindle is provided with a special compensating arrangement which permits the tap to follow its own lead independently of the way in which other taps are working. This insures having

every hole tapped with clean cut threads. It also makes it possible to operate taps with different pitches simultaneously and insures uniform and truly interchangeable work. On reaching the desired depth, the taps are reversed automatically.

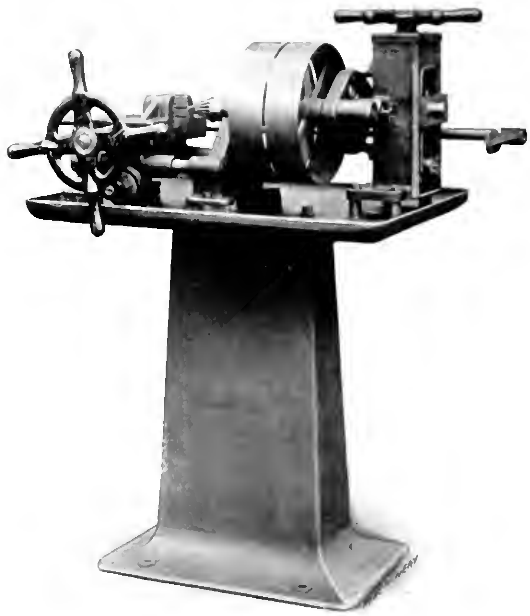
The upright shaft which drives the multiple tapping head also drives a short horizontal shaft at the right of the machine, power for this purpose being transmitted through steel and bronze spiral gears. A steel worm is mounted at the front end of this horizontal shaft which meshes with a worm thread cut in a vertical hub under the work table. This hub has an edge cam path cut on its upper end, and a cam roller which is trunnioned to the stub post of the work table runs over this path when the hub is rotated by the worm on the horizontal shaft. During the tapping operation, the work table is raised by this cam and roller until the taps have penetrated to the desired depth. An automatic trip then operates, shifting the driving belt over to the reversing pulley, reversing the taps and lowering the table at almost double the speed at which the tapping operation was conducted. When the table reaches its lowest position, the trip again shifts the driving belt to the loose pulley and the machine stops, ready for the finished work to be removed and blanks substituted in its place. This cycle of operations is repeated with great precision and rapidity. The automatic stop may be set to stop the table at practically any desired point and the forward and reverse speeds may be closely adjusted to suit the conditions of different classes of work.

Langelier Semi-automatic Multiple Spindle Tapping Machine

The base of the machine carries tight and loose pulleys 6½ inches in diameter which carry a 2-inch driving belt. An automatic oil feed maintains a constant flow of oil on the taps while the machine is running and returns this oil to a self-straining reservoir connected to the pump suction. This enables the same oil to be used over and over without waste and without much attention from the operator. The oil feed operates intermittently, *i. e.*, when the machine stops, the flow of oil also stops automatically, thus preventing flooding the work and fixtures. All running bearings and movable parts are lubricated by means of efficient oilers.

OSTER CUTTING-OFF AND REAMING MACHINE

The machine for cutting off and reaming pipe and tubing which is illustrated herewith has recently been placed on the market by the Oster Mfg. Co., 2107 E. 61st St., Cleveland, Ohio. This machine represents the outcome of an order for a special machine of this type which was received by the



Oster Machine for cutting eff and reaming Pipe

Oster Mfg. Co. some three years ago. The machine proved so satisfactory in operation that it was decided to build machines of the same type for the market. The capacity is for all sizes of pipe up to 2 inches in diameter.

The machine is equipped with a single wheel tube cutter. The pipe to be cut off rests on a pair of rollers, and by turning the handwheel at the top of the machine, the pipe is brought in contact with the cutting disk and quickly severed. A slight pressure on the wheel regulates the speed at which the cutting operation proceeds. The two rollers which support the pipe while it is being cut off are made of steel and revolve in steel bearings. These rollers rest on the bottom of a yoke which slides up and down in the frame. An adjustable gage provides for cutting off duplicate pieces of pipe of various lengths.

The pipe to be reamed is held in the vise jaws which are opened or closed by the handwheel at the front of the machine. The method of control is rapid, so that work can be handled in an efficient manner. The work is fed to the reamer by operating a lever mounted behind the wheel which controls the movement of the vise jaws, this lever causing the pipe to move back or forth as desired. The reamer is held stationary by a set-screw and can be readily removed for sharpening. The bearings of the machine are provided with oil cups which insures efficient lubrication. The range of the machine is for pipe from ¼ to 2 inches inside diameter. The floor space occupied is 24 by 16 inches, and the weight of the machine 510 pounds.

WISCONSIN PORTABLE ELECTRIC GRINDER

The "Dumore" portable electric grinder was designed by Mr. Chester H. Beach, engineer of the Wisconsin Electric Co., Racine, Wis., by which firm the tool is manufactured.

This grinder operates at high efficiency, and when extreme accuracy is desired it is found to give excellent satisfaction. The armature is dynamically balanced, thus insuring satisfactory operation at all speeds and eliminating chatter; what

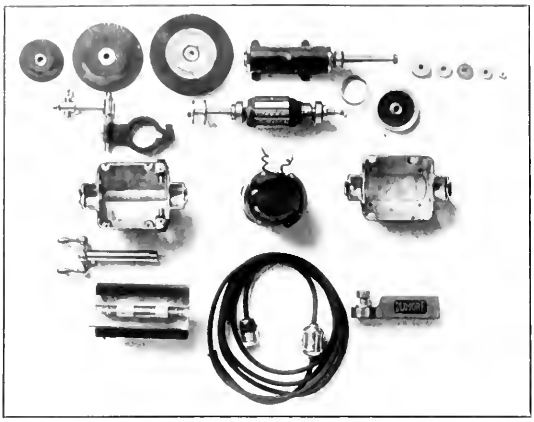


Fig. 1. Parts of the Wisconsin "Dumore" Grinder

is known as the "critical speed" is also avoided. The tool is suitable for handling a great variety of work, such as grinding milling cutters, taper reamers, lathe centers and dies and tools of different kinds.

The tool is of rigid construction and ball bearings are used throughout. The motor casings and internal housings are die-castings. The main shaft or spindle and also the spindle of the internal attachment are ground to within 0.00025 inch and carefully balanced. The motor, which is of the universal type manufactured by the Wisconsin Electric Co., develops $\frac{1}{4}$ horsepower. Wheels $4\frac{1}{2}$ inches in diameter may be driven at 10,000 revolutions per minute which provides a suitable surface speed, and the internal attachment may be driven at

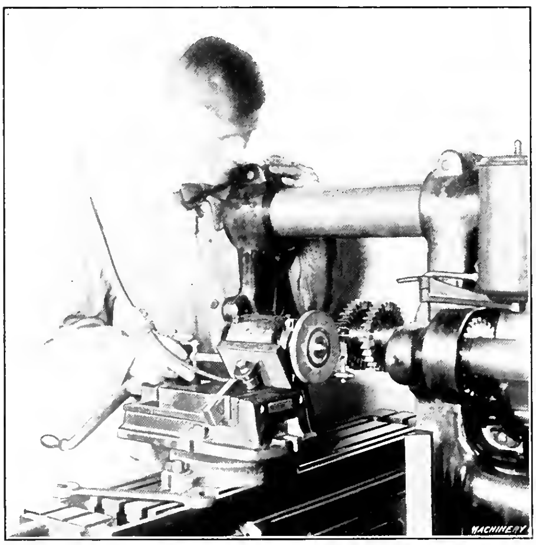


Fig. 2. Sharpening Milling Cutters with the Wisconsin Grinder

speeds up to 35,000 revolutions per minute to obtain the required cutting speed with the smallest wheel used on the grinder.

The parts of the grinder are illustrated in Fig. 1, from which the extreme simplicity and small number of parts will be appreciated. Referring to this illustration, the method of mounting the armature spindle in ball bearings will be readily understood. A complete set of wheels ranging in size from $4\frac{1}{2}$ inches to $\frac{3}{8}$ inch in diameter forms part of the regular equipment of the tool; these wheels will be seen at the top of Fig. 1. The total weight of the grinder is only sixteen pounds.

Fig. 2 shows the grinder employed in sharpening a pair of cutters on a milling machine arbor without requiring them to be removed. For this purpose, a rest is provided for supporting the cutters and the feed-screw of the grinder enables the wheel to be traversed back and forth. This feed-screw is also useful for grinding operations on a lathe which is not provided with a compound rest. Either angular, straight or spiral milling cutters may be ground and the elimination of the necessity of removing them from the arbor means a material saving of time.

In Fig. 3 the "Dumore" grinder is shown grinding a piece of work between centers. In Fig. 4 the internal attachment

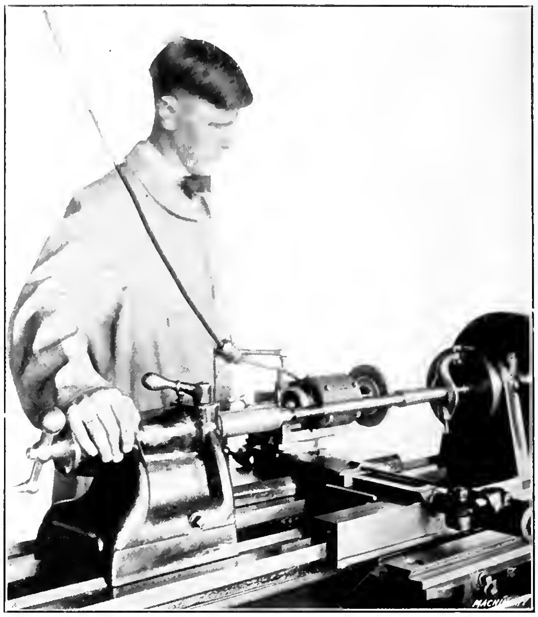


Fig. 3. Grinding Work on Centers with the Wisconsin Grinder

is shown in use. The work shown in this illustration is hardened and has an elongated slot and also a small hole, which are to be finished by grinding. Such work is easily handled by this portable electric tool. The preceding illus-

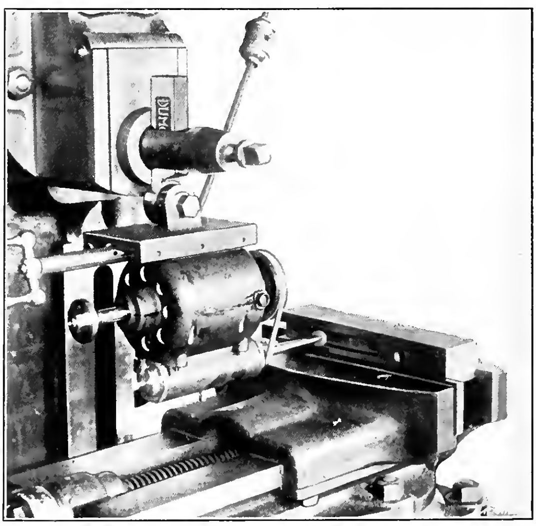


Fig. 4. Application of the Internal Attachment of the Wisconsin Grinder

trations are merely indicative of the classes of work which may be handled, and they will suggest to any practical mechanic a great variety of operations which could be handled to equal advantage.

NIAGARA SIDE SEAMING MACHINE

Fig. 1 shows a side seaming machine which constitutes a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is intended for use in forming the longitudinal seam in sheet metal used in the manufacture of oil and asphalt barrels, ash cans and similar products. Fig. 2 shows in diagrammatical form the ends of two pieces of sheet metal before and after making the lock seam. This seam is formed by two consecutive strokes of the machine. Aside from forming the body, no preliminary work is required. The motion of the machine is controlled by a positive clutch, and the horn has a swinging support on its outer end to provide for entering and removing the work. A safety lock is provided which makes it impossible to trip the clutch before the horn support is in the proper position. This machine has a capacity for work ranging from 9 to 24 inches in diameter, and up to 36 inches in length. Sheet metal up to No. 24 gage can be handled.

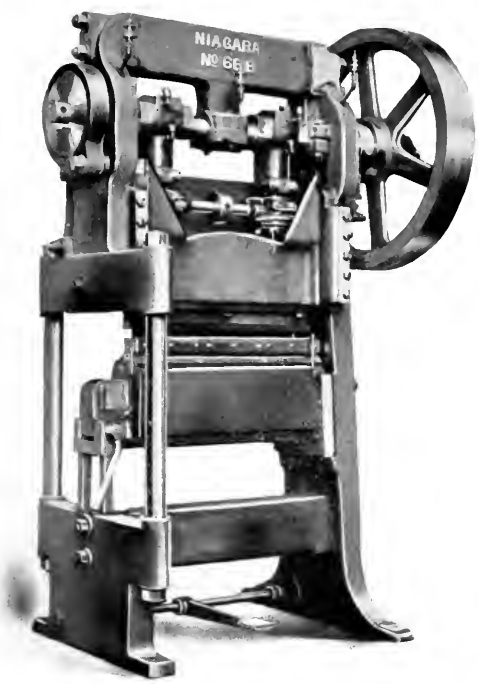


Fig. 1. Niagara Side Seaming Machine

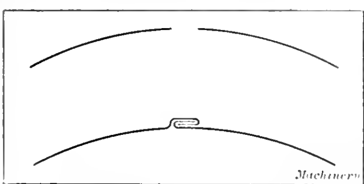
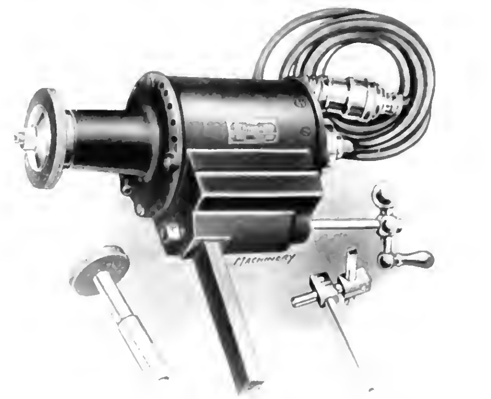


Fig. 2. Diagram showing Ends of Work before and after the Seaming Operation

STANDARD UNIVERSAL ELECTRIC GRINDER

The Standard Electric Tool Co., Cincinnati, Ohio, is now making a line of portable electric toolpost grinders equipped with universal motors. These motors are designed to operate on either direct current or alternating current of zero to 60 cycles, although they are particularly adapted for 25-, 30- or 40-cycle circuits. The spindle runs in ball bearings which are enclosed in dust-proof cases and packed with grease. This arrangement eliminates the necessity of oiling and prevents damaging the motor windings with thin oil used to lubricate the bearings. These grinders are made with either 1/6- or 1/4-horsepower motors and run at a speed of approximately 6000 revolutions per minute, which makes them effective for internal grinding.

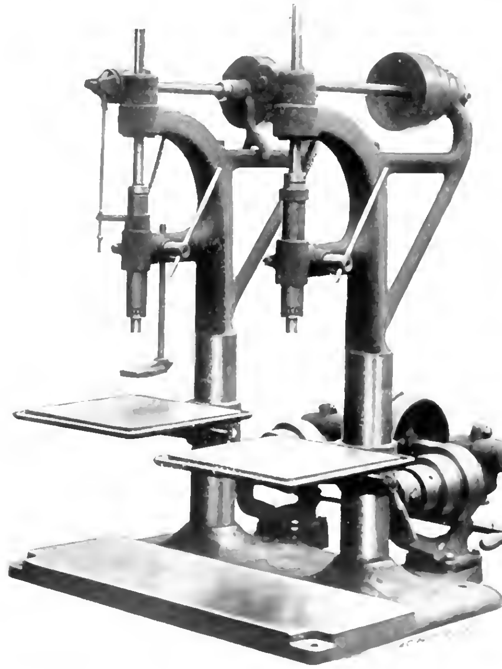
The Standard Electric Tool Co. has also added to its line of universal drills two tools of [illegible] and 1 inch capacity, respectively. These two drills constitute an addition to the seven sizes of the same type of tool which have been on the market for some time. The motors of both the grinders and drills are form wound and impregnated with bakelite which is known to be very effective in preventing short circuits and other trouble incident to the operation of motors at high speed. The motors are air cooled by means of a fan, and are capable of being severely overloaded without damage. The design is simple and rigid, although particular care has been taken to keep the weight down as far as possible. The tools are built on the unit plan so that they are easily taken apart.



Standard Electric Grinder for Use on either Alternating or Direct Current Circuit

PIONEER DUPLEX DRILLING AND TAPPING MACHINE

A 12-inch combination drilling and tapping machine built to meet modern manufacturing requirements has recently been added to the line of the Pioneer Machine Co., Rockford, Ill. The right-hand spindle of this machine is used for drilling and the left-hand spindle for tapping, but the tapping


Pioneer 12-inch Duplex Drilling and Tapping Machine

spindle can also be used for drilling or reaming operations by raising the sliding rod in front of the machine to its highest position and taking off the lower dog on the rod. Referring to the illustration, it will be seen that the front part of the base is planed to form an auxiliary table for use in handling work for which the regular table of the machine is inadequate. The capacity of the machine is for drilling holes up to 1/2 inch in diameter and for tapping holes up to 3/8 inch in diameter.

NEWTON DIE-SINKING MACHINE

The Newton die-sinking machine illustrated in this connection was particularly designed for machining large metal molds, and the control is so flexible that cutters as small as

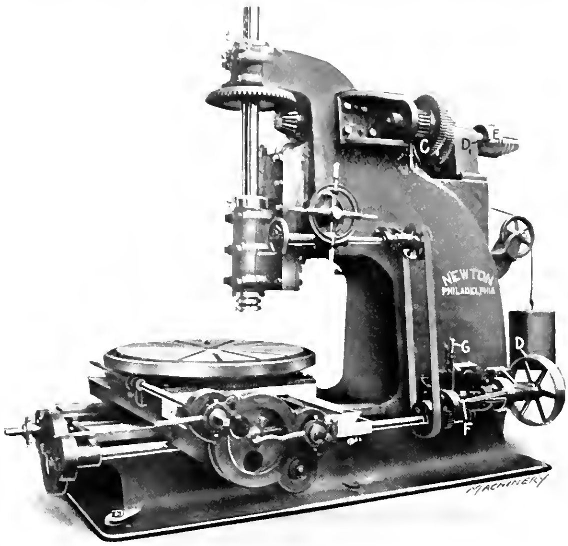


Fig. 1. Operating Side of Newton Die-sinking Machine

1/4 inch in diameter may be used. These cutters are several inches in length and tapered to machine the "drag" in the mold. The machine is driven by an alternating-current

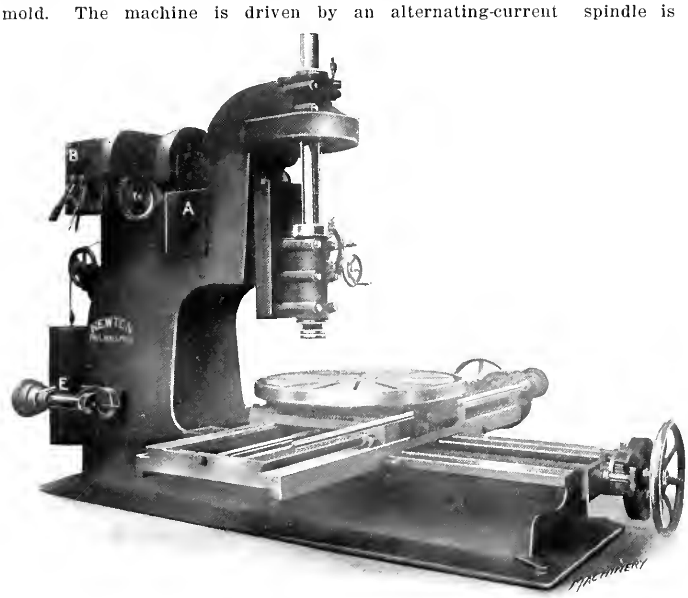


Fig. 2. Left-hand Side of Newton Die-sinking Machine

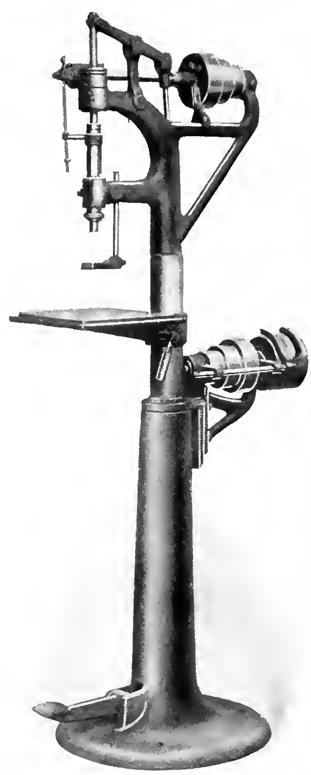
motor, the pad for the motor being shown at *A* in Fig. 2. Changes of speed are provided by gears in the oil-tight case *B*, in which there are eight gears which provide six changes of speed. In addition to these changes, reductions of speed for driving cutters of large diameter are obtained through the back gears shown at *C* in Fig. 1.

Reversing feed and reversing fast power traverse are provided in addition to hand adjustment, and each movement is independently clutched. The motion for the fast power traverse is transmitted from the pulley *D* at the base of the machine in Fig. 1 to the pulley D_1, and the motion for the feed is from the cone pulley *E* to the cone E_1. The lever *F* controls the engagement of the fast power traverse and feed, and the lever *G* controls the direction of traverse and rotation. As the same mechanism provides vertical feed and fast power traverse to the counterweighted spindle saddle, the control is centralized. Movement of the spindle saddle by hand is also available.

This machine was recently built for export, and as it is intended for producing work dimensioned according to the metric system, special indexes were mounted on the feed-screws. In view of the fact that an ordinary die-sinking machine weighs about 6000 pounds, while the present machine has a weight of 30,000 pounds, the accuracy with which it operates is really remarkable. The principal dimensions are as follows: diameter of the spindle, 5 inches; diameter of working surface of table, 48 inches; cross-feed of table, 72 inches; in and out feed, 62 inches; height from center of table to under side of spindle, 22 inches; and distance from center of spindle to face of upright, 38 inches. This machine is a product of the Newton Machine Tool Works, Inc., Philadelphia, Pa.

PIONEER DRILLING AND TAPPING MACHINE

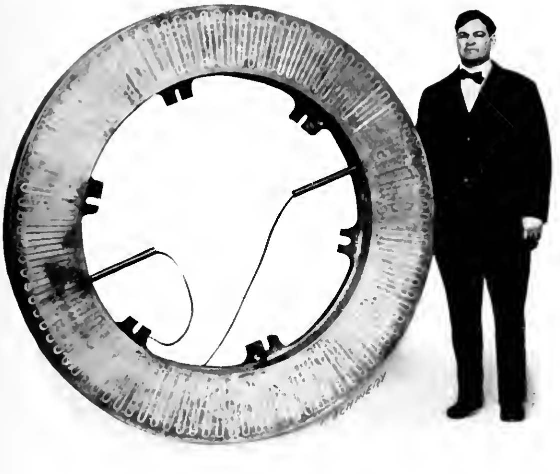
The accompanying illustration shows a 12-inch combination drilling and tapping machine which has been recently brought out by the Pioneer Machine Co., Rockford, Ill. Referring to the illustration, it will be seen that the machine is equipped with a foot treadle for operating the spindle, which leaves both of the operator's hands free to handle the work. The spindle is driven by a pair of spiral gears running in grease and all bearings are equipped with ring oilers. These machines are also built with hand lever feed.



Pioneer Combination Drilling and Tapping Machine

WALKER MAGNETIC CHUCK

O. S. Walker & Co., Worcester, Mass., have just completed what is said to be the largest rotary magnetic chuck ever built. It is 70 inches in diameter (see illustration) and weighs 2400 pounds. It will be seen that the magnetic face of the chuck is ring-shaped; the width of the face is 11 inches and the chuck is $5\frac{1}{2}$ inches thick. It will be used for holding a large quantity of three-inch washers while grinding them and the chuck is designed to be used with water. It will be mounted on a special grinding machine and rotated in a horizontal plane; two grinding wheels will do the facing.



Walker Rotary Magnetic Chuck 70 Inches in Diameter

A general idea of the size of the chuck will be obtained from the illustration. Two hundred and fifty pounds of magnet wire was required for the coils, and there are ninety-six separate poles in the chuck and forty-eight magnetizing coils. As previously stated, the diameter of the chuck is 70 inches; before building this chuck, O. S. Walker & Co. have seldom had a call for rotary chucks larger than from 38 to 44 inches in diameter. The magnetic face of the chuck is very finely divided so that small work may be firmly held on it. The chuck requires 5500 watts to energize it, *i. e.*, 50 amperes at 110 volts. The face of the chuck can be instantly demagnetized by operating a special switch provided for that purpose.

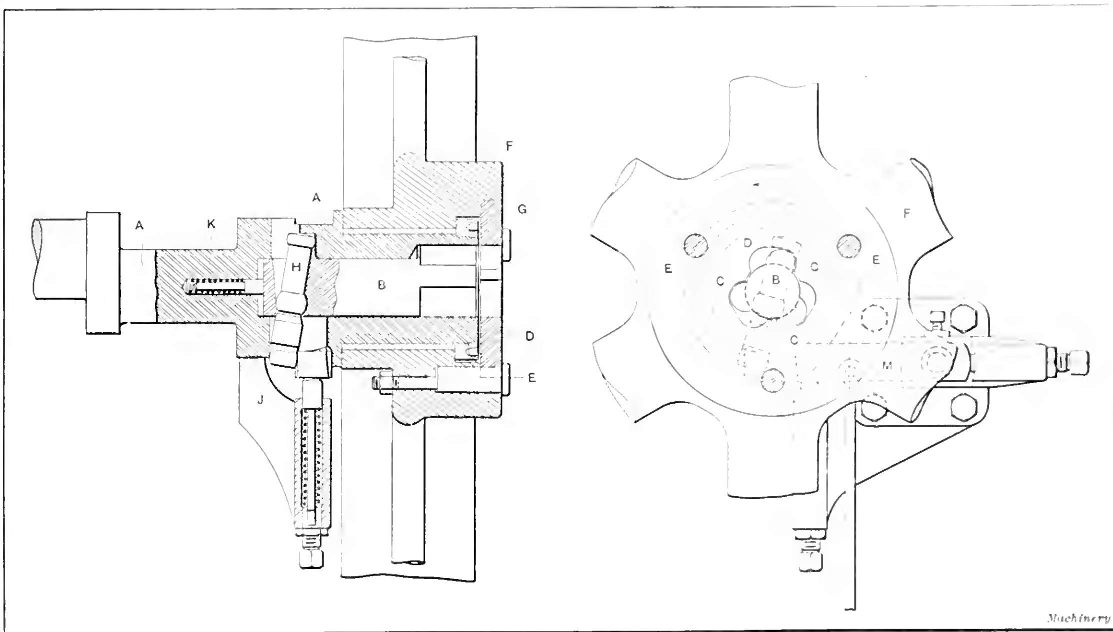
The firm for which this chuck was built intends to feed the work to the chuck through a chute and after grinding the work, it will be swept off while the chuck is rotating.

MAX AMS POWER PRESS CLUTCH

The Max Ams Machine Co., Mount Vernon, N. Y., has brought out a positive type of clutch for use on power presses, and this clutch will be applied on nearly all of the machines built by this company. A cross-sectional and an end view of the clutch are shown, from which the design and method of operation will be readily understood. Referring to this illustration, *A* is an enlargement of the press shaft; *B* is a sliding key or locking pin which has two or more prongs *C* formed on it; and *D* is a hardened plate with an opening in the center which is formed with notches to receive the prongs on the locking pin *B*. Two or more bolts *E* are used to secure the plate *D* to the flywheel *F*. The flywheel runs continuously on the shaft *A* and is held by a nut *G*.

The locking pin *B* is operated by means of the rolling lever *H* and the wedge *J*. The clutch is operated in the usual way. The wedge *J* is connected with the treadle rod and when the treadle is depressed, the spring *K* forces the locking pin *B* into the notched plate *D*, thereby forming connection between the shaft and flywheel. After one revolution of the shaft, the wedge *J* acts upon the lever *H*, withdrawing the locking pin *B* and disconnecting the flywheel from the shaft.

The distinctive features of this clutch are its durability and simplicity. The flywheel is centrally gripped on two or more points, thus avoiding irregular wear in the flywheel bearing. The striking surfaces are as near to the center of the shaft as possible, thereby reducing the velocity to a minimum and avoiding a hard blow; they are of ample size and located at the end of the shaft, where they are easily inspected. The parts subject to wear can be removed quickly and easily without interfering with the flywheel or any other parts. The locking pin *B* can be removed in an instant by simply pushing it against the spring *K* so that the rolling lever *H* can be pushed out sideways, thereby leaving the locking pin free. The steel plate *D* can be removed by simply taking out the bolts *E*; this enables the plate to be



Cross-sectional and End Views of Max Ams Power Press Clutch

reversed when one side has become worn. The wedge *J* is cushioned in order to avoid clicking. It is made with a shoulder which prevents the press from making a second stroke unless the treadle is completely depressed. This wedge is mounted on a separate bracket. Proper oiling devices are provided and a positive stop adjustment can easily be applied, thus making it necessary for the operator to depress the treadle for each stroke of the press.

KOKOMO "HI-SPEED" DRILL

The Kokomo "Hi-speed" drill equipped with power feed and an automatic stop is shown in Figs. 1 and 2, and Fig. 3 shows the same style of machine equipped with hand feed and a friction tapping attachment. It will be seen that these machines are of the sliding head type and they are suitable for driving high-speed drills up to $\frac{3}{4}$ inch and taps up to $\frac{1}{2}$ inch. Removable bronze bushings are provided throughout the machines, which not only insure high efficiency, but also provide perfect alignment and long life. Another advantage of the bronze bushings is that they can be renewed when worn out or damaged without disturbing the alignment of the machine, it being merely necessary to take out the damaged bushing and insert a new one in its place. This can be done with little loss of time.

The tapping attachment shown on the machine in Fig. 3 is easily operated and enables the reverse to be made very quickly. A friction is mounted in the crown gear which gives the forward drive for the tap; and a similar friction mounted in the reverse pulley provides for backing out the tap. A clutch mechanism is located between these frictions,

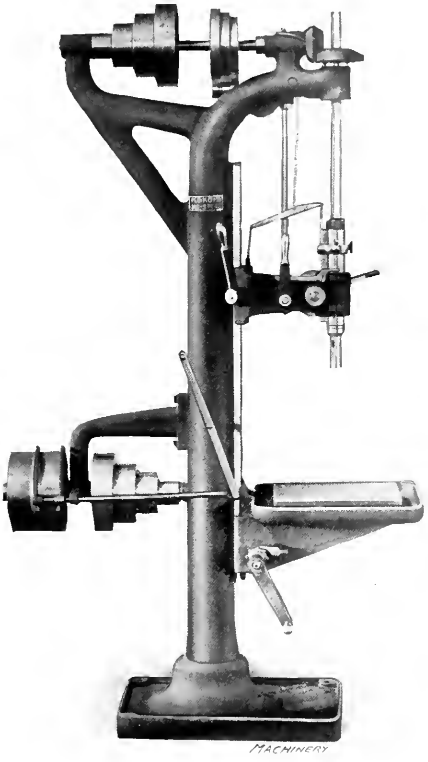


Fig. 1. Kokomo "Hi-speed" Drill equipped with Power Feed

the clutch being operated by a lever by means of which forward or reverse movement of the tap may be obtained, or the lever may be brought to a neutral position to stop the spindle. An important feature of the attachment is that the tap is backed out at practically twice the speed at which it is advanced, thus effecting a material saving of time. A positive clutch is furnished on the horizontal shaft, by means of which the reverse driving mechanism can be disengaged when the tapping attachment is not in use.

The power feed mechanism is of very simple construction. Referring to Fig. 2, it will be seen that power is taken from the horizontal shaft by means of a cone pulley. From the small cone pulley, the power is transmitted through the worm and worm-wheel pivoted on the yoke, thence through the vertical shaft to a second worm and wheel which transmit power to the feed pinion. The lower worm is brought into engagement with the worm-wheel by means of a lever at the left-hand side of the sliding head. This lever,

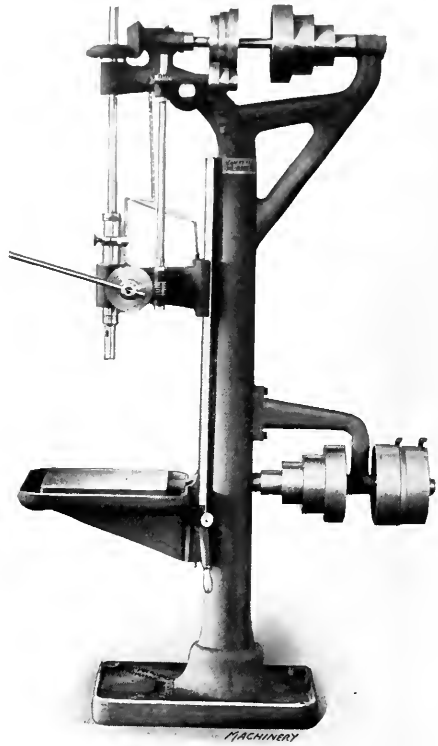


Fig. 2. Opposite Side of Drill shown in Fig. 1

when engaged with the trip finger, applies the power feed to the spindle until the adjustable stop on the sleeve comes into contact with the trip finger, at which time the power feed is automatically disengaged. An auxiliary lever is mounted at the end of the spindle feed shaft, permitting the feed to be operated by this hand lever when the power feed is disengaged or when using the tapping attachment.

The column is of tubular section and is bolted to the base. It is provided with a dovetailed face to which the sliding head and adjustable table are clamped. The column face is accurately planed and scraped into perfect alignment before the column is bored to receive the removable bronze bushings which carry the lower driving shaft, the top shaft and crown driving gear. This method insures perfect alignment of all moving parts. The sliding head is counterbalanced by a weight in the column and it may be clamped to the column face by means of a dovetailed gib. Suitable means of adjustment are provided to take up wear. The table is of the knee type and is raised or lowered by means of a rack and pinion actuated by a lever at the left-hand side of the machine. It is held in any desired position by means of a ratchet and pawl. The working surface of the table is entirely surrounded by an oil channel, and a binder lever clamps it to the column in any desired position.

The spindle is forged from crucible steel and finished by grinding. It is provided with a ball thrust bearing at the lower end of the sleeve and a bronze friction nut and hexagonal jam nut at the upper end of the sleeve. The sleeve is bronze bushed and graduated in inches; it is connected to the spindle feed shaft by means of a steel rack. A substantial depth gage extends entirely around the sleeve

and rack. The power feed will advance the spindle at the rate of 0.0055, 0.0081 and 0.0135 inch per revolution. There are four changes of speed, the available speeds being 110, 235, 460 and 990 revolutions per minute, which give suitable operating speeds for all sizes of drills within the range of the machine. These machines are manufactured by the Superior Machine Tool Co., Kokomo, Ind.

WHITCOMB-BLAISDELL PLANER

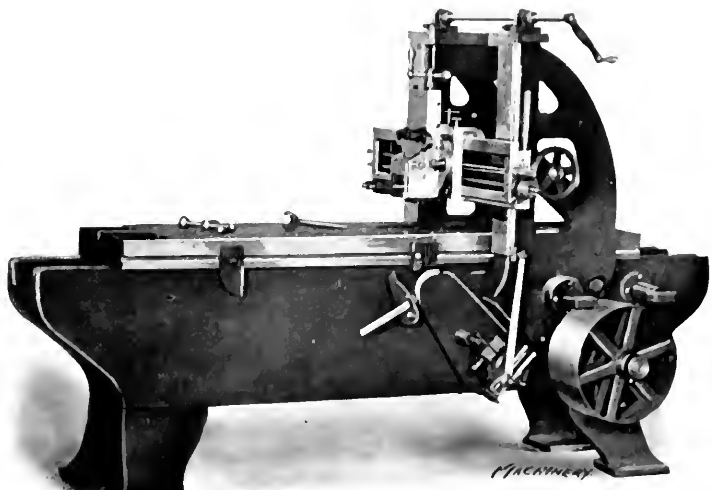
The Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., is now building the 17 by 20 inch planer shown in the accompanying illustration. While nominally a 17 by 20 inch machine, the actual capacity is 21 inches between the housings and 17 inches under the cross-rail. These planers are built with any length of bed from 4 to 10 feet inclusive. This machine replaces the 17 by 17 inch planer formerly manufactured by the Whitcomb-Blaisdell Machine Tool Co. It weighs approximately 1000 pounds more and is a slightly larger machine in every respect, all parts being made from new patterns of increased dimensions. It has been carefully designed to meet the requirements of modern machine shop practice.

The old 17 by 17 inch machine had a spur geared drive while the present machine is equipped with the "second belt drive" as successfully applied to all of the larger sizes of machines built by this company. In addition, an improved type of belt shifter cam has been incorporated in the design which is enclosed in a box on the inside of the bed, where it is thoroughly protected from dirt and chips. The belt eyes are of an improved type and the intermediate pinion and gear in the driving train are of the spiral type. This feature, combined with the second belt drive, does away with the possibility of noise from high-speed spur gears and gives a quiet, smooth running machine.

The machine is equipped with all of the features of the larger sizes of Whitcomb-Blaisdell planers including the cross head fastener; the patented shipper dogs, which are self acting, and may be released by a slight pressure of the finger; and the self-relieving friction box driven by a silent chain, which works with great precision and without drag. An automatic stop for vertical, angular and cross power feeds can be applied, which constitutes a useful feature to have on a machine for tool-room work, as it enables the toolmaker to start the machine working and set the stop, after which no further attention is required.

Particular attention has been paid to the provision of a strong drive, and with this idea in mind, the bearings for the shafts have been made of exceptionally large size. All bearings are self oiling and the ways in the bed are provided with self-oiling rolls. When so desired, individual motor drive may be applied. For this purpose, the motor is either mounted on the housings and belted direct to the driving pulleys; or it is mounted on the floor or on a bracket secured to the bed of the planer and belted to a self-contained countershaft. A two- or three-horsepower motor is required, according to the character of the work and the speed at which it is desired to run the planer. The platen can be run at very high cutting speeds. For example, on bronze work a cutting speed of from 110 to 115 feet per minute is recommended, and operating under these conditions the planer is said to be capable of producing absolutely perfect work. This planer is well adapted for either tool-room or manufacturing work which comes within its range.

Fig. 3. Kokomo Drill equipped with Hand Feed



Whitcomb-Blaisdell 17 by 20-inch Planer

NEW MACHINERY AND TOOLS NOTES

Cleaning Gun: G. H. Dyer Co., 39 Piedmont St., Boston, Mass. A pneumatic cleaning device in the form of a gun which applies a blast of air to the required location. The air blast is controlled by a trigger.

Portable Welding Outfit: Dyer Apparatus Co., 39 Piedmont St., Boston, Mass. A portable welding outfit in which the torch is so arranged that a straight tube may be inserted instead of the bent tube when welding is to be done at the bottom of a hole.

Grinder: Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa. A floor type of dry grinder with an oil reservoir cored out of the head below the spindle. A wick with both ends dipping into the oil keeps the bearings continually lubricated. The bearings are dust-proof.

Oil Cup: Penn Pressed Metal Co., Camden, N. J. An oil cup formed from sheet brass and provided with a cap that has three projecting lugs. Normally the cap is closed through the action of a spring but it is easily opened by bringing the top of the oil-can spout into contact with one of the lugs.

Portable Welding Outfit: Metals Welding Co., Cleveland, Ohio. This outfit consists of the usual pair of tanks for holding the oxygen and acetylene together with suitable connections, flexible tubing and torches. The machine is built primarily for use in garages but is capable of application for use in other shops.

Rail Drilling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A rail drilling machine equipped with four spindles, the fourth being an auxiliary spindle. The three right-hand spindles are employed for the principal drilling operations. The machine is driven by a 10-horsepower Westinghouse motor.

Improved "Kwik-Kut" Machines: E. C. Atkins & Co., Indianapolis, Ind. The "Kwik-Kut" machines of this company's manufacture have recently been improved by the addition of a guide consisting of an upright, through which the blade passes to insure accuracy in cutting. A hydraulic attachment has also been added to regulate the blade pressure.

Lock-nut: Harvey J. Hipple, 121 Charlotte St., Lancaster, Pa. This locking device consists of a wire ring with one end of the ring extended at right angles to its plane. The ring goes between the nut and its seat and the end fits in a groove in the bolt. When the nut is screwed down, this end wire is bent over into the castellations in the nut.

Driving Wheel Lathe: Putnam Machine Co., Fitchburg, Mass. An improved model of the preceding machine of this type. In the new machine the feed is taken directly from the main driving shaft. The tailstock may be operated by an independent motor or from an independent countershaft. The driving shaft is of nickel steel and all gears are of steel.

Eight-spindle Drilling Machine: Edward Board, 619 Filbert St., Philadelphia, Pa. A machine for drilling the mixer ends of gas stove units. This consists of shallow drilling or "spotting." Eight drills 1/8 inch in diameter are used, which are spaced 3/16 inch apart around the arc of a circle. The burner to be drilled is clamped by means of an eccentric binder.

Friction Clutch: Carl G. Westlund Co., Worcester, Mass. A friction clutch made in a variety of sizes. All parts are split so that the clutch may be installed without requiring the shaft to be taken down. The working mechanism is entirely enclosed and all screws and nuts are set flush with the surface. The clutch is designed for both high and low speeds.

Drilling and Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine can be used either as a post drill or horizontally. The maximum length of feed of the spindle is 17 inches and three changes of power feed are provided in addition to hand adjustment of the spindle. The distance from the center of the spindle to the face is 14 inches.

Plate Shear: Long & Allstatter Co., Hamilton, Ohio. A plate shear which has a capacity for plates up to 3/8 inch in thickness and up to 16 feet wide. This machine is provided with the regular type of automatic hold-down for clamping the work which is used on shears built by this company. The slide is provided with an air balance in place of the usual weights.

Blueprint Finishing Machine: Revolute Machine Co., 417 E. 93rd St., New York City. A machine for washing, drying, ironing and finishing blueprints which are either in the form of separate sheets or in a continuous roll. The four essential parts of the machine consist of a washing tank, a wringer, a hot drying and ironing drum and an automatic winding device for long prints.

Open-gap Shear: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A motor-driven machine built for the Pennsylvania railroad for use in the Altoona shops. The machine is intended for shearing 0.40 per cent carbon bars 3 by 12 inches in size. The frame is of steel and the bearing surfaces are bronze bushed. Power is supplied by a 35-horsepower direct-connected motor.

Knuckle Joint Press: Max Ams Machine Co., Mount Vernon, N. Y. A line of embossing and swaging presses made in various sizes. The frames of all machines with a capacity for pressures exceeding 250 tons are reinforced by steel rods. The knuckle joints have adjustable wearing surfaces and hardened steel pins. The range of sizes includes presses with capacities varying from 50 to 1000 tons.

Pipe Fitting Tapping Machine: Pottstown Machine Co., Pottstown, Pa. A single-spindle machine for tapping flanges, single-end fittings and similar parts. The work is held in toggle operated chucks. Ample adjustment is provided on the machine to adapt it for turning out small lots of work quickly. Different sizes are built, the capacity of the largest machine being for fittings up to 12 inches in diameter.

Cutting-off Machine: Matson Machine Co., Concord, N. H. A cutting-off machine which has a capacity for round or square work up to 4½ inches in diameter or thickness. The machine is driven by a worm-gear and is provided with ball thrust bearings at the ends of the driving shaft and feed-screw. The feed is started by engaging a positive clutch which is automatically released. The range of feeds is from 1/8 to 3/8 inch per minute.

Screw Press: Pruyn & Bilodeau, 1876 Broadway, New York City. This machine is intended for use in machine and repair shops. It has columns mounted at each side of the bed which are 15 inches apart and distance pieces 5, 10 and 15 inches in length are provided. This arrangement enables the screw to be brought to any desired position for performing different operations. The table is 26 by 19 inches in size and has an opening in the middle.

Motor Starter: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A high voltage automatic motor starter to provide for starting 1100 and 2200 volt A. C. squirrel cage motors used in industrial plants. The apparatus consists of a frame made of angle iron, upon which the high tension oil immersed solenoid switches, and the relays required to control the motor and auto transformer circuits are mounted. The starting switches are operated by single phase solenoids.

Motor Operated Shear Gage: Long & Allstatter, Hamilton, Ohio. A back gage for use on a shearing machine, which is driven by a 3/4 horsepower electric motor. The gage is provided with a lead-screw near each end for running it forward or away from the shear blade. The movement is controlled by means of a lever at the right-hand side of the machine. After the gage has been run out to an approximate setting, it may be accurately located by means of a handwheel.

Hand Drill and Drill Vise: North Bros. Mfg. Co., Philadelphia, Pa. The drill is provided with an automatic trip for disengaging the feed when the spindle has reached the extreme of its travel. The machines are built in two sizes with capacities for handling drills up to 1/4 and ½ inch in diameter, respectively. The drill vise is 6 inches long by 2 3/4 inches wide by 2 inches high. The jaws are 1 3/8 inch deep and open 3 inches without the swivel jaw or 2 5/8 inches with it.

Balance Indicator: Emery Johnson, Newberg, Oregon. A balance indicator, the operation of which is based on the principle that a perfectly balanced rotating disk which is loosely supported on its axis is free to move in any direction, although its axis may be unsteady. The instrument is momentarily applied to the end of the shaft to be balanced and if this shaft is unbalanced, the spindle of the indicator proceeds in a circuitous path while the disk seeks its own course and revolves steadily.

Pipe Fitting Tapping Machine: Pottstown Machine Co., Pottstown, Pa. A 5-way automatic tapping machine for tapping T's, L's, and Y's, crosses and other fittings of any angle and with side outlet. The tapping heads are carried on a plate which is slotted so that the heads may be adjusted to the required angle. Four spindles are carried in bearings mounted on this plate and a fifth spindle projects through the center of the plate. The spindles are fed in and out by means of interchangeable lead-screws.

Elevating Truck: Cowan Truck Co., Holyoke, Mass. This company has added to its line an elevating transveyor which has a lift of 3 inches and a capacity for handling loads up to 5000 pounds. This transveyor is known as the Type H and has been particularly developed for use in factories where it is required to load work into freight cars. For such service, it has been found that a truck capable of lifting work 1½ or 2 inches is not adequate. The large capacity of the truck enables material to be moved with greatly increased efficiency.

Air Compressors: Sullivan Machinery Co., Chicago, Ill. Two types of a power driven air compressor. The special feature of one of these machines consists of the combination of one horizontal and one vertical cylinder with both pistons driven from one crankpin on a center crank, and both valve gears driven from one crank disk on the end of the shaft. The other unit referred to is a small size single stage compressor. This unit is of the center crank, straight line, single stage type and is belt driven. The design is such that the crankshaft may be taken out and reversed end for end to provide for driving the compressor from either side.

Edging Machine: Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. A machine for edging drawn shells used in the manufacture of products made of pressed and formed steel. The machine takes the shell after it leaves the press, trims the ragged edge, smooths the edge and cuts the shell off to the desired length. The machine is semi-automatic in operation, the shells being fed into the hopper by the operator, after which they are carried automatically to a position directly in line with the chuck. The shells are then pushed into the chuck against a positive stop and the operations performed on them. Machines of this type are made in several styles to meet the requirements of different classes of work.

Horning Press: Cleveland Machine & Mfg. Co., Cleveland, Ohio. In the November, 1913, number of MACHINERY a wiring and horning press built by the Cleveland Machine & Mfg. Co., Cleveland, Ohio, was illustrated and described. This machine has a capacity for closing seams up to 12 inches in length and for wiring work up to 10 inches in diameter. Its weight was 1850 pounds. Since that time a larger machine of the same type has been added to the line of the Cleveland Machine & Mfg. Co. The large machine will close seams up to 20 inches in length and wire work up to 18 inches in diameter. The weight of the machine is 9000 pounds. Both of these machines are equipped with a knee pivoted on the left-hand side of the machine. When it is desired to use the press for horning operations, this knee is swung around out of the way and the horn is set up in a hole in the frame of the press provided for that purpose. In addition to the knee supported on the left-hand side of the press, the large machine is equipped with an auxiliary knee for use in wiring deep cans and similar classes of work. The auxiliary knee is pivoted from the right-hand side of the press, the method of support being the same for both knees.

ROSNER PROCESS OF WELDING HIGH-SPEED STEEL

A process for welding high-speed steel to low carbon steel has been developed by Adolph Rosner, of Bridgeport, Conn. This process enables a small piece of expensive high-speed steel to be fused or welded to a piece of low carbon steel to produce a tool for lathe or planer work, when a high-speed steel cutting edge is necessary. The piece of high-speed steel is not dovetailed or let into the carbon steel shank, but is welded to a flat surface making it one piece with the shank; and the strength of the union is such that the high-speed steel cannot be broken off by the pressure of the heaviest cut. The heat is radiated from the cutting point of a tool built up in this way as readily as in the case of tools which are made entirely of high-speed steel. The Rosner welded tools can be annealed, reshaped, machined over and rehardened as often as necessary. It is also possible to bend and forge such tools to a certain extent without breaking the weld, providing the operation is performed at a high temperature.

The cutting edge of a tool is the only part which need be made of high-speed steel. With ordinary tools, a lot of expensive high-speed steel is wasted in reforging and grinding the tool, but with the Rosner method the shank is made out of steel having from 0.20 to 0.30 per cent of carbon which can be bought for about two cents a pound. The welding is done in a gas furnace at a temperature of over 2000 degrees F.; a special flux is used, and the shank of the tool is cooled in water after completing the welding operation for the purpose of stiffening it. The problem of hardening tools is eliminated in the case of Rosner built-up tools, as the hardening is done at the same time that the welding is performed, but without the use of an air blast. Immediately after hardening, the tools are ready to be ground for use in the lathe or planer.

Die blocks can be made by the Rosner process of welding. For this purpose a thin layer of high-speed steel is welded to the top of the low carbon steel die block. Dies made in this way are much cheaper than those in which expensive steel is used for the entire die, and they do not shrink or crack in hardening. In making such dies, the pieces are machined very close to the desired shape and size before welding; and after the welding operation has been performed, the die will have to be annealed, machined to the required size and then rehardened. There are a great many special cutting tools,

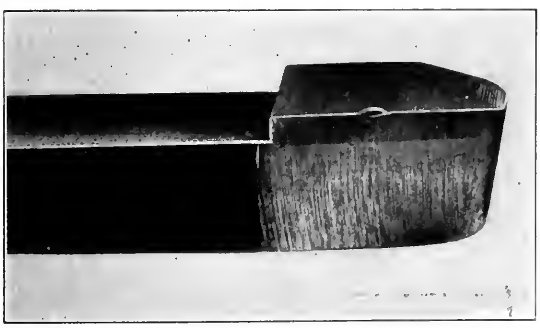


Fig. 1. A Built-up Tool welded by the Rosner Process

such as forming tools, used in machine shops, in which only a small part of the tool can be utilized. This process of welding a high-speed cutter to a shank of cheaper steel lowers the cost of such tools very materially. Cutters for boring bars can be made by welding a piece of high-speed steel to each end of a low carbon steel shank. When the cutter becomes too short through grinding, it may be brought back to the required length by peening the metal in the middle of the shank. The Rosner process has also been successfully applied for making the cutters used on a variety of wood-working machines.

The use of welded, built-up tools means a saving of from 30 to 40 per cent as compared with the cost of solid high-speed steel tools for use in the lathe or planer. The welded tools do not require any reforging and consequently the shop equipment for handling this work is not necessary. When a tool made entirely of high-speed steel has been ground down so that it is too short for further use, it does not pay to draw it out to a smaller section of greater length, because the cost per pound of drawing it out to this section is higher and the quality of the steel considerably lower than that of new metal. The expense of high-speed steel tools has been materially reduced by using tool-holders in which a small piece of high-speed steel is held by means of a set-screw. But these tools are not entirely satisfactory especially for heavy and rapid cutting. It has been found that a small piece of high-speed steel inserted in a holder does not conduct the heat generated in cutting to the shank as well as a solid tool does. The result is that the cutting edge of the small tool does not stand up so well as that of a tool made of one piece of steel.

It is possible to weld high-speed steel to low carbon steel electrically, but this process cannot be applied in making lathe or planer tools. The reason is that in such electrically welded tools, the high-speed steel is full of fine cracks caused by the rapid heating of the metal, and these cracks result in the breaking of the cutter. To give satisfactory results, high-speed steel must be heated slowly. Oxy-acetylene welding cannot be used for the same reason. In addition, these processes do not unite the high-speed and low carbon steels firmly enough to enable a tool made in this way to stand up under the pressure of heavy cuts.

Fig. 2. Test of a Rosner Weld—the Steel broke first

The following outlines the expense involved in reforging and hardening a lathe or planer tool 3/4 by 1½ by 10 inches in size made entirely of high-speed steel. It is estimated that a tool of such dimensions can be reforged and hardened six times, after which the tool will be only 4 inches long—allowing 1 inch for each reforging—and it is then too short to be used satisfactorily. This relation is shown diagrammatically in Fig. 4, where the cutting edge of the tool is marked *A*, the portion of the entire tool actually used *B* and the scrap *C*. The portion of the steel wasted in grinding is marked *D* and the metal cut off in reforging the tool, *E*. It will be evident that the scrap *C* amounts to 40 per cent of the entire tool.

First heating to 1500 degrees F.	4 minutes
Trimming and forging	2 minutes
Second heating	1 minute
Finish-forging	1 minute
Grinding	1 minute
Heating to 2100 degrees F. for hardening	3 minutes
Quenching	1 minute
Time lost in fixing the fire, etc.	2½ minutes
Total time	15½ minutes
Labor	
1 blacksmith	$0.30 per hour
1 blacksmith's helper	0.20 per hour
	$0.50 per hour
	$0.0083 per minute
15½ minutes at $0.0083	$0.1286
General shop expenses 60 per cent	0.0771
Actual cost one reforging and hardening	$0.2057

Good high-speed steel costs from seventy-five cents to $1.50 a pound. An ordinary lathe side tool, 10 inches long, which is made entirely of high-speed steel can be reforged and rehardened about six times, but about 40 per cent of the metal is lost as the tool becomes too short for use. The cost of reforging tools varies with the cross-section. The following tabular matter outlines the cost of reforging the tool six times, together with the cost of the material.

3 pounds of high-speed steel at seventy-five cents	$2.25
Reforging 6 times and rehardening at twenty cents	1.20
Total cost	$3.45
Value of scrap	.08
Net cost of one high-speed lathe tool	$3.37

For comparison with the all high-speed steel tool considered in the preceding discussion, we will consider a Rosner welded tool 10 inches long, which has a piece of high-speed steel $1\frac{1}{2}$ inch long welded to it. It is estimated that five of these built-up tools will do the same work as one all high-speed steel tool of the same length and cross-section. When one Rosner tool is used up, a new one is obtained from the stock-room so that the tool is always of the most efficient length. The low

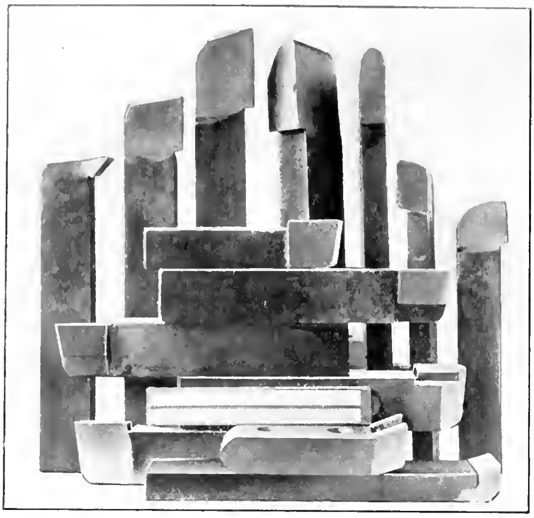


Fig. 3. A Group of Rosner Tools for the Lathe and Planer

carbon steel shank of a worn out Rosner tool may be scrapped or another piece of high-speed steel may be welded to it. On this basis the relative cost of tools of these classes would be as follows:

1 3-pound high-speed steel tool at seventy-five cents per pound and six reforgings $3.37
5 Rosner tools sold for forty cents each.. 2.00

Saving by using welded tools......$1.37 = 41%

By using certain shapes, it is possible to get as much service out of three welded tools as can be obtained from one all

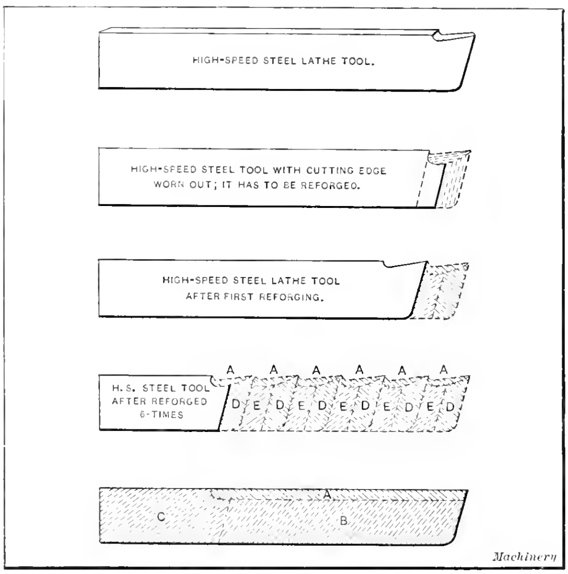


Fig. 4. Diagram showing reduction of a Lathe Tool in reforging and grinding

high-speed steel tool. To do this, the high-speed steel strip welded to the shank of the tool is longer than that ordinarily employed. With such tools, a comparison of efficiency would be as follows:

1 3-pound all high-speed steel tool at seventy-five cents per pound and six reforgings $3.37
3 Rosner tools sold for sixty cents each.. 1.80

Saving by using welded tools.......$1.57 = 47%

As the results of extensive experience in the use of these tools are not available, the comparisons drawn cannot be regarded as iron-clad. They are, however, sufficiently close to give a very fair approximation of the saving made possible through the use of high-speed steel cutters welded to shanks made of less expensive material.

* * *

U. S. COMMISSION ON INDUSTRIAL RELATIONS

The United States Commission on Industrial Relations will hold its first formal public hearing in Washington, April 6, at which collective bargaining, conciliation and arbitration as means of adjusting differences between employer and employe will be considered. Corporation officials and trade union leaders who have negotiated and maintained trade agreements

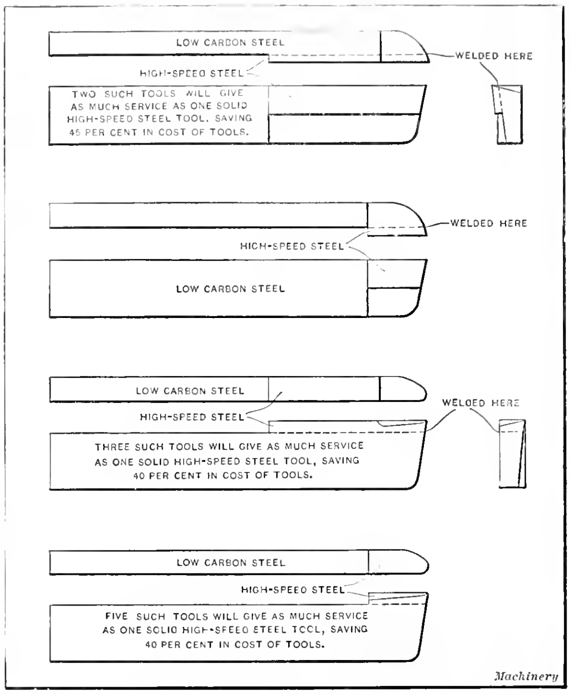


Fig. 5. Rosner Built-up Lathe Tools with Points of Various Lengths

in five of the nation's largest industries will be called to testify. The commission hopes to elicit information that will disclose to what extent improvement in industrial relations might be expected from the general adoption of such agreements in other industries. The hearing will include systematic efforts at peaceable settlement of disputes in the coal mining industry, railroads, clothing and printing trades, the building trades and the molders' trade.

* * *

COLONIAL EXPOSITION IN SEMARANG

A Colonial Exposition will be held in the city of Semarang, Java, Dutch East Indies, in the months of September-November, 1914, to celebrate the centennial of the return of the Dutch East Indies under Dutch rule after political affairs in Europe had been readjusted following the defeat of Napoleon and his banishment to St. Helena. The Dutch East Indies, of which Java, Sumatra, Borneo and Celebes are the principal islands, and which, geographically speaking, form a link between the mainland of Asia and Australia, have a population of over 30,000,000 inhabitants. Further information regarding the Colonial Exposition may be obtained from T. Greidanus, 136 Water St., New York City.

PRESENTATION OF THE E. H. HARRIMAN MEMORIAL MEDALS

The presentation of the E. H. Harriman memorial medals awarded by the American Museum of Safety to the Southern Pacific Co. was made Saturday evening, March 14, in the beautiful studio of A. A. Anderson, 80 West 40th St., New York City. The gold medal was awarded to the Southern Pacific Co., represented by Julius Kruttschnitt, chairman of the executive board, at the annual dinner of the American Museum of Safety, December 12, but the actual presentation of the medals was deferred until the names of the operating official and the employe most deserving of the honor were known. The gold medal is given to the railroad company that has done most for the safety of passengers and employes during the year, a replica in silver to the member of the operating department of the road who has done the most to bring about this condition and a replica in bronze to the employe of the winning road who has been the most conspicuous in the promotion of safety by suggestions or otherwise.

The gold medal was presented to Julius Kruttschnitt by Mrs. E. H. Harriman, assisted by Arthur Williams, president of the American Museum of Safety, who presided; the silver medal was presented to William Sproule, president of the Southern Pacific Co., and the bronze medal to William Schwab, conductor on the Sacramento Division. Mr. Schwab traveled a distance of over 3000 miles across the continent to be present. In acknowledging the receipt of the medal, Mr. Schwab mentioned the encouragement that he had received from the superintendent of the Sacramento Division to make safety suggestions. He cited an example of the suggestions made. Two stations, Fair Oaks Bridge and Fair Oaks Junction, are only two miles apart, and the names are so similar that confusion often resulted and mistakes in reading train orders were made. Mr. Schwab suggested that the name of one of the stations be changed to avoid the confusion, which was immediately done. Mr. Kruttschnitt, in receiving the gold medal, spoke of the great volume of traffic on the Southern Pacific Co., and the team work necessary to conduct such great operations without serious accidents and loss of efficiency. Not one passenger has been killed in the past five years, though 41,783,000 passengers were carried 1,756,482,000 miles. Mr. Sproule, president of the Southern Pacific Co., said that the record was made possible by the loyalty of the men and their general cooperation.

The E. H. Harriman memorial medals are awarded yearly to the railroad that has made the best record for safety of life and limb of passengers and employes. It was especially gratifying to the principals concerned that the first award should go to the Southern Pacific Co., the reorganization of which had been an important part of Mr. Harriman's work.

Mr. Williams announced that the American Museum of Safety has been assigned the awarding of another annual medal, this being the Anthony N. Brady memorial medal for the street railways making the best safety records.

* * *

PERSONALS

Roland Cole of Rochester, N. Y., has joined the Ferro Foundry & Machine Co., Cleveland, Ohio, as advertising manager.

M. P. Fillingham has been appointed district sales manager for Van Dorn & Dutton Co., Cleveland, Ohio, with an office at 50 Church St., New York City.

William Sloane Accles, European manager of the Niles-Bement-Pond Co., sailed from Southampton, England, on the *Olympic* February 18 for a visit to the United States.

Joseph M. Schaeffer, European representative of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., sailed for England on the *Minnetonka* February 28.

Dyer Smith, patent attorney, has removed from the Woolworth Bldg., New York City, to 32 Liberty St., where he is now associated with Samuel O. Edmonds in the practice of patent and trade-mark law.

Harry A. Hey, office manager of the American Society of Mechanical Engineers, New York City, has resigned to become assistant to Henry Souther, vice-president of the Ferro Foundry & Machine Co., Cleveland, Ohio.

George A. Gallinger of Pittsburg, Pa., has been placed in charge of the pneumatic tool department of the Ingersoll-Rand Co., with the title of manager of pneumatic tool sales. His headquarters will be at 11 Broadway, New York City.

Harry E. Harris has taken a position as consulting engineer with the Greenfield Tap & Die Corporation, resigning his former position as superintendent of the Wells Bros. Co., now a division of the Greenfield Tap & Die Corporation.

Charles T. Lamb, for many years assistant treasurer and office manager of the F. E. Reed Co., Worcester, Mass., manufacturer of Reed lathes, and for the past two years office manager of the Reed-Prentice Co., has resigned, to take effect May 1. Mr. Lamb will engage in other business.

Dr. W. M. Leiserson, state superintendent of employment offices in Wisconsin, has been engaged by the United States Commission on Industrial Relations to take charge of its investigations into irregularity of employment and to assist in formulating recommendations for remedial legislation.

Frank A. Mossberg, president of the Frank Mossberg Co., Attleboro, Mass., was re-elected president of the board of trade of Attleboro at the annual meeting, February 18, and was also presented with a loving cup for his energetic and able services in the interests of the association during the past year.

Henry Souther has been elected vice-president and general manager of the Ferro Foundry & Machine Co., Cleveland, Ohio. Mr. Souther is a graduate of the Massachusetts Institute of Technology and for some years was consulting engineer to the Association of Licensed Automobile Manufacturers.

Robert W. Barwood of Philadelphia, an experienced machine tool salesman, has made an agreement with the Carter & Hakes Co., Winsted, Conn., to act as its representative in New England and the territory adjacent to New York and Philadelphia. Mr. Barwood's headquarters will be the Bourse, Philadelphia.

A. J. Borget, formerly of the Chalmers Motor Car Co., Detroit, Mich., has been made district sales manager of the Van Dorn Electric Tool Co., of Cleveland, Ohio, manufacturer of portable electric tools. Mr. Borget's office is at 1013 Mutual Life Bldg., Buffalo, N. Y. He will cover the territory in New York State west of Rochester.

A. B. Hazzard, general manager of the J. Morton Poole Co., Wilmington, Del., for the past six years, has resigned to take a position on the staff of managers of the Detroit Engine Works, Detroit, Mich. The employes of the J. Morton Poole Co. presented Mr. Hazzard with a loving cup February 21, and a farewell dinner was tendered him by his friends at the Hotel DuPont, at which a number of handsome presents were given him as tokens of kindly remembrance.

A. S. Baldwin, for the past three years general manager of the Alberger Pump & Condenser Co., Newburg, N. Y., builder of turbines, condensers, vacuum pumps, Corliss engines, ice machines and all types of centrifugal pumps, has resigned his position. Mr. Baldwin was for four years and a half superintendent of shops for the Driggs Seabury Ordnance Corporation of Sharon, Pa., and previous to that superintendent of the American & British Mfg. Co., of Bridgeport, Conn., for two and one-half years.

* * *

OBITUARIES

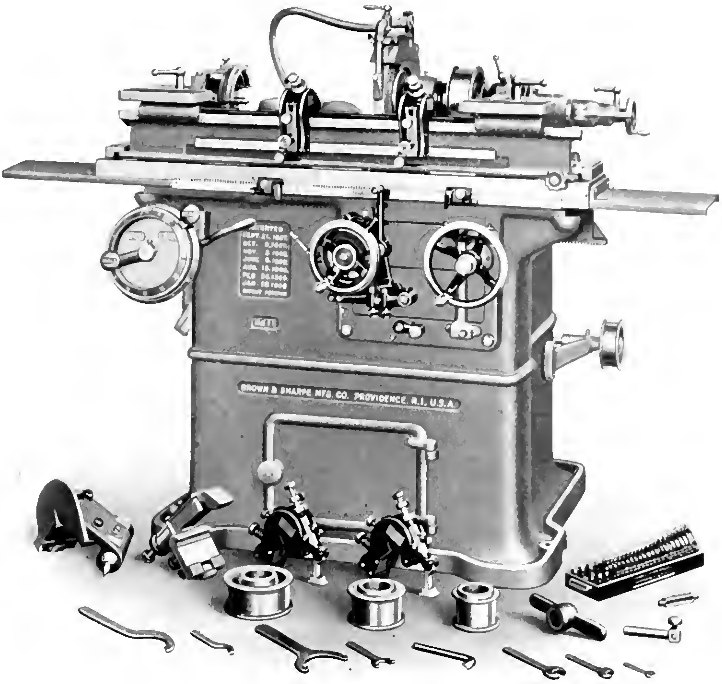
Robert C. Moodey, president of the Cleveland Machine & Mfg. Co., and several other corporations, died in Cleveland, March 15, aged fifty-six years.

Adolph Zuest, vice-president and treasurer of the G. A. Gray Co., of Cincinnati, Ohio, died on February 19 following an attack of pneumonia. Mr. Zuest was fifty-nine years of age and a bachelor. He was born in Cincinnati, and for over twenty-seven years had been connected with the G. A. Gray Co. Mr. Zuest's engaging personality and kindly manner made many friends among those having business relations with that company and in the circle, who regarded him highly. His loss will be greatly felt by his business associates.

GEORGE WESTINGHOUSE

George Westinghouse, the famous inventor and engineer, died of heart disease at his New York City residence March 12, aged sixty-seven years. His health had been failing for some time and consequently his death, though a great shock to his friends and acquaintances all over the country, was nevertheless in a measure anticipated. The mental alertness and wonderful vitality that had so characterized his brilliant career remained with him to the end. Although actively associated with a large number of industries, he had during the last few years begun to transfer his responsibilities to the shoulders of his trusted lieutenants, the fortunate selection of which has always been one of the leading characteristics of his varied career.

Mr. Westinghouse was born at Central Bridge, Scholarie Co., N. Y. His father was an inventor, who, in 1856, removed his family to Schenectady, N. Y., where he established



No. 11 Plain Grinding Machine

The principle of the mechanism of the speed case shown opposite is simple. A series of several tapered friction disks, rotating at constant speed, transmit power to a series of recessed disks. The disks interlock and the point of contact is on the edge of each recessed disk. Thus, as one series is swung toward the other, the part of the disk actually driving decreases in radius and the speed decreases.

There are two of these mechanisms in the case, one for driving the work, the other for the table. Powerful springs serve to hold the disks in contact, the whole furnishing ample power for all work within the machine's capacity.

The No. 11 Plain Grinding Machine in addition to the new speed changing mechanism embodies many other features which make it an easily operated machine for handling the most accurate classes of work in large quantities.

Have you ever investigated our automatic cross feed which can be set to grind to a required diameter and then automatically release? It feeds as fine as one quarter-thousandth for each traverse and is quickly set to remove any desired amount on the diameter.

Then there are the Universal Back Rests which follow the work down to the required diameter with equal pressure to a positive stop. If you are interested in these production points we will send you a circular.

ROVIDENCE, R. I., U. S. A.

Canadian: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfort, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain. The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

Read page 75

the Schenectady Agricultural Works. The boy attended the public and high schools of the town, spending much of his leisure time, after studies, in his father's machine shop. What to other lads would have been regarded as irksome and confining young Westinghouse found to be a source of amusement and instruction. Before he was fifteen he invented and made a rotary engine, and passed at an early age the examination for the position of assistant engineer in the United States Navy. Following honorable military service from 1863 to 1865, he entered Union College, where he remained until the close of his sophomore year, and obedient to his impulse toward experiment, abandoned his classical studies and entered upon active life, to find a wider scope for his inventive genius. In 1865 he invented a device for replacing railroad cars upon the track, which, being of cast steel, was manufactured by the Bessemer Steel Works, at Troy, N. Y. Going to Troy one day, a delay caused by a collision between two freight trains, suggested to Mr. Westinghouse the idea that a brake under the control of an engineer might have prevented the accident. His first thought was an automatic brake attached to the couplers which was unsuccessful. This was followed by steam, which proved also to be unsatisfactory because by the time it reached the brake from the engineer's cab it had lost its power. At this point fate seems to have entered his life. In the pages of a magazine he had subscribed to, through the solicitation of a young girl, he saw an account of the use of compressed air in digging the Mont Cenis Tunnel, three thousand feet under ground. Instantly the inventor saw light. After much further study and investigation, the feasibility of compressed air further impressed itself on him. Drawings of the air-pump, brake cylinder and valves were made, but considerable time elapsed before a practical trial of the brake was obtained. The first patent was issued April 13, 1869, and the Westinghouse Air Brake Co. was formed on July 20 following.

About 1880 Mr. Westinghouse became interested in the operation of railway signals and switches by compressed air, and soon after there was developed and patented the system now manufactured by the Union Switch & Signal Co. The pneumatic interlocking switch and signal apparatus, whereby all the signals and switches are operated from a given point, using compressed air as the motive power and electricity to bring that power into operation, has been successfully introduced in Boston, Jersey City, Philadelphia, Chicago, St. Louis, and many other places. In 1886 the Westinghouse Electric Co. was formed for the manufacture of lamps and electric lighting apparatus, Mr. Westinghouse having become interested in the subject. The business rapidly developed, and in 1889 and 1890 this company absorbed the United States Electric Co. and the Consolidated Electric Light Co. In 1891 all these properties were reorganized into the Westinghouse Electric & Mfg. Co., which owns extensive works at East Pittsburg, employing over 22,000 people.

The question of the steam turbine and its applications was investigated by Mr. Westinghouse and he secured the patent rights of Charles A. Parsons of England on the turbine in 1897-98. This development of a new prime mover soon led the inventor to consider the use of the turbine as a prime mover for ships. The trouble was the high speed. Mr. Westinghouse then developed and brought out one of the most ingenious devices of modern engineering. This was the mechanical reduction gear for reducing the inherently high speed of a turbine to the slow speed of a ship propeller or direct-current dynamo. He accomplished this work in collaboration with the late Rear Admiral George W. Melville, U. S. N., and John H. MacAlpine. Within the last few years he also occupied himself with the development of an air spring for automobiles and motor trucks.

Mr. Westinghouse rendered an invaluable service to the electrical development of the world when, in spite of opposition, ridicule and all the unfair efforts to crush his alternating-current system, he remained steadfast in his belief that this class of high-tension transmission would make distant electrical distribution possible. This system his en-

George Westinghouse

gineers developed, and, incidentally, secured the cooperation of Nicola Tesla, 1887, who invented the alternating-current induction motor. The world today, lighted by distant waterfalls and central stations, now recognizes its debt to Mr. Westinghouse's foresight and perseverance. A struggle almost identical with that of the earlier fight for alternating-current transmission is the recent development of alternating-current traction by means of the single-phase motor which the Westinghouse Electric & Mfg. Co. has now wrought into an accomplished reality in the case of a number of traction lines, railroad terminals and tunnels.

Originating with the air brake, the growth of the various Westinghouse industries has been largely identified with railway progress, and it is interesting to note that this progress has represented increased security of life, increased capacity of the railway and reduced cost of operation. It is simply stating a fact to say that Mr. Westinghouse has been a great factor in the advance of civilization as represented by the important part he has played by introducing improved means of transportation. When the apparatus had passed the experimental state and was ready for commercial exploitation, he established factories which are themselves models, and which show the same anticipation of future development. Not only are the buildings handsome and well equipped with the best tools, but the comfort of the employes has been generally considered. It is worth noting that the nine-hour day, or rather the fifty-four week, was started with the Westinghouse Air Brake Co. in 1869, and has been adopted in all the other works as they were established.

Owing to his many achievements in mechanics, electricity, steam and gas, his name was known the world over, and he had many honorable distinctions conferred upon him for his achievements and in recognition of the services he rendered the various branches of engineering. He was an honorary member of the American Society of Mechanical Engineers, of which body he was also president in 1910. He was one of the two honorary members of the American Society for the Advancement of Science. He received the Edison gold medal for meritorious achievements in the alternating-current system of electrical distribution and the Grashof gold medal from the Society of German Engineers in Germany, which acknowledged him the greatest American engineer.

Mr. Westinghouse was connected with a large number of industries at home and abroad, many of which bore his name. These companies employ 50,000 men, and are capitalized at $200,000,000. He was married in 1867 to Marguerite Franklin Walker. His widow and son George survive him.

COMING EVENTS

April 4-11.—First National Efficiency Exposition and Conference, Grand Central Palace, New York City. Walter H. Tallis, director, Efficiency Society, Inc., 41 Park Row, New York City.

April 18-25.—Better Industrial Relations Exhibit at 2 W. 64th St., New York City. The exhibit will show the devices in modern business which tend to make more harmonious the relations between employer and employe and to better the conditions of employment. C. J. Primm, exhibit manager. Further information can be obtained from J. R. Rankin, 2 W. 64th St., New York City.

April 21-22.—Annual meeting of the National Metal Trades Association, Worcester, Mass. Hotel Bancroft, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

April 23-24.—Semi-annual convention of the National Machine Tool Builders' Association, New York City. Hotel Astor, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

April 29-30.—Annual meeting of the National Association of Cotton Manufacturers, Boston, Mass., in the Paul Revere Hall of the Mechanics Bldg. C. J. H. Woodbury, secretary, 45 Milk St., Boston, Mass.

May 1-October 31.—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

June 10-12.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

June 16-19.—Spring meeting of the American Society of Mechanical Engineers, Minneapolis and St. Paul, Minn. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

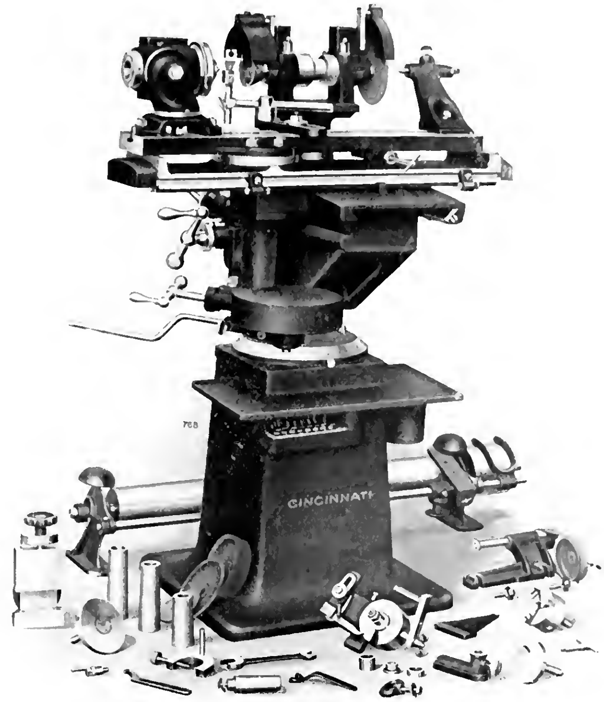
June 30-July 4.—Annual meeting of the American Society for Testing Materials, Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Warburg, secretary, University of Pennsylvania, Philadelphia, Pa.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

The Pentane Lamp as a Working Standard. By E. C. Crittenden and A. H. Taylor. 17 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 216 of the Bureau of Standards, Vol. 10.

CLEARANCE



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Incorrect cutter clearance will reduce the output of your milling machines twenty per cent.

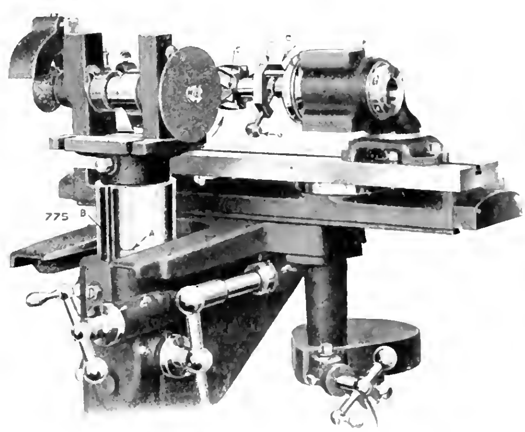
Clearance depends upon certain mathematical relations between the cutter and the grinding wheel.

To obtain these on the ordinary grinder requires several measurements and reference to diagrams, tables or charts.

The average operator doesn't understand these and after a couple of trials grinds until the clearance looks right—and your milling department suffers.

Compare the Cincinnati method. After a simple preliminary setting the swivel head is revolved the desired amount, the clearance angle being read directly from the dial—and your milling department profits.

This is only one of our *exclusive features.*



Method of setting for clearance.

Catalogue tells them all.

Cincinnati Milling Machine Company

CINCINNATI **OHIO, U. S. A.**

Modern Punch and Die Construction. Third revised and enlarged edition. 48 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

The Testing of Barometers. 12 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular 46 of the Bureau of Standards.

Fuel Briquetting Investigations. By C. L. Wright. 277 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 58.

Micrometer Microscopes. By Arthur W. Gray. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 215 of the Bureau of Standards, Vol. 10.

Note on the Setting of a Mercury Surface to a Required Height. By M. H. Stillman. 6 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 214 of the Bureau of Standards, Vol. 10.

Mud-laden Fluid Applied to Well Drilling. By J. A. Pollard and A. G. Heggem. 21 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 66.

Hydraulic Mine Filling with Reference to Its Use in the Pennsylvania Anthracite Fields. By Charles Enzian. 77 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 60.

The Action of Acid Mine Water on the Insulation of Electric Conductors. By H. H. Clark and L. C. Ilsley. 26 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 58.

Accuracy of the Formulas for the Ratio, Regulation and Phase Angle of Transformers. By P. G. Agnew and F. B. Silsbee. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as No. 211 of the Scientific Papers of the Bureau of Standards.

How to Build Up Furnace Efficiency. By Joseph W. Hays. 126 pages, 5 by 7½ inches. Illustrated. Published by the author at Rogers Park, Chicago, Ill. Price, $1.

This book, which is the seventh edition, revised and enlarged, treats of fuel waste, how to find fuel wastes and how to stop them. The treatise is one that can be profitably studied by fuel users in general.

Machine Forging. By Douglas T. Hamilton. 36 pages, 6 by 9 inches. 36 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This book describes the machines and methods used in the forming, welding and upsetting of machine parts by modern forging machinery. Typical machines are shown and a great number of examples of operations are illustrated with line-engravings. Applications to the automobile field and to the engine-building field are especially prominent.

The Mortar-making Qualities of Illinois Sands. By C. C. Wiley. 44 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill., as Bulletin 70.

The bulletin discusses the effects of the characteristics of the sand upon the quality of mortar. The results of a series of tests on thirty-two representative Illinois sands are given in tabular form and are discussed. A classification of different sands is then proposed and specifications for each sand suggested.

Electric Toy Making for Amateurs. 206 pages, 5 by 7 inches. 77 illustrations. Published by Norman W. Henley & Son, New York City. Price, $1.

This work treats of the making of electrical toys, apparatus, motors, dynamos and instruments in general. Its popularity is attested to by the fact that it has passed into the twentieth edition. The work has been revised and several new chapters added, thus bringing it up to date. The contents by chapter heads are Batteries, Permanent Magnets, Electromagnets, Electric Motors, Electric Bells, Miscellaneous Toys, Spark and Induction Coils and Allied Subjects, Hand Power Dynamo, Miscellaneous Receipts and Formulas, etc.

Bevel Gearing. By Ralph E. Flanders. 48 pages, 6 by 9 inches. 38 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is the fourth edition of this popular book, of which 28,000 copies have been published. This edition is practically the same as the third, except that part of the chapter on the strength and durability of bevel gears has been revised. The book contains seven chapters, headed as follows: Bevel Gear Rules and Formulas; Examples of Bevel Gear Calculations; Systems of Tooth Outlines used for Bevel Gearing; Strength and Durability of Bevel Gears; Design of Bevel Gearing; Machines for Cutting Bevel Gear Teeth; and Cutting the Teeth of Bevel Gears.

High-speed and Carbon Tool Steels. 44 pages, 6 by 9 inches. 16 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This treatise is No. 117 of MACHINERY'S Reference Books. It contains a collection of the best articles that have been published on the subject in MACHINERY during the past few years. The first chapter gives specifications for high-speed and carbon tool steel used in the United States navy yards. Chapter II is on the relation of the price of tool steel to manufacturing costs. Chapter III deals with the influence of heat on hardened tool steels with relation to their cutting qualities. Chapter IV is quite a complete review of the development and use of high-speed steel, while Chapter V deals in detail with the hardening and tempering of steel, giving specifications for quenching baths and tempering baths, and showing illustrations of practical designs of tanks for these baths.

Arbors and Work-holding Devices. 18 pages, 6 by 9 inches. 53 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 120 of MACHINERY'S Reference Books and contains a number of chapters dealing with holding devices and appliances used when turning, boring and grinding work of difficult and unusual character. The devices are all illustrated by line engravings showing, in detail, the design and constructional features. Two of the chapters contain the descriptions of the holding devices for first and second operation work recently published in articles in MACHINERY by Albert A. Dowd. One chapter shows devices designed by the Jones & Lamson Machine Co. for holding work in the Fay automatic lathe. These devices, however, are applicable to any engine lathe. This book will be of especial value to all tool designers and to other mechanics who have to devise ways and means for setting up work in lathes and boring mills.

Bolt, Nut and Rivet Forging. By Douglas T. Hamilton. 43 pages, 6 by 9 inches. 44 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This book contains the articles on bolt, nut and rivet forging machinery, methods and operations which have appeared in MACHINERY during the past year. The book is divided into three chapters, the first of which deals with bolt heading machines of a general type, describing the main features of their construction and operation; the second chapter deals with continuous-motion bolt and rivet headers, and the third with nut-forging machines. Tables of standard proportions of forged bolts and nuts are included. The book deals with a subject on which little has been published, and will, therefore, be of interest as a record of the present state of this branch of the forging art; it should appeal both to those directly interested in this field and to mechanics in general, who wish to keep informed on the progress of their trade as a whole.

The Manufacture of Steel Balls. By Robert H. Grant. 48 pages, 6 by 9 inches. 40 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Little has been published on the manufacture of steel balls, no complete review of the process of manufacture ever having been attempted. In fact, no treatise on this subject has been published except a number of articles by Mr. Grant, which appeared two years ago in MACHINERY. These articles have been collected in the book under review and present a complete description of the manufacture of steel balls, including a historical review; the book begins with the various methods employed for making the blanks, rough-grinding, hardening and finish-grinding the balls, concluding with a chapter on the inspecting, gaging and testing of balls. Being the only treatise on this subject published, it will, no doubt, appeal to mechanical men in general, who are interested in the somewhat unique processes employed in this specialized manufacture.

Experimental Mensuration. By H. Stanley Redgrove. 328 pages, 4¾ by 7¼ inches. Illustrated. Published by D. Van Nostrand Co., New York City. Price, $1.25.

The author presents the science of geometry by the inductive rather than by the deductive system. He holds that the argument in favor of the old style geometry as providing for a training of the faculty of deduction must be given up. The distinction between geometry and mensuration is held to be artificial; while it is true that no experiments can establish absolutely that the sum of three angles of a triangle is equal to two right angles, practical methods, using the most accurate instruments that can be made, show that the three angles of a triangle are as nearly equal to two right angles as human beings ever require. This is sufficient for the present state of development. The work contains fourteen chapters and three appendices as follows: Geometrical Fundamentals—Measurement of Length; Measurement and Properties of Angles; Rectangles and Parallels—Measurement of Area; The Construction of Properties of Triangles; The Areas of Parallelograms and Triangles; Construction and Mensuration of Polygons; Mensuration of the Circle and Ellipse; Some Geometrical Properties of the Circle; Mensuration of Prisms and Cylinders — Measurement of Volume; The Theorem of Pythagoras and Its Applications; Proportion—Drawing to Scale; Mensuration of Pyramids and Other Solids; Mensuration of Irregular Figures; The Trigonometrical Solution of Triangles; Duodecimals; Trigonometrical Tables; Answers to the Numerical Exercises. The numerical exercises interspersed throughout the work offer the student many examples to be worked out. The book lends itself to home study as well as regular school work. The typographical make-up is excellent.

NEW CATALOGUES AND CIRCULARS

A. W. Cadman Mfg. Co., Pittsburg, Pa. Catalogue and price list No. 5 of valves and other specialties.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 150 on Chicago pneumatic coal drills.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Bulletin on the automatic motor control as applied to LeBlond motor-driven lathes.

Volcano Torch & Mfg. Co., Erie, Pa. Circular of the "Volcano" gasoline blow-torch which generates the pressure required to operate it.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Price list of portable ozonators for house and general use.

Lagonda Mfg. Co., Springfield, Ohio. Catalogue of Lagonda automatic cut-off valves, showing installations in manufacturing plants, power stations, hospitals, railroad stations, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Booklet of the N. T. C. regrinding globe valves, containing a catechism designed to show the advantages of this make of valve.

Perfection Spring Co., Cleveland, Ohio. Short treatise on physics and chemistry with reference to the care of automobiles and the manufacture of springs as conducted by the company.

Stow Mfg. Co., Binghamton, N. Y. Bulletins of Stow ½-inch electric breast drill, electric bench grinder, electric toolpost grinder and "Gee Whiz" radial flexible boring machine for wood-working.

Dyer Smith, 32 Liberty St., New York City. Reprint of an address entitled, "Patents—Some Essential Facts for the Engineer," presented before the students of Lehigh University, January 9, 1914.

Grant Engineering Co., Free Press Bldg., Detroit, Mich. Booklet on "Pioneers," being an appreciation of John James Grant by Elbert Hubbard. The many friends of Mr. Grant will read this short account of his life and works with interest.

Oster Mfg. Co., 2107 E. 61st St., Cleveland, Ohio. Circular of the new Oster cutting-off and reaming machine for pipes and tubes, having a maximum capacity for ¼-inch to 2-inch pipe inclusive, and a minimum capacity for ¼-inch pipe.

Ronald Trist & Co., Ltd., 4 Lloyds Ave., London, England. Circular of the thermo-feed differential governor for steam boilers. The apparatus will keep the water level at the same height within one-eighth inch, its operation being entirely automatic.

Argentine Social Museum, Buenos Aires, Argentine. Pamphlet giving part of the statutes of the Argentine Social Museum, treating of the object, methods of action, lectures, library, monthly bulletin, members and adherents, international relations, permanent exposition, etc.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City. Catalogue No. 329 of electric fans for 1914, comprising both direct current and alternating current desk and bracket fans, oscillating fans, residence fans, ceiling fans and exhaust fans.

Jackson Machine Tool Co., Jackson, Mich. Circular of the No. 6 duplex die sinker, designed for cutting drop-forge dies or metal core boxes. It has a longitudinal feed of 40 inches, cross feed of 13 inches and vertical feed of 21½ inches. The net weight of the machine is 4700 pounds.

Wheelock Mfg. Co., Wheelock, Vt. Circular of flexible metallic tubing made wholly of steel wire with no packing. This tubing is recommended for use on automatic screw machines, gear-cutters, milling machines, and other machines using oil or other lubricant on the cutting tool.

Windsor Machine Co., Windsor Vt. Catalogue of the Gridley automatic multiple spindle drill designed for rapidly drilling parts which are difficult to handle in the ordinary manner. Details of the machine are shown and examples of drilled work for which it is especially suited.

Hammacher, Schlemmer & Co., 4th Ave and 13th St., New York City. Catalogue of casters for machine shops and factories and all purposes, containing thirty-eight 9 by 12 inch pages and 190 illustrations. The catalogue shows twenty-four distinct lines of casters, including a full line of truck casters.

General Electric Co., Schenectady, N. Y. Bulletins A 4200, 44590, 45600, 45601 and 47400 on strain insulators and strain clamps, type ML governor for motor-driven air compressors, vacuum tube lightning arresters, artificial lightning arresters for alternating current circuits and Type F form K 12 oil switches, respectively.

Coates Clipper Mfg. Co., Worcester, Mass. Bulletin 24 on Coates "Flexishaft," showing applications of this type of flexible transmission shaft to drilling, polishing, grinding, erasing, setting screws, etc. The bulletin is profusely illustrated and shows many interesting applications of Coates tools and devices in manufacturing, repair and jobbing work.

Allen-Bradley Co., 495-497 Clinton St., Milwaukee, Wis. Bulletin B-541 on Type H resistance starting switch for alternating current induction motors which is claimed to give the motor absolute protection from running single phase should only one fuse blow or if for any other reason one line becomes interrupted, and to give positive no-voltage protection in all phases.

Detroit Tool Co., Detroit, Mich. Catalogue of a semi-automatic four-spindle drilling machine, in which the drill spindles are cam-operated, thus insuring positive feed. The claims made for the machine are: saving of time, drills, floor space and belt troubles. The catalogue shows a number of examples of automobile work advantageously drilled on this type of machine.

Mummert-Dixon Co., Hanover, Pa. Catalogue of oilstone grinders for fine edge tools. Several sizes and types of machines for grinding the knives of wood-working machines are shown and an oilstone

face and tool grinder for machine shops. This is a two-purpose machine, designed for sharpening scrapers, lathe tools, planer tools, etc., and for face grinding and all kinds of vise work.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Circular of the Blanchard high-power vertical surface grinder, listing work being done on Blanchard grinders in customers' shops. The numbered paragraphs describe the work and give production figures, limits, etc. The circular will be found of suggestive value to manufacturers having work that can be finished on this type of machine tools.

Standard Gage Steel Co., Beaver Falls, Pa. Catalogue and price list of turned and cold-drawn steel shafting; cold-drawn screw stock; finished flats, squares, rounds, hexagons, angles, channels and special shapes; compressed steel elevator guides; connecting rods; crankshafts; finished machine keys; Woodruff keys; taper pins; machine racks; feed screws; lead screws and worms; automatic machine work and drop-forgings.

Richardson-Phenix Co., Milwaukee, Wis. Bulletin 57 of the Phenix sight-flow indicator, illustrating and describing a device which can be inserted in any pipe line carrying a liquid, such as the water lines of jacket-cooled transformers and the supply pipes of gas engines and air compressors. The device shows at a glance or indicates electrically by lighting a lamp or ringing a bell when the flow of liquid is interrupted.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Data sheets showing mountings of Hess-Bright ball bearings for vertical armature shaft of electric motors, release fork for automobile clutch, front and rear truck hubs, marine propeller shafts, shafts without shoulders to support radial loads and opposed thrusts, double exhaust fan and wheel hubs. Tables of dimensions of annular radial bearings and thrust bearings are included.

Acme Machine Tool Co., Cincinnati, Ohio. Bulletins of the "Acme" combination flat turret lathes, single pulley drive, 3¼ by 36 inches capacity and 2¼ by 26 inches capacity; Cincinnati "Acme" screw machine from ⅝ by 4 inches capacity to 2¼ by 11 inches capacity in seven sizes; Cincinnati "Acme" turret lathes in 14-, 16- and 18-inch and 20-inch sizes. The bulletins illustrate details of construction of headstocks, roller feeds, turret toolholders, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin 15 containing a set of specifications for pipe used for drilling purposes; an illustration showing samples of "National" pipe after torsional tests have been made ranging from 180,000 to 215,000 inch-pounds; also illustrations and tables showing weights and dimensions of "National" drill pipe, "National" special rotary pipe, "National" special upset rotary pipe and "National" seamless interior upset drill pipe.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Catalogue 40, containing 128 pages 8¾ inches by 11 inches. The first fifteen pages show the home office, factory and branch office facilities. In the following pages hydraulic presses and pumps for all high pressure purposes are illustrated and described. Various designs of hydraulic presses and pumps recently described and illustrated in MACHINERY are shown which convey an idea of the scope of the field covered by the company.

Niles-Bement-Pond Co., 111 Broadway, New York City. Circular of Niles new design boring and turning mills of 44 inches, 53 inches, 62 inches and 73 inches table capacity. These machines are furnished with direct-current motor drive, push-button control and automatic brake for table, with alternating-current motor drive or belt drive through a single pulley. Independent motors located on the top brace of the mill are provided for adjusting the cross-rail and providing rapid power traverse to the bars and saddles.

Garvin Machine Co., Spring and Varick Sts., New York City. New 1914 catalogue containing 322 pages, 4 by 6¼ inches. This catalogue illustrates and describes the complete line manufactured by this company and contains a number of tables of value to mechanics, draftsmen, etc. Among the machines described are milling machines, profilers, cam cutters, die slotters, screw slotters, tapping machines, duplex horizontal drills, screw machines, monitor lathes, grinders, and various classes of special machinery.

Lees-Bradner Co., Cleveland, Ohio. Catalogue of Lees-Bradner thread milling machines made in four sizes, all having the same diameter capacity but varying in length. The machines are primarily designed for milling screws such as worms, lead-screws, feed-screws, rear axle worm drives and steering worms for automobiles, etc. Spiral gears and spur gears can also be cut on the machines. The catalogue is a handsome publication 8½ by 11 inches, illustrated with fine halftones. Three diagrams are shown to designate the various parts by name.

Bill Deezy Co., 141 Milk St., Boston, Mass. Catalogue of construction material for toy making, model making, etc. The principal parts are a four-arm flexible joint and coppered steel rods. With these parts a great variety of forms can be constructed by modifying the flexible joint. This is trimmed, bent or twisted as required. Inventors, model-makers, engineers and others can sometimes, no doubt, utilize these construction materials, especially as wheels are also furnished which enable the constructor to make working models.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular No. 205, being a pocket daily reminder of the Garvin products. It illustrates the line of Garvin milling machines, including knee-type, vertical spindle type and Lincoln type milling machines, cam or form milling machines, duplex milling machines, profile milling machines, die slotting machines, screw slotting machines, etc. Grinding machines, hole grinding machines, right angle drilling machines, automatic tapping machines, and automatic oil grooving machines are also shown.

Keystone-Hindley Gear Co., 701 Pennsylvania Bldg., Philadelphia, Pa. Catalogue of Keystone-Hindley worm gears. The lists are accompanied with diagrams and the gears and worms are numbered so that customers can order any combination desired within the range of the lists by giving the number and the hand of the helix. For example, gear No. 2013 is 16 to 1 ratio; 10.18 pitch diameter of wheel; 1 circular pitch; 32 teeth. The pitch diameter of the worm is 4.57 inches; lead, 2 inches; number of threads, 2; distance from center to center, 6.625 inches; either right or left hand.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins 1037 and 1038, superseding Bulletins 1035 and 1036 on Type B limit stops for direct-current motors and Form H dynamic braking Dinkey controllers for direct current motors, respectively; also reprints of article, "Application of Electric Power in the Foundry," illustrating and describing the application and use of electric controllers on cranes, sand mills, sprue cutters, tumbling barrels, cupola blowers, pipe core machines, roller-ramming molding machines and grinders. The use of lifting magnets in foundries for handling castings is illustrated with a number of striking views.

Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Data book 125 on "Silent Chain" drives, which will be welcomed by the mechanical public. For the first time a book has been published by a manufacturing concern which will enable users of power to select the correct silent chain drives for their work and to determine the exact costs from list prices shown in the book. Besides giving engineering information in simple and compact form, this data book describes many uses of silent chain for the efficient transmission of power and shows illustrations of a large variety of applications. It contains 112 pages bound in flexible red covers. Copies can be obtained free of charge by addressing the Link-Belt Co.

New York Belting & Packing Co., 91-93 Chambers St., New York City. General catalogue of mechanical rubber goods. Rubber belting for all purposes is listed and rules for calculating the horsepower of belts and directions for the use and care of rubber belts are included. Rubber hose, armored hose, steam and air hose, suction hose, etc., are listed, the various types being illustrated. Packings in great variety, diaphragms, hot water valves, washers, perforated mats, rubber tubing, hat bags, rubber stoppers, hammer cushions, rubber tiling, are a few of the specialties also included. The catalogue is a fine example of typographical excellence, illustrations, printing and paper being high grade. The illustrations of rubber tiling are beautifully printed in colors.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin 11-B on the history, characteristics and advantages of "National" pipe, containing eighteen chapters, as follows: 1. A Short History of Pipe and Early Methods of Manufacturing. 2. First American Pipe Furnaces. 3. History of National Tube Company. 4. Materials for Pipe. 5. The First Steel Pipe. 6. Pipe Threading. 7. Spellerizing "National" Pipe. 8. Full Standard Weight Pipe only Manufactured. 9. The Continuous Uniformity of "National" Pipe. 10. Physical Properties. 11. Bursting Pressure. 12. The Inspections and Tests of "National" Pipe. 13. Changes in the Tubular Industry (1888 to 1913). 14. "National" Pipe for Refrigeration Systems. 15. Corrosion of Pipe in Hot Water Systems. 16. The Design of Hot Water Supply Systems to Minimize Corrosion. 17. Corrosion of Pipe in Coal Mines. 18. Remarkable Ductility of "National" Pipe.

TRADE NOTES

Keuffel & Esser Co., Hoboken, N. J., announces that the price of Smith's fountain drawing pens which were described in the July, 1913, number of MACHINERY has been reduced from $7 to $5.

Monarch Machine Co., Sidney, Ohio, manufacturer of engine lathes, is putting up an office building; also an addition to its plant 90 by 150 feet. The company reports a rapidly increasing business.

Interstate Machinery Co., Troy, N. Y., recently erected a large addition to its plant. The company buys and sells used iron- and wood-working machinery and is also a jobber in new machinery.

C & C Electric & Mfg. Co., Garwood, N. J., announces that the Indianapolis territory will be temporarily taken care of by its Cincinnati representative, F. A. Saylor, 6th and Vine Sts., Cincinnati, Ohio.

National Tube Co., Frick Bldg., Pittsburg, Pa., because of certain articles published in the technical press in regard to wrought-iron pipe, makes the statement that it has not made wrought-iron pipe for some years.

Carpenter Steel Co., Reading, Pa., has appointed James W. Sederquist district sales agent for Boston and Eastern New England with offices at 131 State St., Boston, Mass. Mr. Sederquist will be assisted by William T. Dunn.

Hill Clutch Co., Cleveland, Ohio, manufacturer of power transmission machinery, announces the appointment of P. W. Alling as Eastern representative in charge of the company's New York office at the Hudson Terminal, 50 Church St., New York City.

Index Office, Inc., 31 W. Lake St., Chicago, Ill., has been incorporated for indexing, compiling and abstracting literary and statistical material for the use of manufacturers, scientists and investigators. Aksel G. S. Josephson, secretary. The annual membership fee is $5.

D. H. Stoll Co., Inc., Buffalo, N. Y., manufacturer of presses, shears, dies and other sheet-metal working machinery, has recently arranged for the construction of a three-story addition to its plant. The building will be 40 feet wide by 118 feet long and will be constructed of brick and steel.

Allen-Bradley Co., 495-497 Clinton St., Milwaukee, Wis., announces that its Chicago representative, Frank L. Gohl, has moved from his old headquarters at 540 Commercial National Bank Bldg. to 307 Webster Bldg., 327 La Salle St., Chicago, Ill. The change was necessitated by an increase in business, the old offices proving too small to accommodate the same.

Carter & Hakes Co., Sterling Place, Winsted, Conn., manufacturer of Lincoln milling machines and special machinery, has made Robert W. Barwood of Philadelphia, Pa., a well and favorably known machine tool salesman, its representative in New England and the territory adjacent to New York and Philadelphia. Mr. Barwood's headquarters will be at the Bourse, Philadelphia.

Lapointe Machine Tool Co., Hudson, Mass. Walter F. Rice, Joseph F. Owens, and their associates have taken over the common stock formerly owned by J. Keyes Hall and Joseph N. Lapointe. The officers of the company are Walter F. Rice, president; Joseph F. Owens, treasurer; and William P. Everts, secretary. The new management will put on additional men at once in order to make better deliveries.

Acklin Stamping Co., Toledo, Ohio, reports an unusually bright outlook for business during the coming year. A few days ago the company entered its order No. 1000. When it is remembered that the company began business about two and one-half years ago and that many orders for stampings are from 500,000 to 2,000,000 pieces, it can be readily seen how much business is represented by one thousand orders.

Tate-Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., installed the new heat-treating department of the Ingersoll-Rand Co.'s plant at Phillipsburg, N. J. The plant handles a large output of drills and compressors and the furnace equipment consists of two large double chamber annealing furnaces, two semi-muffle furnaces for pre-heating, six lead and two solution baths for hardening and three oil baths for tempering. All the furnaces are fired with fuel oil.

Dodge Mfg. Co., Mishawaka, Ind., has purchased the gear patterns, gear machinery and powder machinery patterns of the I. & E. Greenwald Co., Cincinnati, Ohio, together with all records, drawings and the good will of the business. Most of the patterns and all the records are now in Mishawaka. The addition of the gear patterns to the already extensive list of Dodge gears gives the company the most complete line and widest list of gears in the United States.

H. W. Johns-Manville Co. has removed its Indianapolis, Ind., and Louisville, Ky., branches to larger quarters with better facilities for handling increased business. The new address of the Indianapolis branch is 408-410 N. Capitol Ave., and that of the Louisville branch, 659-661 So. Fourth Ave. Both branches will include ample warehouse accommodations in addition to showrooms for the display and sale of the company's line of asbestos roofing, pipe coverings, insulating materials, lighting fixtures, automobile accessories, etc.

L. S. Starrett Co., Athol, Mass., has accepted the invitation of the Rice Leaders of the World Association to join its organization. This association will be limited to fifty manufacturers from all lines, and the invitation is extended only to the recognized leaders in the various kinds of manufacturing. Competitors in any line cannot be members. The association which was founded by Elwood E. Rice, president, has for its principles honor, quality, strength and service, and an emblem which signifies these principles will be worn by salesmen and other representatives of the members of the association.

Ingersoll-Rand Co., 11 Broadway, New York City, has placed George A. Gallinger, of Pittsburg, in charge of its pneumatic tool department with the title of manager of pneumatic tool sales, headquarters at 11 Broadway. The company felt warranted in establishing this special department and in placing at the head of it a man who understands the business from a mechanical as well as a commercial standpoint. Mr. Gallinger's time and service are at the disposal of those contemplating the use of pneumatic tools and his long experience and practical knowledge commend him to the consideration of the trade in general.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, states that the new South Works of the J. I. Case Threshing Machine Works at Racine, Wis., is roofed with asbestos and Trinidad Lake asphalt, two of the most enduring mineral substances known. Asbestos is an indestructible fibrous rock, and for roofing purposes it is made into a felt, layers of which are cemented together with asphalt. This roofing is not affected by changes of temperature. The hottest weather does not cause it to dry out, melt or run, and the coldest weather does not crack it. A booklet describing the roofing in detail will be sent to anyone interested.

Cleveland Twist Drill Co., Cleveland, Ohio, has begun the publication of a monthly house organ called "Drill Chips" edited by Andrew E. Coburn,

MACHINERY

MAY, 1914

MODERN EQUIPMENT FOR INDUSTRIAL PLANTS

A COLLECTION OF METAL EQUIPMENTS THAT ARE DURABLE AND FIREPROOF

BY HARRY C. SPILLMAN

THE design and selection of factory equipment, such as partitions, bins, racks, etc., seldom receive the proper attention. Often a wood partition is installed which has to be removed in a few months; likewise, a bin or rack becomes obsolete in a short time, and whenever a condition like this occurs the material is broken up and usually ends in a bon-fire. Few manufacturing plants realize the vast loss which occurs in this way, and, in reality, it is one of the serious wastes in a plant. Going concerns are compelled to make changes almost continuously, and as a large amount of this equipment is built in their own shops by millwrights and carpenters, they do not appreciate the enormous cost involved. Often the foremen of a plant are allowed to order the necessary equipment for their departments, and they do not appreciate its cost. One large manufacturing concern discovered the folly of this plan and appointed a committee which had to pass and sanction the building and purchasing of all new equipment. Modern factories are usually housed in fireproof buildings but the value of fireproof equipment is often overlooked. Most industrial plants have very few firewalls, and in case a fire starts in a large room containing a quantity of wooden equipment, which, as a rule, is more or less saturated with oil, it is almost certain to spread very rapidly and the fireproof construction of the building will have very little effect in checking it.

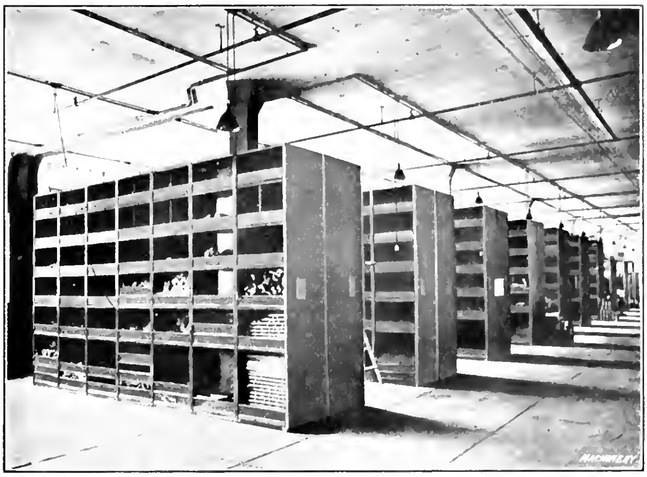


Fig. 1. Arrangement of Metal Stock Bins made up in Sections

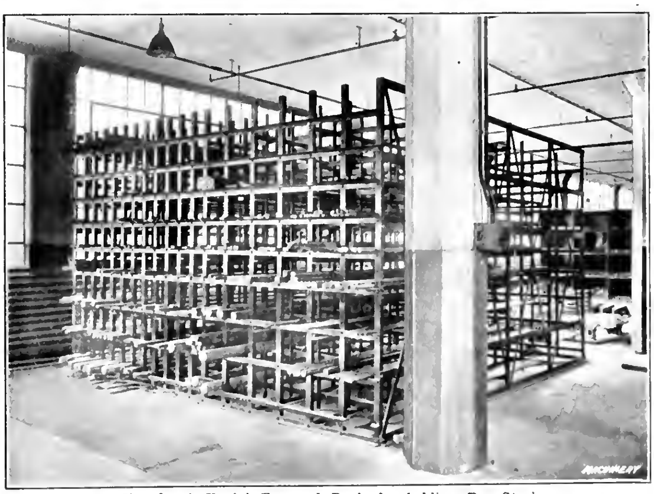


Fig. 2. A Useful Form of Rack for holding Bar Stock

The illustrations in this article show some of the devices which can be made out of metal at a cost that compares favorably with wood. Fig. 1 shows metal bins made up in sections which allows any size or combination of shelves. It is a unit system of construction by which the sections are made to form a concrete whole. These bins are designed to carry a load of 400 pounds per square foot of shelf with a large factor of safety. The sections are bolted together which allows them to be easily altered or taken down and stored away when not required. Considering the slight difference in the first cost of metal and the great advantage of being fireproof, sanitary, adjustable and made up in sections, it is more than good policy to give preference to metal bins. An inexpensive bar rack is shown in Fig. 2. This bar rack is made out of 2 by 2 by ¼ inch angle irons bolted together. Flat bars 2 by ¼ inch in size are bolted along the sides and placed diagonally in order to add to its strength and rigidity. A bar rack is subject to a large amount of abuse, and at times it must support an enormous load. This rack will meet these requirements and it is self supporting and can be easily made and erected.

The problem of taking care of workmen's clothes can only be solved by using individual lockers. Nothing is more unsightly in a work-room than the street clothes of the work-men scattered along the walls and work-benches. Fig. 3 shows a locker room containing metal lockers which are well adapted for shop use. These are set up in solid groups and each group contains a number of lockers which costs less than having each compartment built as a separate unit. Each locker is 36 inches high, 12 inches wide and 15 inches in depth, and they are made up in double tiers. They are supported on legs 6 inches high which gives sufficient space to sweep underneath. Each compartment contains a hat shelf and five two-prong steel hooks. The doors are made of ¾-inch, diamond-mesh, 15-gage expanded metal which gives good ventilation and shows at a glance the contents. Each locker is numbered and has a master keyed flat key lock fitted with a three-way locking device. The compact and sanitary features, protection against fire and security against petty theft make these lockers particularly suitable for industrial plants. The use of pipe for railings, belt guards and skeleton racks is another valuable feature to adopt for industrial plants. Fig. 4 shows an excellent method for supporting time clocks on a skeleton rack. They are rigidly supported on 1¼-inch steel pipe securely anchored to the floor and ceiling. A pipe railing is installed beside each clock in order that the workmen will form in line and only one man at a time can reach the clock. As a rule time clocks receive

* Address: 1537 Second Ave., Detroit, Mich.

Fig. 3. Sanitary Metal Lockers for holding Workmen's Street Clothes

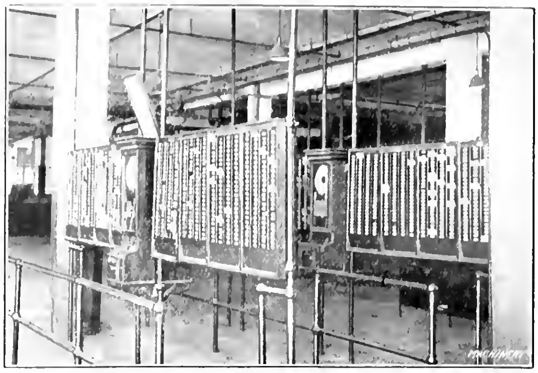


Fig. 4. Time Clocks supported by Pipe Racks and Rails to keep Men in Line

very rough treatment and are easily thrown out of adjustment. A framework of this kind is rigid and also makes a neat and attractive support for the clocks.

Wooden partitions are a fire menace and according to insurance reports they supply excellent fuel to a fire. Metal partitions are far more attractive; they have a larger percentage of glass area, and if made up in standard width sections, it is an easy matter to remove them to some other location. Unfortunately, wooden partitions cannot be moved without practically wrecking the material. A partition which is self supporting and made up in unit sections is shown in Fig. 5. This style of partition has recently been placed upon the market and its many advantages are shown in the illustration. Fig. 6 shows a very inexpensive metal partition which can be built at almost the same cost as a wooden one. This style of partition is made up in sections 4 feet wide, and a 4 by 1/4 inch stiffening bar is placed between each section, which adds to its stiffness. The framework of the panel is made up of 1-inch angle irons having a metal panel 4 feet high for the lower portion. This panel is made out of No. 10 gage steel and riveted to the angle iron frame. The upper space of the panels is divided into sections for supporting the glass. Either 1/8 inch ribbed or double strength American glass is used. The glass is bedded in metal putty and wooden pegs are used instead of glazing points; the glass is also back puttied which holds it rigidly in place. The doors are made of the same material, using 1 by 1/8-inch angle iron for the framework and 1-inch channels for the door stops. The glass in the doors is held in place with metal strips instead of putty. This illustration also shows a watchman's and fire alarm box located on the column. Near the ceiling is an autocall bell and on the floor is shown an inexpensive shop cuspidor made out of pressed steel. The wiring is encased in steel conduit, and although the building is fireproof a sprinkler system is installed. Equipment of this kind is an excellent means for keeping the insurance rate down to a minimum, and it shows the results which can be accomplished by giving the subject the proper study.

Fig 7 gives an excellent example of wire partitions worked out on the unit basis. These partitions are made up in sections 4 feet wide and have a metal panel below. The framework is 1-inch channel iron and the woven wire is No. 10 gage, having a 1-inch mesh. The corners of these partitions and all door openings are reinforced with a 2-inch steel pipe securely anchored to the floor and ceiling. This gives the partition more strength and protects the corners and openings in an effective manner. The design of work-benches should have careful attention, as most plants have considerable bench work. A work-bench poorly installed continually demands repairing. Fig. 8 shows a work-bench with a 3- by 12-inch maple plank along the front and the remainder of the top covered with maple flooring having a 2-inch face. A 1- by 6-inch timber along the back supports the maple flooring and also allows the legs to be placed from 8 to 10 feet apart, instead of the usual 6-foot spacing. The metal legs are provided with two cross braces for supporting shelves underneath the bench. A strip of wood is placed along the back and ends to keep small parts from rolling off. The woodwork is given a coat of shellac which adds to its appearance and preserves the wood. The bench drawer shown in this illustration is made out of heavy metal and is equipped with trays divided into compartments. The drawers have separate change keys which are master keyed with the lockers. The price of these bench drawers ran slightly lower than the same size made out of wood, which shows that metal equipment compares favorably with wood. The design will be fully understood by referring to Fig. 9.

Fig. 10 shows a Dormant scale which is built into the floor. The scale has an indicating dial and tare beam which makes a quick and effective method for weighing material in a receiving room. The scale is made entirely out of metal except the central portion of the platform; this is made flush with the floor, which is convenient for weighing material carried on trucks. Metal channel irons and I-beams bolted to the ceiling and trusses for supporting hangers and shafting is a far better method than using wood stringers. The power transmission equipment does not get out of alignment from the shrinkage of the stringers and there is less danger of the bolts and nuts becoming loose and doing considerable damage.

The introduction of a factory fence made of metal is fast

Fig. 5. Metal and Glass Partitions made up in Unit Sections

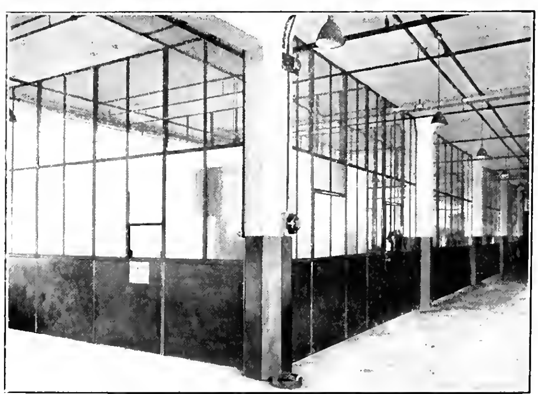


Fig. 6. An Inexpensive Form of Metal and Glass Partition

Fig. 7. A Good Example of Wire Partitions built on the Unit Plan

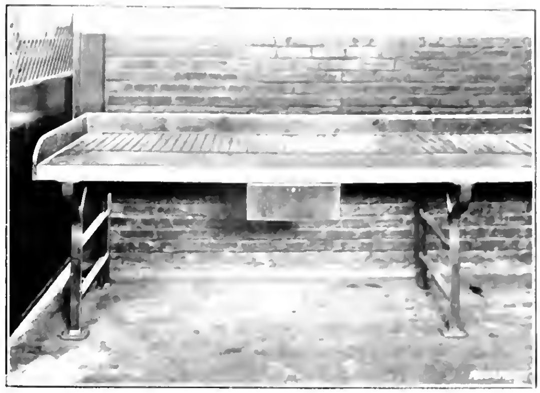


Fig. 8. A Substantial Form of Work-bench

causing the disappearance of the wooden fence which continually demands repairs. Fig. 11 shows a non-climbable fence which will stand up under rough abuse. The posts are spaced eight feet apart and imbedded in concrete. They are made out of 2-inch galvanized pipe and a 3/4-inch pipe ties the top of the posts together. A close woven wire mesh made out of No. 9 gage galvanized wire is stretched between the posts and the fence is made unclimbable by means of five strings of heavy barbed wire along the top. An industrial plant enclosed with a fence of this type is made far more attractive than one enclosed with tight boards. By careful planning and giving metal the preference, the equipment of a plant can be made completely fireproof. It will possess the greatest possible strength and stability and have the combined qualities of adjustability and adaptation for the many uses and changes necessary for the equipment of a going concern.

* * *

ALUMINUM CHEAPENING

The housewife who steps into the hardware store to price an aluminum kettle or saucepan and pays handsomely for it without complaining because the kettle is worth it in convenience and durability, perhaps does not always realize that aluminum is no longer the rare, expensive metal it was portrayed to be not many years ago. She does not know that aluminum is now quoted on the open market at 19 cents a pound, with copper at 14½ cents and tin at 38½ cents. Furthermore, the price figures of 19 and 14½ cents for aluminum and copper are misleading, since, because aluminum is only three-tenths as heavy as copper, for most purposes only three-tenths as much by weight of the metal is needed. The metal for a vat weighing ten pounds made of copper ought to cost $1.45; the aluminum for a vat of the same size would weigh three pounds and ought to cost 57 cents. The use of aluminum in the industries is still in its early stages, and the manufacturing cost is still excessive, but we may shortly expect lower prices.

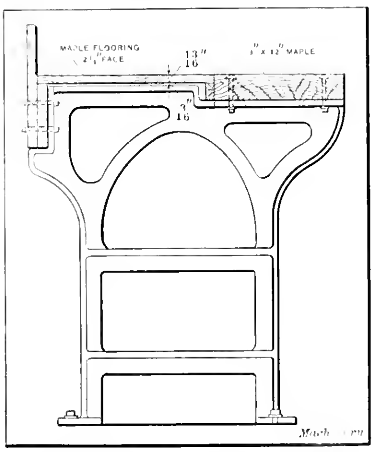


Fig. 9. End View of Bench shown in Fig. 8

It is no doubt the prevailing opinion that iron is the most abundant of all metals. As a matter of fact, of all the seventy odd elements which make up the earth, only two are more abundant than aluminum—namely, oxygen and silicon—and these are not metals. Besides, it is of common occurrence, being a principal ingredient of the ordinary clay that the farmer turns up every time he lets the points of his plow down into the subsoil. This clay contains sometimes as much as 25 per cent of aluminum in chemical combination with silicon. However, as yet no process has been devised by which it can be recovered cheaply from common clay. The metal now on the market is reduced from the mineral bauxite, which is found in Georgia, Alabama and Arkansas in this country, in County Antrim in Ireland, and in the north of France. The process for its reduction was developed in the years from 1886 to 1889 by C. M. Hall in this country and P. T. L. Heroult in France. The pure oxide of aluminum is heated to melting by an electric current and separated electrolytically while in this condition from the oxygen.

Weight for weight, aluminum is stronger than any other metal except the best cast steel and some of its own alloys. Therefore it is coming into considerable use in boat building and other kinds of construction where lightness is an object. As a conductor of electricity, an aluminum wire 0.126 inch diameter carries the same current as a copper wire 0.100 inch diameter and weighs only 69 pounds per mile, while the copper weighs 162 pounds per mile.—*Michigan College of Mines Bulletin.*

Fig. 10. Dormant Scale built Flush with the Floor to facilitate weighing

Fig. 11. "Non-climbable" Factory Fence made entirely of Metal

OIL SEPARATOR EQUIPMENT OF THE NEW PROCESS GEAR CORPORATION

The New Process Gear Corporation, Syracuse, N. Y., manufactures gears, automobile differentials, transmission gears, etc., and in the various machining operations performed produces about two tons of oil-soaked chips daily. The oil is removed from the chips in the separator room shown in Figs. 1 and 2. The apparatus used includes a steam turbine driven separator made by the Oil & Waste Saving Co. of Philadelphia, Pa., a machine simple in construction, consisting of a vertical shaft carrying a bucket wheel and a basket in which the chips are deposited. Steam for driving the wheel is admitted through a nozzle from which it impinges on the bucket wheel and drives it and the separator basket at high speed. The use of steam for driving a centrifugal separator directly eliminates the belt troubles incident to belt-driven separators and it also provides heat for warming the chips, thus facilitating the separation of the oil.

Fig. 1. Steam Turbine Oil Separator used in New Process Gear Corporation Plant

Fig. 2. Steam Turbine-driven Oil-drying, Filtering and Sterilizing Machine

The separator baskets are filled with chips shoveled from the chip bin in the corner and are then transported to the separator by the overhead trolley and pneumatic hoist. They are lowered into the separator and a heavy cast-iron cover mounted on a vertical spindle is swung into place when the basket is in position. Thus, all heavy lifting by the attendants is avoided.

The operation of starting the machine and separating the oil from a basket of chips requires but a few minutes. The separated oil runs through a pipe into a sump and from the sump it is lifted to a tank shown in Fig. 2 with a geared pump driven by a small electric motor. This tank acts as a settling place where the fine chips and dirt are partially removed. From the tank the oil is directed into a centrifugal oil drying and sterilizing machine made by the same concern that manufactures the steam turbine separator. The function of this machine is to evaporate the water contained in the oil and to subject the oil to a temperature that will sterilize it and thus reduce the danger of blood poisoning of screw machine operators to a minimum. It also filters the oil.

A cross-section of the machine is shown in Fig. 3. It consists of a cast-iron case in which is mounted a vertical spindle carrying the steam turbine bucket wheel and the separator basket. The oil flows into this separator and is hurled by centrifugal force through the filtering medium lining it. The oil flies from the outside of the basket against the steam coils which are filled with high temperature steam. Then being in a finely divided condition, it is instantly raised to a high temperature and the water is evaporated, escaping as steam through the holes in the top. The dry and sterilized oil flows from the machine into another sump, from which it is raised by a hand pump shown at the right in Fig. 2, and drawn into cans for distribution throughout the plant. Two men are employed in the separator room. They handle about three tons of oil-soaked chips daily, from which about 200 gallons of oil is extracted. The oil, being free from water and in a practically sterile condition, is an efficient and safe lubricant.

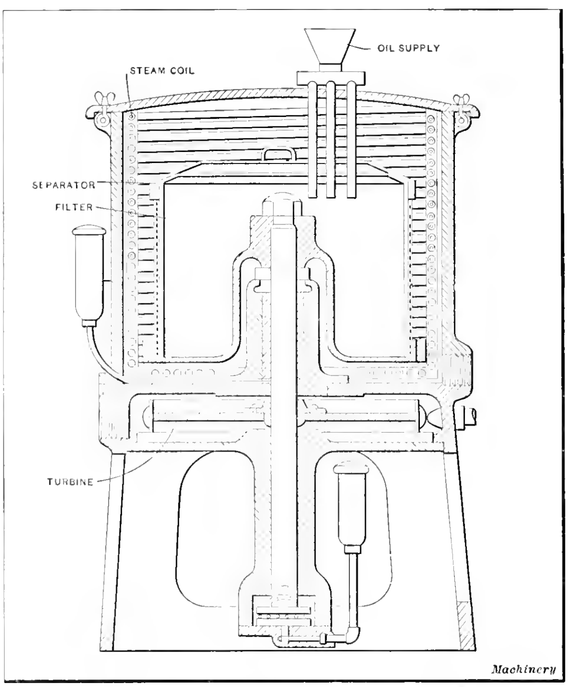


Fig. 3. Vertical Section through Oil-drying, Filtering and Sterilizing Machine

* * *

An invention has been made by a citizen of Reichenberg, Bohemia, for producing a substitute for all classes of marble, including the most highly priced Italian marble. It is claimed that the artificial product is fully as strong or stronger than the genuine article, that it is less liable to cracks or surface damage, and that especially in working, drilling, or mounting work upon it, the danger of injury to it is less than with the real marble, although it is only one-third the price. Factories for producing this product are already in operation in Vienna, Berlin, Mannheim and Hamburg, and arrangements have been made for selling the British patent rights to a London company.

THE CLEVELAND AUTOMATIC SCREW MACHINE—2

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON*

THE turret end of the Cleveland automatic screw machine incorporates a number of interesting mechanical movements and features of design that are well worth attention. Among these are the details used for indexing and locking the turret, the methods of rotating, and the means employed for regulating the feed of the tools. These various details will be taken up in the order of their relation, as regards position, to the turret drum.

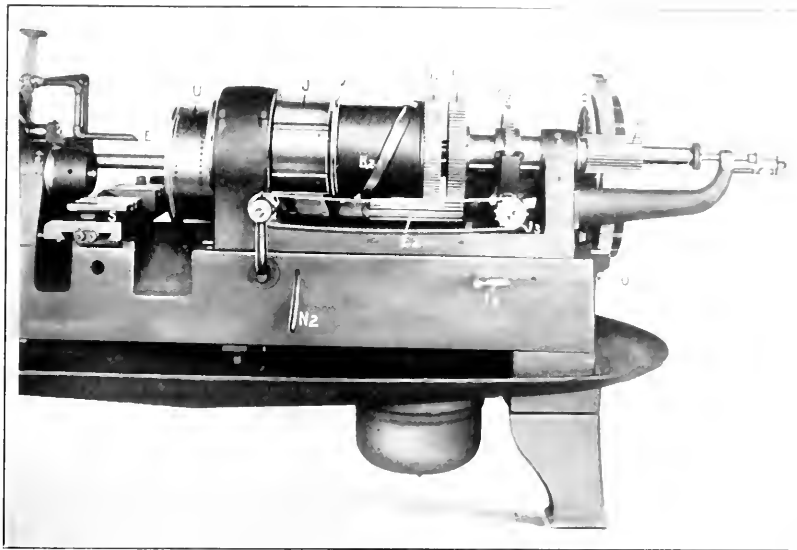


Fig. 11. Turret End of 3¼-inch Cleveland Automatic Screw Machine

Turret and Turret Slide

The turret J, as shown in Figs. 11, 13 and 14, is of the drum type and is carried on a shaft A_2, parallel with the axis of the work-spindle. The turret on the 3¼-inch machine accommodates six tools, which are held by two clamping bolts each, in the holes in the front end of the turret, and are located concentrically with the axis of the work-spindle. The turret J is driven forward and backward by a cam drum K which is free to rotate on shaft A_2 and carries segment cams B_2 fastened to its periphery. These cams work against the roll C_2 which is held on a stud driven into a hole in the base of the machine, and owing to its positive relation to the axis of the tools in the turret gives a very rigid drive; that is, the angle made by the position of the roll in relation to the axis of the tools is very slight, obviating any cramping of the turret and giving almost a straight-line drive to the turret tools. Cast integral with a drum K is a spur gear D_2 which rotates it. Gear D_2 receives power from the pinion E_2 beneath it that acts as a "continuous" key. Pinion E_2, in turn, is rotated by gear F_2 keyed to the same sleeve as that on which the worm-wheel G_2 is held. The method of driving the worm-wheel at different speeds—for the cutting and idle movements of the machine—will be described later.

* Associate Editor of MACHINERY.

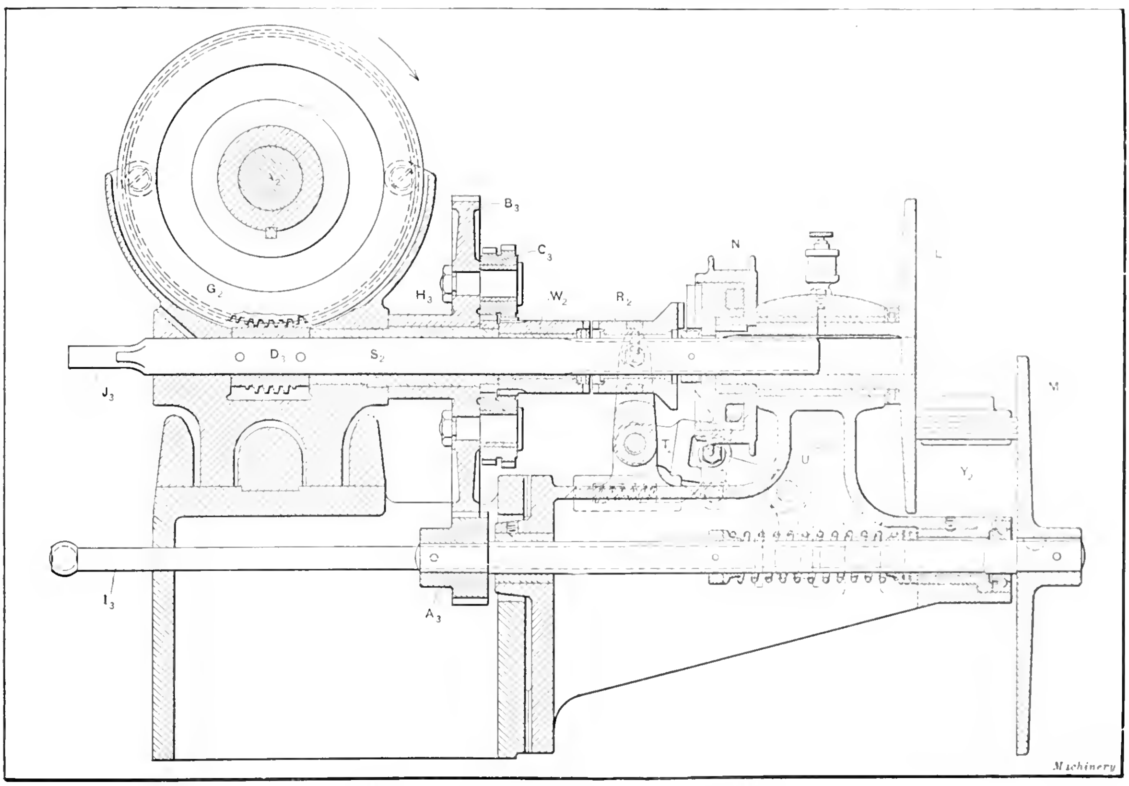
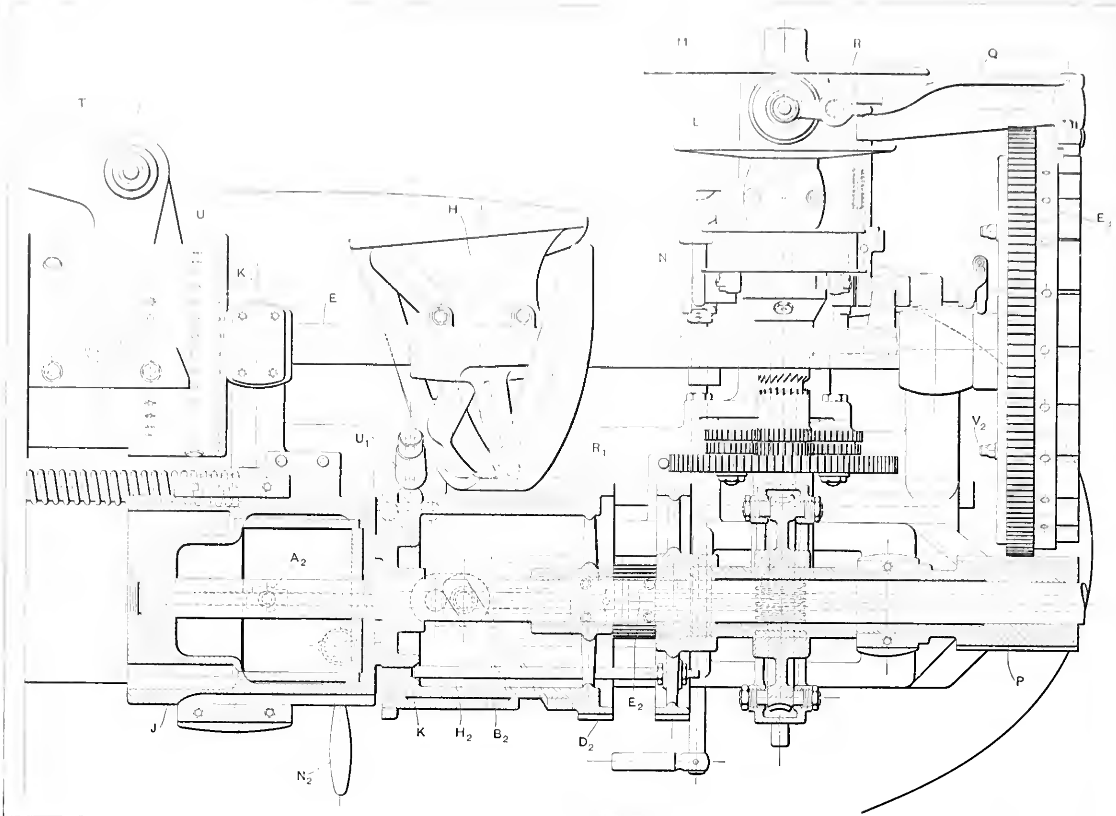


Fig. 12. Sectional View showing Feed driving Mechanism



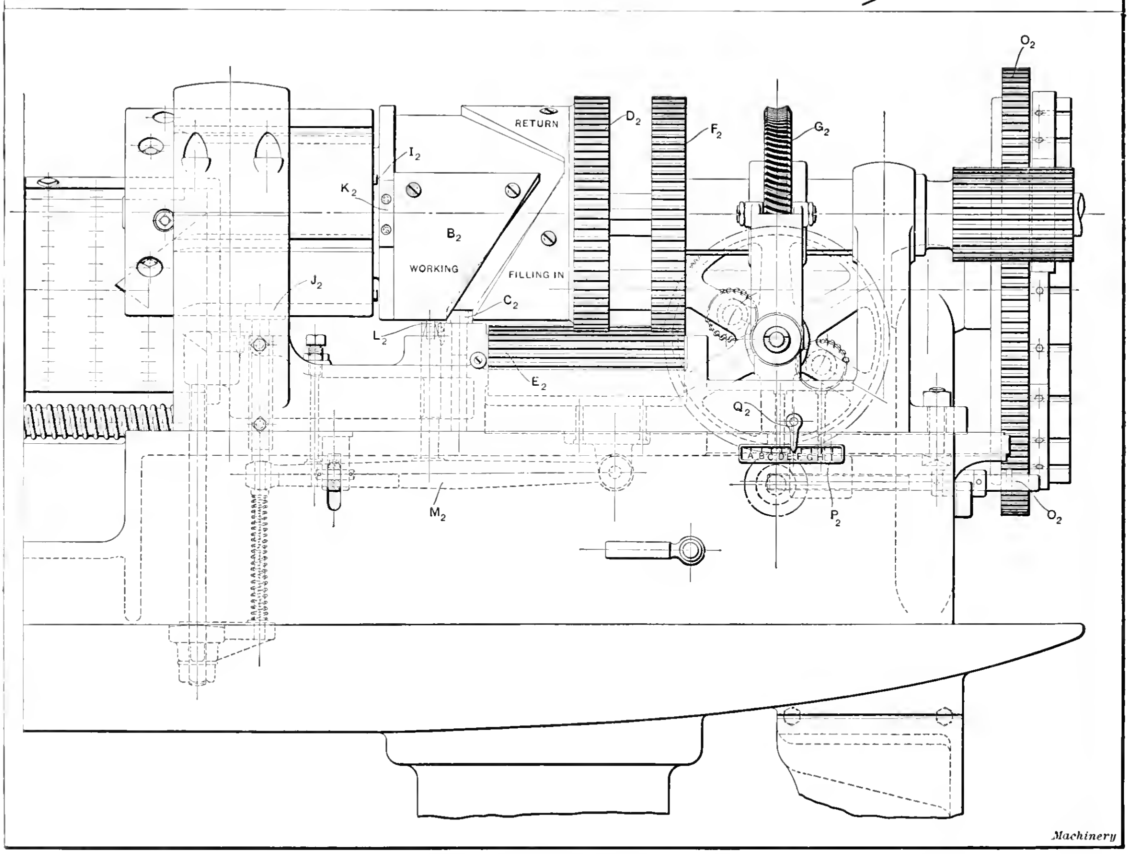


Fig. 13. Sectional Plan View of Turret End of Cleveland Automatic, showing Construction of Turret, Regulating Drum and Auxiliary Mechanism. Fig. 14. Front Elevation of Turret End of Cleveland Automatic

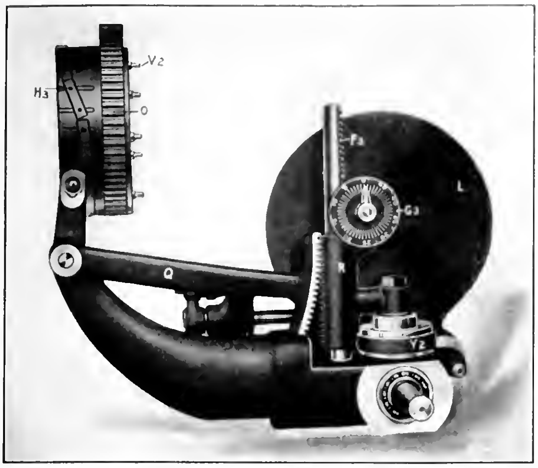


Fig. 15. Detailed View showing Feed Roll

The turret is indexed upon its back stroke by means of a rod H_2 held adjustably by locking nuts in the gear F_2, which comes in contact with hardened pins I_2 held in the rear face of the turret. Before the turret can be turned around, however, it is necessary to disengage the locking wedge J_2 from the slot in the circumference of the turret. This is accomplished by means of a cam block K_2 held on the flange of drum K which contacts with the pin L_2. This pin, in turn, is fastened to a lever M_2 located in the bed of the machine, which is spring-controlled and holds up the locking wedge J_2 in the manner illustrated in Fig. 14. As the turret retreats, cam K_2 comes into contact with plunger L_2, depressing lever M_2 and pulling down the locking wedge J_2, thus disengaging it from the slot in the turret circumference. Then the turret is indexed by the rod H_2 as previously described. The indexing can be also effected by hand by simply depressing the handle N_2 which has the same action on the locking wedge as the cam block held upon the drum K. The turret can be rotated by hand by means of a handle which fits on shaft J_3.

The turret head, which has two bearings as illustrated, one of which supports the central shaft A_3 and the other the turret J, is mounted on the bed of the machine and can be adjusted to suit various lengths of work and tools held in the turret. This adjustment is effected by means of the screw O_2 which works in a threaded projecting lug cast integral with the base of the turret head casting. The turret is held to the base of the machine by means of bolts as illustrated. A scale P_2, fastened to the base of the machine, and a pointer Q_2, held on the turret-slide, enable the operator to obtain the same setting of the turret head when setting up a job for the second time.

The method of driving and rotating the turret is clearly illustrated in Fig. 12 which shows a section of the driving mechanism located at right angles to the axis of the turret shaft. Power is conveyed to this mechanism from the overhead countershaft through the medium of the pulley N, keyed to the shank of the friction disk L. The method of driving the turret direct or at its fast speed for accomplishing the idle movements of the machine is as follows: The sliding clutch R_2, shown in its neutral position in the illustration, is thrown to the right and contacts with the pulley N. The power is then direct through the sliding clutch to the worm-shaft S_2 and then to the worm-wheel G_2, turret, etc. The sliding clutch is keyed to the worm-shaft and is operated

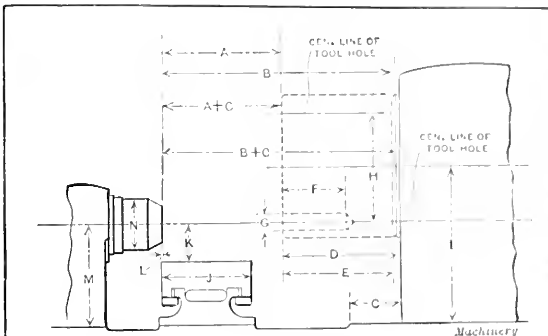
TABLE I. SPINDLE CAPACITIES OF CLEVELAND AUTOMATIC SCREW MACHINES

Size of Machine in Inches	Spindle Capacities in Inches for Round, Hexagon and Square Stock								
	Solid Shell Chuck			Pads in Chuck			Pads in Feed Tube		
	Round	Hexagon*	Square*	Round	Hexagon*	Square*	Round	Hexagon*	Square*
3/8	3/8	5/16	1/4	....	....	....	....	....	....
3/8–1/2	9/16	15/32	3/8	....	....	....	....	....	....
3/8–5/8	5/8	17/32	7/16	....	....	....	....	....	....
5/8	5/8	17/32	7/16	....	....	....	....	....	....
5/8–3/4	3/4	5/8	1/2	....	....	....	....	....	....
5/8–7/8	7/8	3/4	19/32	....	....	....	....	....	....
5/8–1 1/16	1 1/16	29/32	3/4	....	....	....	....	....	....
7/8	7/8	3/4	19/32	....	....	....	....	....	....
7/8–1 1/16	1 1/16	29/32	3/4	....	....	....	....	....	....
7/8–1 1/4	1 5/16	1 1/8	29/32	....	....	....	....	....	....
7/8–1 3/8	1 3/8	1 3/16	31/32	....	....	....	....	....	....
1 1/4	1 5/16	1 1/8	29/32	....	....	....	....	....	....
1 1/4–1 3/8	1 3/8	1 3/16	31/32	....	....	....	....	....	....
1 1/4–1 1/2	1 1/2	1 9/32	1 1/16	....	....	....	....	....	....
2	2 3/16	1 7/8	1 1/2	1 15/16	1 11/16	1 3/8	1 15/16	1 11/16	1 3/8
2–2 1/2	2 1/2	2 5/32	1 3/4	2 1/4	1 15/16	1 19/32	2 1/4	1 15/16	1 19/32
2–2 3/4	2 13/16	2 7/16	1 31/32	2 3/8	2 1/32	1 21/32	2 3/8	2 1/32	1 21/32
2 1/4	2 1/2	2 5/32	1 3/4	2 1/4	1 15/16	1 19/32	2 1/4	1 15/16	1 19/32
2 1/4–2 3/4	2 13/16	2 7/16	1 31/32	2 3/8	2 1/32	1 21/32	2 3/8	2 1/32	1 21/32
2 1/4–3 1/4	3 1/4	2 13/16	2 9/32	3	2 19/32	2 1/8	2 7/8	2 1/2	2 1/32
2 3/4	2 13/16	2 7/16	1 31/32	2 3/8	2 1/32	1 21/32	2 3/8	2 1/32	1 21/32
2 3/4–3 1/4	3 1/4	2 13/16	2 9/32	3	2 19/32	2 1/8	2 7/8	2 1/2	2 1/32
2 3/4–3 3/4	3 3/4	3 1/4	2 5/8	3 3/8	3 1/4	2 21/32	3 3/8	3 1/4	2 21/32
4 1/4	4 9/16	3 15/16	3 7/32	4 3/8	3 25/32	3 3/32	4 3/8	3 25/32	3 3/32
6 1/4	6 1/4	5 13/32	4 13/32	6 1/4	5 13/32	4 13/32	6 1/4	5 13/32	4 13/32
6 1/4–6 3/4	6 3/4	5 27/32	4 25/32	6 3/4	5 1/2	4 1/2	6 3/4	5 1/2	4 1/2
7 1/4	7 1/4	6 9/32	5 1/8	7 1/4	6 9/32	5 1/8	7 1/4	6 9/32	5 1/8
7 1/4–7 3/4	7 3/4	6 23/32	5 15/32	7 3/4	6 3/4	5 7/32	7 3/4	6 3/4	5 7/32

Machinery

* The sizes for hexagon and square stock are given to the nearest 1/32 inch to the corresponding diameters of round stock.

TABLE II. PRINCIPAL DIMENSIONS OF TURRET, CROSS SLIDES AND MISCELLANEOUS DATA



A = TURRET HEAD IN FRONT POSITION.
B = TURRET HEAD IN REAR POSITION.
C = ADJUSTMENT OF TURRET SLIDE ON BASE.
D = GREATEST MILLING STROKE.
E = TOTAL ADVANCE OF TURRET HEAD.
O = APPROXIMATE LENGTH THAT CAN BE FORMED
P = MAXIMUM LENGTH OF STOCK FEED.

Principal Dimensions in Inches	Sizes of Machines. Rated Chuck Capacities in Inches*									
	3/8	5/8	7/8	1 1/4	2	2 1/4	2 3/4	4 1/4	6 1/4	7 1/4
A	2 7/32	3 3/16	4 1/16	5 3/16	4 5/8	6 1/4	6 13/16	8 1/4	10	10
B	4 23/32	7 3/16	9 1/16	11 7/16	10 7/8	13 5/8	14 13/16	17 5/8	19 5/8	19 5/8
C	1 3/4	2 1/2	3 1/2	4	4	5 1/4	5 1/2	7	7 1/4	7 1/4
A+C	3 31/32	5 11/16	7 9/16	9 3/16	8 5/8	11 1/2	12 5/16	15 1/4	17 1/4	17 1/4
B+C	6 15/32	9 11/16	12 9/16	15 7/16	14 7/8	18 7/8	20 5/16	24 5/8	26 7/8	26 7/8
D	2 1/2	4	5	6 1/4	6 1/4	7 5/8	8	9 5/8	9 5/8	9 5/8
E	2 1/4	3 3/4	4 3/4	6	6	7	7 5/8	9	9	9
F	3 3/8	4 1/2	5	5	5	6 1/4	7	8	8	8
G	7/8	1 1/16	1 1/4	1 1/2	1 1/2	1 3/4	2	2 1/4	2 1/4	2 1/4
H	3 1/2	4 1/2	5 1/2	7 1/2	7 1/2	8	8 3/4	10	10	10
I	6	7 1/4	8 1/4	10 3/4	10 3/4	12	13 5/8	15	15	15
J	3 3/4	5 1/2	6 5/8	6 7/8	6 3/4	8	7 11/16	8 1/4	10 1/4	10 1/4
K	1 5/16	2 1/4	2 3/8	2 5/8	2 5/8	2 3/4	2 3/4	4	4 1/4	4 1/4
L	23/32	1 21/32	1 11/16	11/16	1 1/4	1 1/8	3/16	....	....	....
M	4 1/4	5	5 1/2	7	7	8	9	10	11 1/2	11 1/2
N	1 5/8	2 1/4	2 5/8	3 5/8	5 3/16	5 3/4	6 1/2	10 5/8	15 13/32	15 13/32
O	3/4	1 3/4	3	4 1/4	4 1/4	5 1/2	6	6 1/4	6 1/4	6 1/4
P	4 3/4	6 1/2	8 1/2	10 1/2	10 1/2	12 3/8	13 3/8	16 3/8	16 3/8	16 3/8
Approximate Horsepower required to Drive										
H. P.	1	1 1/2	2	2 1/2	3	4	5	6	8	10

Machinery

* For work which does not require heavy cuts these sizes of machines can be obtained in the following increased sizes: 3/8–1/2; 3/8–5/8; 5/8–3/4; 5/8–7/8; 5/8–1 1/16; 7/8–1 1/16; 7/8–1 1/4; 7/8–1 3/8; 1 1/4–1 3/8; 1 1/4–1 1/2; 2–2 1/2; 2–2 3/4; 2 1/4–2 3/4; 2 1/4–3 1/4; 2 3/4–3 1/4; 2 3/4–3 3/4; 6 1/4–6 3/4; 7 1/4–7 3/4.

through the bellcrank levers T_2 and U_2, which are actuated by dogs V_2 (see Fig. 15) adjustably mounted on the rear face of the regulating drum.

The method of driving the turret at its slow or cutting speed is as follows: The sliding clutch R_2 is thrown to the left by means of the dogs held on the regulating drum, and contacts with the pinion W_2 which has clutch teeth cut in it similar to those on the sliding clutch. The drive is then through pulley N, friction disk L, roller Y_2, disk M, pinion and gear A_3 and B_3 to the epicyclic train of gears C_3 down to the pinion sleeve W_2 and through the sliding clutch R_2 to the worm D_3. The changing from slow to fast speed can also be effected by pushing in or pulling out handle I_3. This reduction in speed with roll Y_2 in the position shown in Fig. 12 is in a ratio of about 25 to 1.

In order to make clear the manner in which this great reduction in speed is accomplished, it might be well to deal briefly with the train of epicyclic gears, giving especially the data relating to the computations involved. Referring

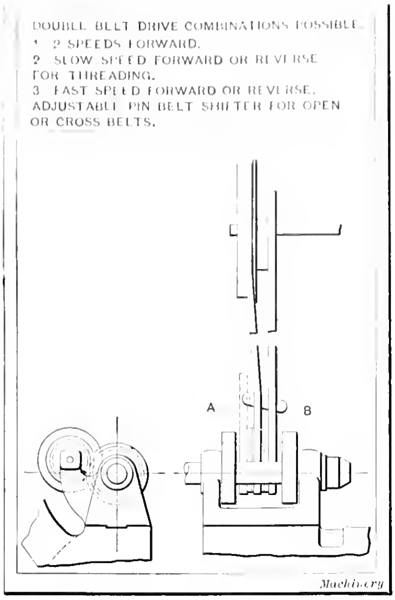


Fig. 16. Standard Double Belt Type of Spindle Drive

This is the speed at which the idle movements of the machine are accomplished.

Now a great variation of speed is obtainable for driving the turret at its cutting speed by the use of the friction disks. The position of the roll between these disks, as was previously explained, is controlled by a regulating drum. In order to make this description clear, it will not be necessary to give any more than three variations of speed, that is when the roll is in the central or neutral position B giving a ratio of 1 to 1, when it is at the extreme outside of the driven disk in position A, and when it is at the outside circumference of the driving disk in position C. As stated, to drive the turret drum at the cutting speed, the clutch R_2 is shifted to the left, engaging with pinion W_2. The drive is then as follows: As pulley N is keyed to the shank of friction disk L, the drive is from pulley N to friction disk L, roller Y_2, disk M, then to pinion A_3, gear B_3, and through the epicyclic gears C_3 and E_3 back to gear W_2 and from there to clutch R_2, shaft S_2 and worm D_3 to worm-wheel G_2.

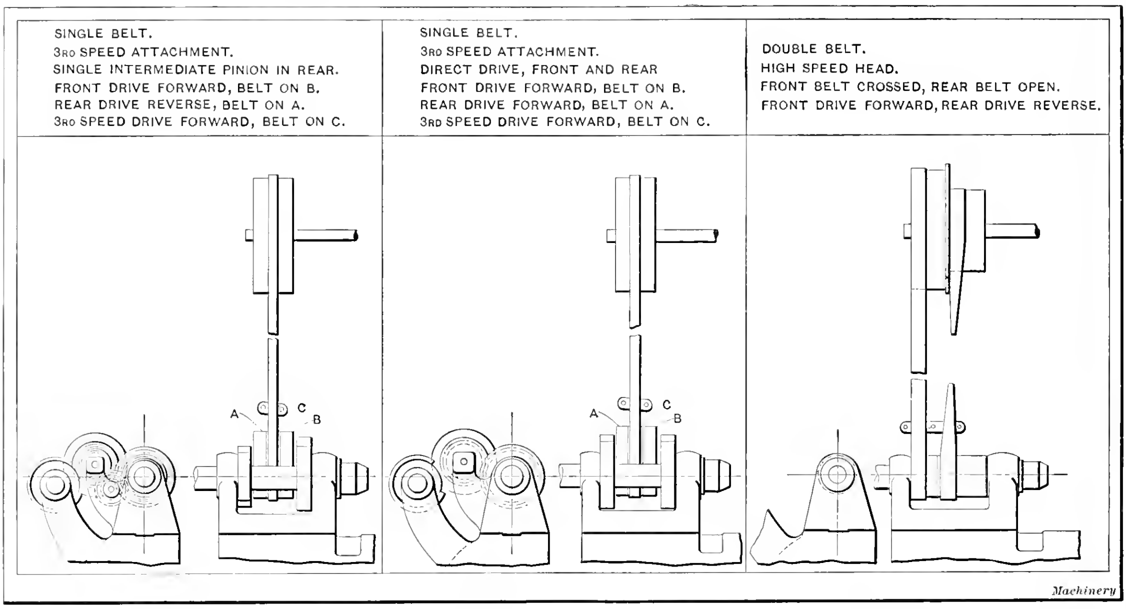


Fig. 17. Third-speed Type of Spindle Drive for Heavy cutting, and High-speed Spindle Drive particularly adapted for Brass Work

to Fig. 18, it will be seen that pulley N, on the 3¼-inch machine, rotates at a constant speed of 630 R. P. M. Then to drive the turret direct, that is at its highest rate of speed, clutch R_2 is thrown to the right and engages with this pulley. The drive is then direct through the clutch to shaft S_2 and from there to the worm D_3 and worm-wheel G_2. Now as pulley N rotates at 630 R. P. M., the shaft S_2 and worm will rotate at the same speed, so that the worm-wheel and the turret drum will be driven at a speed of $630 \div 76$ or about 8.3 R. P. M.

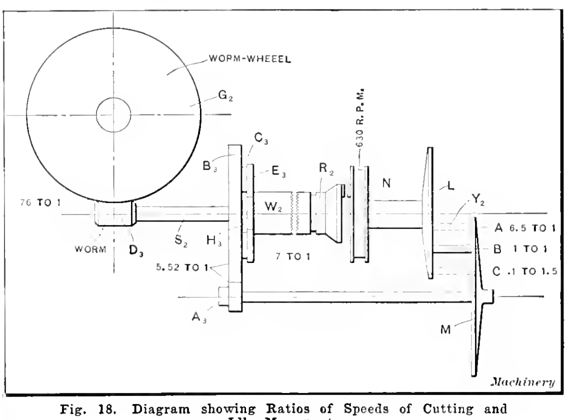


Fig. 18. Diagram showing Ratios of Speeds of Cutting and Idle Movements

Making our calculations with the roll Y_2 in the intermediate position B, giving a speed ratio between the two disks of 1 to 1, we can find the speed of the turret drum in revolutions per minute as follows: With roll Y_2 in the intermediate position, the pinion A_3 will rotate at 630 R. P. M., and the large gear B_3 will rotate at $\frac{630}{5.52}$ or 114 R. P. M., approximately. The next calculation is for the epicyclic train. This can be obtained by using the formula on page 702 of MACHINERY'S

Handbook. Worked out to suit this case it is as follows:

Let S = speed of worm-shaft S_2; then:

$$S = \frac{C_3 \times W_2 - E_3 \times H_3}{C_3 \times W_3}.$$

Assuming the following numbers of teeth in the gears in the epicyclic train to be C_3, 14; E_3, 15; H_3, 16; W_2, 15; we find that the ratio between the speed of gear B_3 and shaft S_2 is

$$\frac{14 \times 15 - 15 \times 16}{14 \times 15} = \frac{30}{210} = \frac{1}{7}.$$

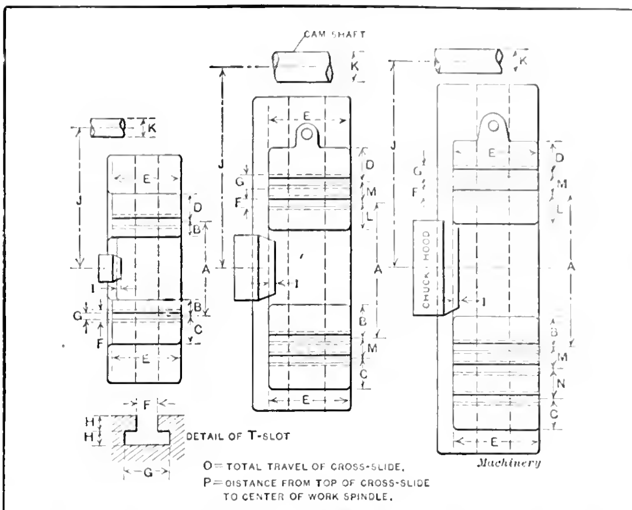
Then as gear B_3 rotates at 114 R. P. M., shaft S_2 will rotate at $\frac{114}{7} = 16.3$ R. P. M., approximately. Then the revolutions of the turret drum with roll Y_2 in position $B = \frac{16.3}{76} = 0.2$ R. P. M., approximately.

With roll Y_2 in position C, the speed of rotation of the turret drum will be $0.2 \times 1.5 = 0.3$ R. P. M., approximately. This is the fastest speed of rotation of the turret drum when driving at the cutting speed. The slowest speed of the turret drum when driving at the cutting speed is when the roll is in position A. Here the speed of the turret will be $\frac{0.2}{6.5} = 0.0308$ R. P. M., approximately.

As previously described, the variation in feed given to the turret and cross-slide tools is accomplished by means of a regulating drum O on which strip cams are held. Fig. 15 shows the action that takes place by shifting one of these cam strips H_3 on the regulating drum. As the cam is shifted, a movement is transmitted to the bellcrank lever Q which has rack teeth cut in its outer end, meshing with teeth in the sliding sleeve R on the rod F_3. This rod is held in a bracket attached to the machine.

Now as a movement is transmitted to the bellcrank lever Q, the sleeve R is moved up and down on the rod, and consequently the position of the roll Y_2 is changed between the two friction disks, thus varying the speed at which the disk M, Fig. 12, is rotated. In order to facilitate set-

TABLE III. PRINCIPAL DIMENSIONS OF CROSS SLIDES ON MODEL A CLEVELAND AUTOMATICS



Principal Dimensions in Inches	Sizes of Machines. Rated Chuck Capacities in Inches*									
	3/8	5/8	7/8	1 1/4	2	2 1/4	2 3/4	4 1/4	6 1/4	7 1/4
A	6 1/4	8 1/8	9 3/8	10 1/4	10 1/4	11 3/4	13 1/4	15 1/4	15 1/2	15 1/2
B	1 1/8	1 7/16	1 5/8	2 1/4	2 1/4	2	3 1/4	3 1/8	2 7/8	2 7/8
C	2 3/8	2 3/4	2 11/16	2 3/4	2 3/4	3	3	3 1/8	3	3
D	2 3/8	2 3/4	2 11/16	2 7/16	2 7/16	2 1/4	3 1/4	3 1/8	3 1/2	3 1/2
E	3 3/4	5 1/2	6 5/8	6 3/4	6 3/4	8	7 11/16	8 1/8	10 1/8	10 1/8
F	1/2	9/16	5/8	5/8	5/8	5/8	3/4	3/4	1	1
G	7/8	1 1/16	1 1/8	1 1/8	1 1/8	1 1/8	1 1/4	1 1/4	1 5/8	1 5/8
H	1/4	5/16	3/8	3/8	3/8	3/8	1/2	1/2	5/8	5/8
I	23/32	1 21/32	1 11/16	11/16	1 1/4	1 1/8	3/16	....	....	....
J	7.293	10.256	11.337	12.577	12.577	14.457	16.944	20.396	20.396	20.396
K	1 5/16	1 7/16	1 13/16	1 15/16	1 15/16	2 3/16	2 7/16	3 3/16	3 3/16	3 3/16
L	....	....	....	....	....	....	2 3/4	3 1/8	2 7/8	2 7/8
M	....	....	....	....	....	....	2	2	3 1/2	3 1/2
N	....	....	....	....	....	....	....	3	3 1/2	3 1/2
O	4 1/8	6 1/8	7	7 3/4	7 3/4	9 1/4	11 1/4	13 1/4	13 1/4	13 1/4
P	1 5/16	2 1/4	2 3/8	2 5/8	2 5/8	2 3/4	2 3/4	4	4 1/4	4 1/4

Machinery

* See Table II.

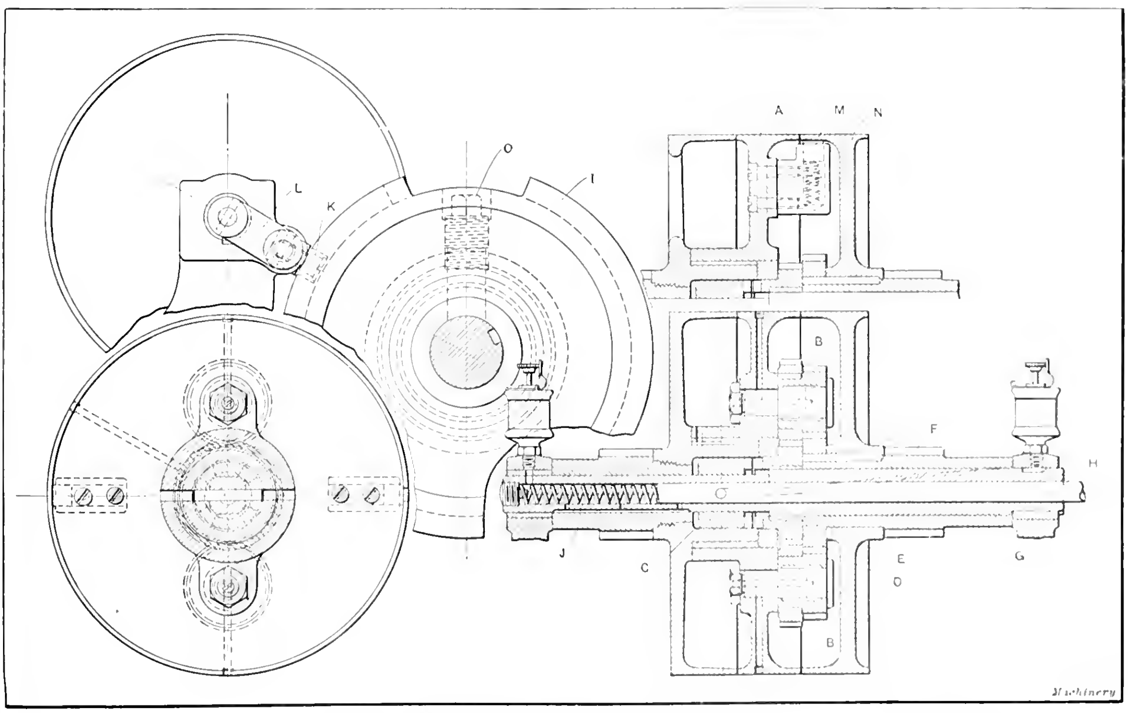
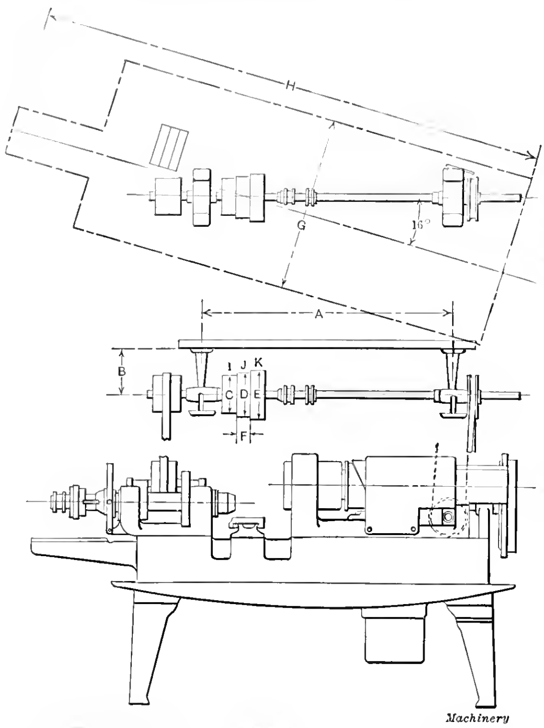


Fig. 19. Detailed Sectional View of Third-speed Spindle Drive

ting up the machine on the same job one or more times, a small attachment G_3, as shown in the illustration, has been provided which consists of a pinion running in the rack teeth in the rod F_3. This conveys a movement to the indicator pointer so that the strip cams on the regulating drum can be set in the proper position if the job has been taken down and is to be set up again. This data, of course, is put on the operation card that goes with the job.

The position of roll Y_2 between the two disks is controlled, as previously explained, by means of the fulcrum lever that receives its movement from the strip cam on the regulating drum. It is therefore evident that a wide range of feed for the turret and cross-slide tools is easily secured, and the

TABLE IV. PRINCIPAL FLOOR AND COUNTERSHAFT DIMENSIONS AND R. P. M. OF CONE STEPS ON COUNTERSHAFT



Principal Dimensions in Inches	Sizes of Machines (Rated Chuck Capacities in Inches)*									
	3/8	5/8	7/8	1 1/4	2	2 1/4	2 3/4	4 1/4	6 1/4	7 1/4
A	22	35	41 1/2	51	51	56	60 1/2	71 3/4	82 3/4	82 3/4
B	13	13	12	12	12	12	12	12	12	12
C	8	8	8	8	10	10	11	11	11	11
D	9	9	9	9	11	11	12 1/2	12 1/2	12 1/2	12 1/2
E	10	10	10	10	12	12	14	14	14	14
F	2 1/8	2 1/8	3 1/8	3 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8
G	30	36	41	46	46	51	64	68	68	68
H	61 1/2	78	95	112 1/2	116 1/2	131	156	177	198	198
	Cone Step Revolutions per Minute									
I	566	533	533	462	450	450	436	436	436	436
J	480	450	450	390	390	390	360	360	360	360
K	410	385	385	330	341	341	300	300	300	300

Machinery

* See Table II.

change in the feed of the tools can be accomplished while the machine is in operation. This is a good feature, especially when setting up a job for the first time. After a job has once been set up, the position of the pointer, as shown in Fig. 15, is indicated on a card and the operator in setting this job up again simply shifts the cams until the pointer comes to the required point on the indicating dial. The regulating drum is driven from the turret shaft by the pinion P, Fig. 13, meshing with teeth cut in the rim of the drum.

Construction and Operation of the Cross-slide

On the Cleveland automatic screw machine, as regularly equipped, the cross-slide for holding both the rear and front cutting tools consists of one casting, but a double cross-slide can be supplied when desired. The cross-slide is actuated by means of a fulcrum lever T (Fig. 13), which derives motion from cams K_3 on the drum U carried on the rear shaft E. The flange of this drum is numbered so that the position of the various cams can be recorded on a lay-out card to facilitate resetting the work. As shown in Fig. 11, the cross-slide is provided with an adjustable stop-screw so that accurately formed work can be obtained. It is also provided with adjustable gibs to compensate for wear. The position of the cross-slide relative to the axis of the spindle is controlled by regulating nuts on the connecting-rod fastened to the rear of the slide.

Spindle Capacities and Spindle Drives

Table I gives a list of spindle capacities of the various sizes of Cleveland automatics, for handling round, hexagon and square stock. In this table the sizes for hexagon and square stock are only given to the nearest 1/32 inch corresponding to the diameters of the round bar stock. This, of course, is close enough for all practical purposes. It will be noticed under the column "size of machine in inches" that there are a number of machines having two different spindle capacities. The meaning of this is (referring now to the 5/8—3/4 size) that the machine is the same in both, except for the spindle, which is bored on the enlarged size to take 3/4-inch instead of 5/8-inch bars. This enables work on which there is no extremely heavy cutting to be accomplished to be turned out much more rapidly than it could be on a larger sized machine, because the idle movements take less time.

In order to make the Cleveland automatic adaptable for brass, iron and steel work, it is necessary to provide a variety of spindle drives. Figs. 16, 17 and 19 show the different types of spindle drives that have been devised for handling a large variety of work. Fig. 16 shows the standard drive. Fig. 17 shows what is known as the third-speed attachment; two combinations of this attachment are illustrated, while the last view shows the type of drive particularly adapted to brass work and similar materials.

A detail and sectional view of this third-speed drive is shown in Fig. 19, where its construction can be clearly seen. This attachment is contained within the spindle driving pulleys on the back-shaft of the spindle head. Its purpose is to provide a slow and very powerful speed to the spindle for heavy thread cutting or work of a similar nature, requiring great power in the spindle. The result is obtained by shifting the belt to the center pulley A which brings into play the set of hardened steel epicyclic gears B. To accomplish this, the sliding clutch C is engaged with the gear D, and as the clutch slides upon a square shaft and cannot revolve it causes the gears B to rotate around the fixed gear D, thus driving gear E at a very powerful speed. Gear E is securely keyed to the sleeve pinion F which meshes directly into the front spindle gear of the machine.

When the third-speed drive is not in use, the clutch C is moved out of engagement, allowing the entire train of epicyclic gears to be free upon the loose center pulley A. The clutch C is moved along the shaft G by means of the rod H controlled by a cam I, shown in the end view. This cam moves the rod to the left for disengaging the clutch and the spring J moves the clutch to the right for engaging it, when the roll K drops off the end of the cam. There are two frictions M which serve to keep the center loose pulley A driving at the same speed as the pulley N, when the third speed is not engaged, so that the planetary pinions will not rotate on the stud at this time. The cam I is adjustable around the cam-shaft and is clamped into any desired position by the screw O and stud. The lubrication of the entire third-speed attachment with the exception of the planetary pinions is secured by means of a sight-feed oil-cup, while the planetary pinions are lubricated through the oil-hole extending to the rim of the center pulley A. The connection between the rod H and the cam I is link L which carries the cam-stud and roll K.

Principal Dimensions of Turret, Cross-slides and Miscellaneous Data

Tables II and III and the illustrations accompanying them give all the data pertaining to the turret and cross-slides on the various sizes of Cleveland automatics. By referring to the illustrations, it will be seen that the cross-slide on the various sizes of machines is provided with from one to three slots for holding cross-slide working tools. These are furnished in order to enable the tools to be held in the most convenient position in relation to the work. It is obvious, of course, that on the larger sizes of machines a greater range of positions is necessary than on the smaller sizes. This data will not only be of value to the operator when setting up the machine but will also be of use to designers when devising special tools or the attachments for use on this type of machine.

Principal Dimensions and Set-up Plan

The principal dimensions, capacities, etc., of the various sizes of Cleveland automatic screw machines are given in Table IV. The diagram accompanying this table shows how the Cleveland should be set up to economize on floor space, and in the lower part of this table are given the revolutions of the countershaft when driven from the main lineshaft at the speed recommended.

* * *

METHODS OF STANDARDIZATION BY ENGINEERING SOCIETIES

The ground covered by many societies in standardizing engineering details overlaps in many cases, and it has often occurred that different societies have adopted conflicting standards. It would, therefore, be desirable if some understanding could be arrived at between the societies in order to prevent duplication of work. Prof. F. B. Crocker, of the Crocker-Wheeler Co., Ampere, N. J., has prepared a statement on this subject, from which the following paragraphs are abstracted. Professor Crocker is president of the Electric Power Club and has also been a member of the standardization committee of the American Institute of Electrical Engineers; he is, therefore, in a position to write authoritatively on this subject. Owing to the fact that he is especially interested in electrical work, reference is made particularly to standards in the electrical engineering field, but of course the rules and methods laid down are equally applicable to the standardization work done by any engineering body or society.

Fundamentally there are three broad divisions of standardization—scientific, technical and industrial. As true examples of scientific standards, we have the resistivity and temperature coefficient of copper. A proper matter for technical standardizing is the safe temperature limits of the various kinds of insulating material. As clear cases of industrial standardization may be cited the shaft diameters and speeds of different types and sizes of electric motors. A scientific problem should be handled by the U. S. Bureau of Standards or the American Physical Society. A technical electrical matter should be decided by the American Institute of Electrical Engineers, and an industrial electrical question properly belongs to the National Electric Light Association or the Electric Power Club.

The best way to solve the problems of standardization is not by conferences between a number of bodies acting jointly on the various subjects. Of course cooperation is very desirable in some cases, but in dealing with many matters it is unnecessary. Standardization should be carried on in accordance with the following general scheme: First, each organization should have definite jurisdiction, within which it has full authority; second, each organization should confine its action as far as possible within its own jurisdiction; third, when questions arise that are on the border, or when the authority and interest of two or more organizations overlap, then a conference between the interested parties should be held.

In order to determine jurisdiction, the following plan of procedure may be adopted: When any organization considers it desirable that something should be standardized, its secretary communicates that fact to the secretaries of the other bodies likely to be interested in the same subject. Communication between the standards committees is not sufficient, because there may be several in one society and they may change from year to year. In most cases, from the nature of the particular matter involved, it is clear that it properly belongs to a certain organization, and the others will accordingly acquiesce. In other instances, it is evident that a question is on the boundary between two bodies and they will therefore agree to cooperate in acting upon it. When there is doubt or difference of opinion as to jurisdiction that cannot be settled by correspondence between the parties interested, then the case may be referred to an arbitrator, for example, the director of the U. S. Bureau of Standards, or the president of one of the national engineering societies not interested. The arbitrator merely decides which body or bodies shall have jurisdiction over that subject. The actual standards are determined by this body or bodies.

On account of the very rapid differentiating and specializing in electrical science, technology and industry it would seem that some general plan is needed for present and future standardization. In some cases it is quite evident that a certain body should have sole authority over a certain subject. For example, an organization of men who devote themselves to a particular subject should be able to determine standards for it most correctly and most quickly. Special subjects should be dealt with by those who live with them, so to speak, and devote their thoughts and efforts to them.

In all matters affecting standards it is of the utmost importance to give them very careful consideration. It is much better to have no standard than to have an ill-advised one or to have different standards for the same thing. It is difficult to rectify mistakes of this kind. In looking back over the history of electrical standardization, we see that the tendency has been to standardize too quickly, too often and too much. There have been dozens of wire gages, for example, and electrical books in the English language may use the American, Birmingham or the Standard British gages, each materially different from the other two. Many technical terms have also been introduced that were absolutely unnecessary. Experience, therefore, indicates that we should be conservative in establishing standards. This is another reason why each organization should limit its action to those matters which it best understands; thus fewer mistakes are likely to be made. All standardization committees should be careful not to rush in where angels fear to tread. It is surely a mistake for any organization to reach out and attempt to standardize in any field that does not clearly belong to it. Each organization already has far more that is unquestionably within its province than it can possibly cover, and new ground is being rapidly opened up.

A great deal of trouble is caused to manufacturers and users of machine tools by the varying types, sizes and speeds of electric motors employed to drive them. Hence, the standardizing of motor dimensions for machine tool drive is very desirable. It is solely an industrial matter that should be dealt with by the Electric Power Club and the National Machine Tool Builders' Association acting jointly. Neither the American Institute of Electrical Engineers nor the American Society of Mechanical Engineers should have anything to do with it, because it is clearly outside of their jurisdiction. As a matter of fact, it has been considered by committees of both these bodies. Little has been accomplished, however, because it was thought necessary to consult all four organizations, and everybody's business is nobody's business.

* * *

A German contemporary states that a method has been invented by means of which aluminum may be dissolved so that it may be spread cold over any dry surface and applied like paint with a brush. The appearance of aluminum so deposited is like that of a dull silver coating. It is claimed that this coating is an excellent preventative for rust, that it is durable and resists heat well, and that it can be used as a good substitute for tin-plating.

SPECIAL HOB-TOOTH SHAPES*

METHODS OF DESIGNING AND MAKING SPECIAL HOBS FOR GEARS, RATCHET WHEELS, SPLINED SHAFTS, ETC.

BY JOHN EDGAR†

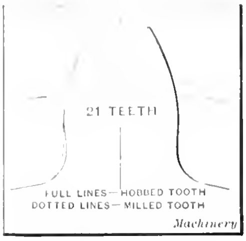


Fig. 1. Comparison between Hobbed and Milled Gear Teeth

There is always an objection to changing existing methods in shop practice when the change necessitates discarding established standards and valuable tools and fixtures. Whether such a change will be profitable or not is a question that requires a close study of the conditions in each case. When the change means an improvement in the quality of the product, the cost of the tools and fixtures should, of course, be a secondary consideration. When the question is mainly one of quantity, the problem must be solved on a cost basis only.

Another factor to be considered, however, is that of interchangeability. This is a most important item in the case of a product in connection with which renewals are constantly being made. Many improvements in design and in methods of manufacture are sacrificed in deference to the demands for interchangeability. In the case of gears, interchangeability is supposed to be rigidly adhered to, but while we have a standard which is supposed to produce interchangeable gears, we have so many variations of the standard, due to the secret forms established by different manufacturers of cutters, that it is necessary in many cases to adhere to one make of tools if interchangeability is to be maintained in any degree. Many manufacturers have installed the hobbing machine in the desire to reduce the cost of gearing, only to encounter the non-interchangeability of the product of the hobbing machine with the milled tooth gear; this has been the cause of turning many against the hobbing machine, through no fault of the process itself.

Variations from the True Involute Tooth Shape

The form of the standard tooth, as adopted by the cutter manufacturers, is not the true involute, but an improvised form built around the involute as a basis. The deviation from the involute is necessary for several reasons: 1. The inability of the formed milling cutter to mill an undercut tooth. 2. The necessary alteration in the form of the point of the mating tooth caused by the fullness of the milled tooth below the pitch line. 3. The desire to make the contact

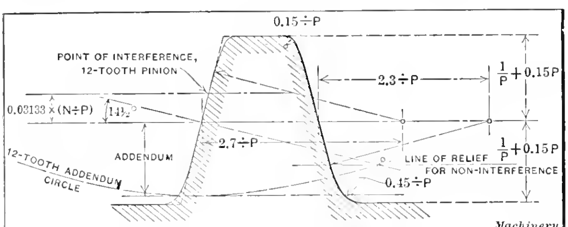


Fig. 2. Hob Tooth designed to generate the Approximate Shape of a 14½-degree Involute Milled Tooth

of the approach as gradual as possible by a slight easing off of the form at the point of the tooth; this provides against the slight variation in the form of the tooth due to irregularities in the division of the space and to the elasticity of the material. 4. The interference in gears with thirty-two teeth or less when in mesh with those of a greater number of teeth. As the 14½ degree formed gear-cutters are based on the twelve-tooth pinion with radial flanks, a rack tooth to mesh with this radial flank tooth can be made with the straight sides extending only to a point 0.376 inch outward from the pitch line in a rack of one diametral pitch. The remainder of the tooth must be eased off from this point outward, sufficiently to clear the radial flank of the pinion tooth. This rounding off of the rack tooth may be made by using the cycloidal curve from the interference point, with a rolling circle of a diameter equal to that of the twelve-tooth pinion. A circular arc tangent to the tooth side, drawn from a center on the pitch line at the point of intersection of the normal to the tooth side at the point of interference, will be a near approximation to the cycloidal curve.

The hobs used extensively today are not made to produce teeth in any near approximation to the shape produced by the milling cutter. The only correction that is made, in many cases, is to make the teeth of the hob a trifle fuller at the base or root to ease the approach; even this is done only in a few instances. The difference between the hobbed tooth and that produced by milling is seen in Fig. 1. The hobbed tooth is shown in full; this shape was traced from an actual hobbed tooth, photographed and enlarged. The gear had twenty-one teeth. The hob used was corrected for the "thinning" of the tooth at the point, but in a gear of this diameter the effect would not show to any great extent. The dotted lines are drawn from actual milled tooth curves and show the difference between the two forms of teeth. Attention is called to the fullness of the milled tooth at the root, and the thinning of the tooth at the point. The difference would be greater in the case of a twelve-tooth pinion.

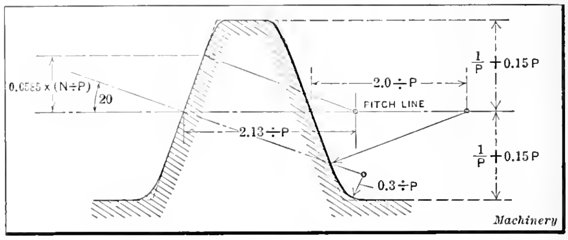


Fig. 3. Hob Tooth for generating a 20-degree Involute Milled Tooth

The filling-in of the flank of the tooth is not done to any rule based on a proportion to the number of teeth in the gear. The curve selected is made to fill in the space at the root to just clear the corrected rack tooth. Neither is the thinning of the tooth at the point proportional to the diameter in the sense that the curve of the hobbed tooth is. Each form of the cutter system is made and varied to the extent necessary for smooth action, and the curves of the entire system cannot be produced by the hobbing process with a single hob. To accurately reproduce the form of the milled tooth, a special hob would be necessary for each number of teeth. However, a close approximation may be obtained, within a narrow range of teeth, with a hob generated from a milled tooth. This is being done in the automobile industry with good results. The necessity for interchangeability makes the duplication of the milled tooth imperative when the originals were made with the formed cutter, and the introduction of the hobbing machine, in such cases, depends on the successful duplication of these forms. It is no exceptional thing to see the hobbing process used in conjunction with the automatic gear-cutter in the production of interchangeable transmission and timing gears. The shapes produced by the standard sets of cutters, from a rack to a twelve-tooth pinion, cannot, however, be generated by a single hob, because the shapes are only an approximation of the correct curve. The gears mentioned above as being successfully hobbed are, therefore, when milled, cut with special cutters for each number of teeth, as in this way only can a curve of correct shape be obtained.

As stated above, most hobs are of the straight-sided shape, and the tooth hobbed is of pure involute form. In gears

* For previous articles on this and kindred subjects see MACHINERY, March, 1914, "Hobbing vs. Milling of Gears"; July, 1912, "Hobs for Spur and Spiral Gears," and also articles there referred to.

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of less than thirty-two teeth, the flank is undercut to a considerable extent. This undercutting does not involve any incorrect action in the rolling of the gears, but in the case of the twelve-tooth gear, for example, the involute is cut away at the base line close to the pitch line, giving but a line contact at a point which is subjected to heavy wear. This eventually develops backlash. The teeth of the gears also come into action with a degree of pressure that is continuous throughout the time of contact; this results in a hammering which in time develops into a humming noise.

Special Hobs for Gear Teeth

To overcome these objections a hob tooth may be developed to generate a curve which will closely resemble that of the formed tooth. Such a hob tooth is shown in Fig. 2. Theoretically, the correction for interference or undercutting should begin at a point located above the pitch line a distance as determined for a twelve-tooth pinion by the expression:

$$0.03133 \times \frac{N}{P}$$

in which N = number of teeth in the smallest gear to be hobbed;

P = diametral pitch of gear.

However, to begin the correction for interference at this point would reduce the length of the true involute and result in too full a tooth, causing noisy gears. Therefore, a compromise is made and the correction is obtained for a minimum of twenty-one teeth. To compensate for the extra fullness of the tooth at the root, the point of the tooth is thinned down in proportion, and this is done by leaving the tooth of the hob full below the pitch line by striking an arc from a center on the pitch line, and also employing a large fillet having a radius equal to $0.45 \div P$ (see Fig. 2). It will be noticed that the radius of the arc at the top of the hob tooth is smaller than the radius at the bottom of the hob tooth. This will thin the tooth of the gear in excess of the amount necessary to clear the flank, easing the action and eliminating the hammering effect due to the theoretical contact. It will be seen from the illustration that the thinning of the teeth does not affect the twelve-tooth gear to any appreciable extent, but is gradually increased with the number of teeth. The fact that a twelve-tooth gear will mesh without interference at the point of the teeth makes the thinning unnecessary; besides, the small pinions are usually the drivers.

Fig. 3 shows a twenty-degree hob tooth with standard addendum and corrections for non-interference. The curve

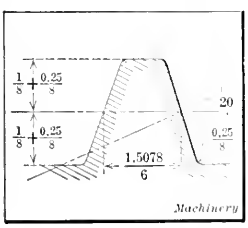

Fig 4. Hob Tooth for a 6/8 Pitch Fellows System Stub Gear Tooth

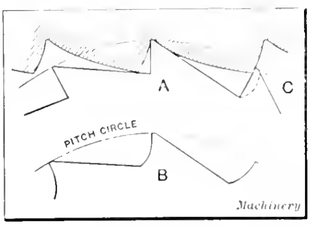

Fig. 5. Diagram showing how Hob may be used for generating Ordinary Ratchet Teeth

of the tooth begins at a point 0.702 inch from the pitch line, in the case of a one diametral pitch tooth, and is based on non-interference with all teeth from twelve teeth up.

Fig. 4 shows the shape of the hob tooth to reproduce the stub teeth of the gears generated on the Fellows gear shaper. The particular tooth in the figure is a 6/8 pitch tooth, and the proportions are given in terms of the pitch numbers so as to be easily applied to the other pitches; thus the height of the tooth above the pitch line is stated as: $1/6 + \frac{0.25}{8}$ where 8 is the addendum number of the pitch designation.

The shape of the rack or hob tooth to roll with the gears produced by the gear shaper should be generated from the cutter used. The Fellows cutters have perfect involutes above the base line, with radial flanks, so that the hob tooth would be straight only a distance from the pitch line equal to $0.0585 \times N \div P$, where N is the number of teeth in the cutter; in most cases the cutter would have more than seventeen teeth and the hob tooth would be straight-sided to the point. In this system the radial flank of cutters with more than seventeen teeth does not affect the shape of the face of the tooth, as the involute portion of the cutter tooth generates a pure involute. The straight side of the hob tooth should extend to the root in such cases.

To reproduce gears of some standard the exact shape of which is not known, the hob-tooth shape can be easily generated from the gear tooth on the milling machine, as will be explained in a subsequent part of this article.

Applications of the Hobbing Process

The hobbing process is not limited to the production of gears, but can be used to generate teeth of almost any shape, such as the teeth of ratchets, milling cutters, reamers with equally spaced teeth, chucking drills, multiple splined shafts

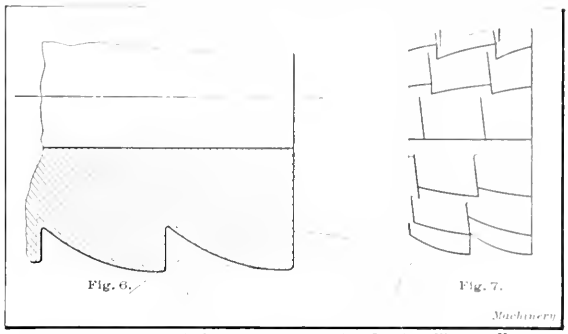

Fig. 6. Type of Hob for generating Ratchet Teeth. Fig. 7. View showing the Relief in the Hob for generating Ratchet Teeth

for automobile transmissions, cams, sprockets, etc. Fig. 5 shows the shape of hob tooth to generate the teeth of ratchets. There is no shape of tooth that will generate the radial teeth of ratchets of the type shown at A; the nearest that can be obtained is the modified shape at B with the filleted root. Should the tooth of the hob be made straight and normal to the axis of the hob, the tooth produced would be undercut as shown at C.

The shape shown is generated from a 12-tooth radial ratchet and would produce a nearer approach to the radial form in ratchets of a larger number of teeth. The back of the teeth would be concave instead of straight in the case of larger numbers of teeth. A good compromise would be to make the back of the hob tooth straighter, the shape being obtained by generating from a ratchet of, say, forty-eight teeth. The back of the teeth of ratchets of a smaller number of teeth would then be convex in shape. Hobs of this kind have been used successfully in hobbing milling cutters, a single hob covering a limited range of sizes. The difficulty in having a hob cover a wide range of cutter sizes is the fact that the pitch of the teeth is not constant, as in the case of gearing. When making cutters in quantities, the cost of the hob is soon covered by the saving in the manufacture of the cutters over the cost of milling. In the case of spiral cutters, the angle can be altered to make it possible to make the hob cover a greater range of sizes. The hobbing process is especially adapted to the making of spiral milling cutters.

The form of hob shown in Fig. 6 is a cross between a hob and a formed milling cutter, and can be employed profitably in the milling of radial teeth by the hobbing process. The form is made with a normal face and is generated back as in the case just shown. The hob is set so as to be all on one side of the center of the blank being cut, as shown. The radial face of the tooth is formed with the face of the hob tooth acting as a fly-cutter, the form of the face being a reproduction of the face of the last hob tooth, which is set radial with the axis of the blank. The fronts of the hob teeth are relieved on the sides; this can be done by using the combined side and radial relief cams, or, if that combination is not available, the side relief can be given as a separate operation. The latter will cause a widening of the top of the tooth as the hob wears back in sharpening. Fig.

7 shows a view of the hob. The convex shape of the generated form of the hob tooth will have the same effect on the shape of the back of the tooth as stated above in the case of the generated hob. This portion of the tooth cannot be made to act as a fly-tool, as it cannot be set on the radial line and must generate the form by a regular generating action.

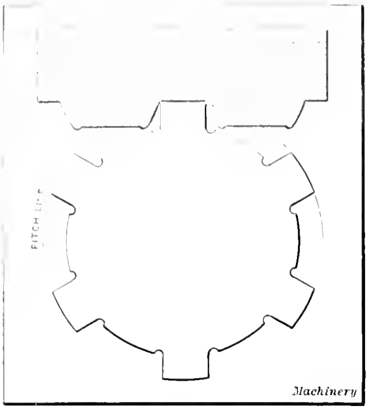

Fig. 8. Hob Tooth for generating a Six-spline Shaft

A form of hob that can be used to advantage in the automobile industry is that for forming the splines on the transmission shaft. This shaft commonly has six splines, as shown in Fig. 8. The face of the splines or teeth have a negative rake, being set ahead of the radial line, and for that reason can be formed with the hob if the depth and thickness are not too great in proportion to the diameter. In the illustration the proportion is six to one, and the hob form is such as to give a very close approximation to the desired form; however, if the shafts are to be used as left by the hob, that is, without grinding, it would be well to make the broach by the same process to insure a duplication of shape in the keyways in the gears. In all these special forms the pitch is taken from the outside of the blank; if taken inside of this point, the hob tooth, if radial, would have to be undercut, which is not practical.

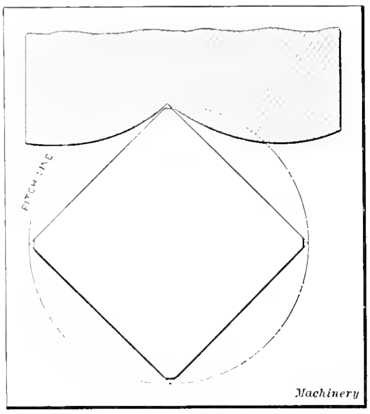

Fig. 9. Hob Tooth Shape for generating Squares

In Fig. 9 is shown another shape that could be used to advantage for hobbing squares. Hobs for this purpose could be used in squaring the ends of such shafts as, for instance, the ends of milling machine feed-screws, cross-screws, and the elevating shafts. If there is a job that is handled to disadvantage on the milling machine, it is the squaring of these shafts and screws. A similar hob could be developed for the hobbing of hexagons and other polygon shapes on the ends of shafts, or for the heads of bolts.

The great disadvantage of the hobbing of the shapes just mentioned is the low number of "teeth" or divisions, which necessitates a rapid travel of the index gear and high ratio gears to give the proper spacing, and also the long lead of the hobs. The latter is not so objectionable in the case of the small squares and hexagons generally used, as the lead in most cases can be lower than one inch.

The examples given do not exhaust the field for the hobbing process, but give an array of cases which are out of the ordinary and show the application of the process to other than the ordinary work of gear-cutting. The shapes have been laid out on the drawing-board in each instance, but a far more accurate way to obtain them is by generating them on the milling machine. This generating process is in reality a duplication of the hobbing process, but in generating the tooth shape for the hob the process is reversed, that is, the shape to be generated by the hob is used in generating the hob-tooth shape.

Generating Hob-tooth Shapes

In Fig. 10 is shown a milling machine set up for generating the hob-tooth templet. This is done on the universal milling machine, or on the plain milling machine if the screw can be connected up with the worm of the dividing head, as in milling spiral work. The spindle of the dividing head is set vertical, and the master gear or templet of the shape it is desired to produce by hobbing is mounted on an arbor in the spindle. In making the master templets, care should be taken to produce the correct shape and to be sure that the shape is true with the hole; if the templet is not true, the shape generated will not be accurate, of course.

[The gearing connecting the feed-screw and the dividing-head must be for a lead equal to the circumference of the pitch circle of the gear from which the hob templet is generated.—EDITOR.]

To provide a rest on which the tool templet to be laid out may be clamped, a parallel is bolted to the outer arbor support so as to be horizontal and parallel with the milling machine table and at right angles to the machine spindle. The rest may also be in the form of an angle plate clamped to the face of the column, but the former type is the most desirable, as it brings the work in a more accessible position.

The blank templet should be a piece of sheet steel about one-sixteenth inch thick, one edge of which should be straight and true and the surfaces smooth and bright. The surface to be laid out can be given a coat of copper solution, or, still better, varnished so that the lines may be etched deeper, as the handling in working out the shape tends to obliterate the shallow lines in the thin copper coat. This blank templet can then be clamped to the rest in a convenient position. There must be plenty of room for the travel of the gear, so as to obtain the proper amount of "roll" to generate the shape desired. The true edge of the plate should be parallel with the rest and the direction of the movement of the milling machine table. Adjust the knee vertically so that the plate will come up under the gear on the dividing head so as to just clear it; the saddle can then be adjusted across to bring the edge of the plate in line with the end of a tooth in the gear when the center line of the tooth is about at right angles to the axis of the feed-screw as shown in Fig. 11. In this way the templet is set to the proper position for depth. The backlash should be taken up by turning the screw in the direction in which it is to be used.

Now select a tooth space *A*, Fig. 11, as the one to be used in the scribing operation, and run the point of a slim, sharp scriber along the outline of the tooth space, scratching the line on the plate; then move the table about one-half turn of the lead-screw and scribe another line, and repeat the operation until the table has been moved through a length equal to three times the circular pitch. When this has been done the lines on the templet will resemble that in Fig. 12. The lines should now be etched in and the plate polished.

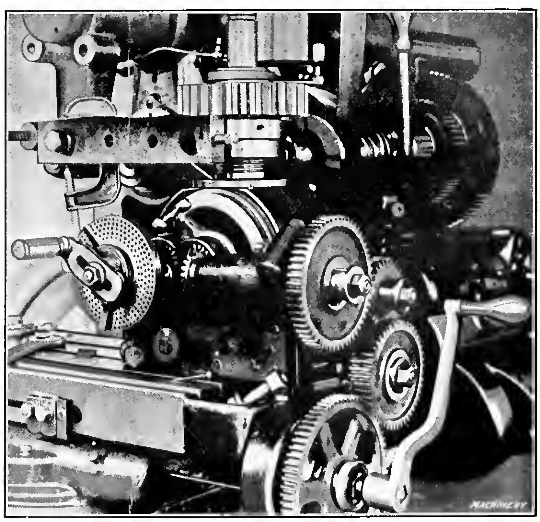

Fig. 10. Milling Machine set up for laying out the Shape of a Hob Tooth

The combined lines on the plate will be seen to describe the rack tooth shape of the hob teeth in a clear-cut manner, if the operation has been carefully carried out. If the gear tooth from which the lines were taken is theoretically correct, the sides of the outline on the plate will be straight a greater portion of the way from the point of the tooth to the edge of the plate; the lines diverge from the straight line at a point near the edge of the plate, as shown by the dotted lines in Fig. 12. This point will be found to be, in the case of the 14½-degree tooth, at a distance from the pitch line of $0.0313 \times N \div P$, where N is the number of teeth in the gear and P the diametral pitch. If the hob to

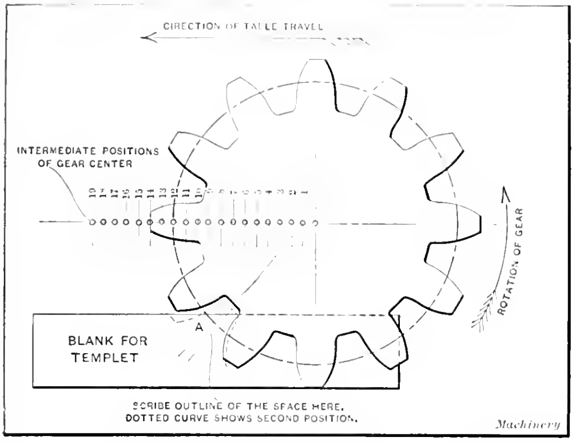

Fig. 11. View showing the Relative Position of Gear and Templet

be made from this form is to be used for N teeth or less, the shape of the templet will be correct, but if the hob is to cut gears of a larger number of teeth, the straight portion of the tooth must be carried down to the edge of the plate in order that the teeth of the larger gears will not be cut away too much at the points.

In making a templet in this way for any other shape than for gears, it should be cut to the lines on the plate, as no correction can be intelligently made in those cases. Some success has been made in the layout of templets for a hob tooth for gears of a limited range of teeth by using the space below the pitch line of the smallest gear in the set and the space above the pitch line of the largest gear in the set as the shape in generating the hob tooth templet. This is of value in generating a hob-tooth shape to reproduce a set of gears milled with formed cutters. However, the best and easiest method is to take the smallest gear in the set as the one from which to generate, and prolong the straight portion of the hob tooth to the edge of the plate, easing the side at A, to point the teeth slightly. The teeth of the hob are generally made with an extra clearance at the bottom as shown. This is a matter on which authorities differ, some preferring to have the hob cut the top of the teeth, to make the teeth of standard length if the blanks should be over size; however, the general practice is to make the tooth the same length both above and below the pitch line as in Figs. 2 and 3.

If the form is for a generated gear and results in the straight-sided tool in Fig. 12, all that is necessary is to measure the angle and make a thread tool that will cut a thread of this section. Should the shape turn out to be a compound of curves, as will be the case in reproducing the milled tooth, the templet should be filed out to the lines, making a female gage to which a planing tool is made, the planing tool being a duplicate of the hob-tooth shape. The threading tool is planed up with this tool. In making the thread tool, it is not usual to make it of female shape, that is, like the templet, but pointed as usual, planing the sides with the opposite sides of the planing tool. The proper corrections should be made in the thread tool to correspond to the angle of the thread, and the setting of the tool and the fluting of the hob, whether it is gashed parallel to the axis or normal to the thread helix.

A master planing tool can be made in the following manner, without the use of the scribed line templet. It is necessary to have a universal milling attachment for the milling machine. The spindle of the attachment is set in the horizontal position with the axis parallel with the direction of the table movement. A fly-tool holder is then placed in the spindle, in which the blank planing tool is to be held. This tool should be roughly formed to the shape to which it is to be finished. The top of the tool should be radial, that is, it should be in the plane of the center of the spindle. The gear or other master templet that it is desired to duplicate by hobbing must be hardened and ground to a cutting edge on one face, preferably the top face when mounted in the spindle of the dividing head, so that the pressure of the cut will be downward. The knee should be adjusted to bring the ground face of the gear to the level of the center of the spindle of the attachment. The dividing head and the table screw are connected in the same way as previously described, but in this case the power feed can be used and the saddle can be fed in to depth as needed, care being taken to use the power feed, in generating the tool, only in one direction, as the backlash in the gears and screw will throw the tool and dividing head out of relative position if used in the opposite direction. As many cuts can be taken as required to obtain a tool of the correct shape.

If the tool is to be used in making more than one threading tool, as might be the case in many instances, the planing tool can be made in the shape of a circular tool which can be ground indefinitely without losing the shape. In this case the fly-tool holder would give place to the standard milling machine arbor. This method is the most accurate way of making the master planing tool, and where the universal milling attachment is available, it should be used where accurate results are desired. It eliminates the human element and the amount of skill required in making the master templet. The inaccuracy of the machine is the only element that is likely to cause error.

One point that is likely to cause difficulty is the relation of the generated tool shape to the thread shape, as it appears in the normal section of the hob tooth. The simple fact is that the master tool shape, as generated by the direct method of making the master planing tool, or the shape as outlined on the hob tooth templet in the first method, is

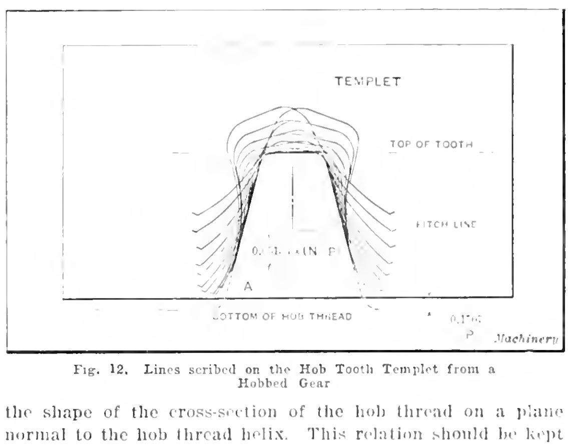

Fig. 12. Lines scribed on the Hob Tooth Templet from a Hobbed Gear

the shape of the cross-section of the hob thread on a plane normal to the hob thread helix. This relation should be kept in mind throughout the process of making the tools and hob. This statement also clears any haziness regarding the question of the lead, as in single-threaded hobs this must be such that the normal pitch of the thread is equal to the circular pitch of the teeth hobbed. In the case of hobs of small thread angles, the normal and axial leads are practically the same, and may be treated as such in cases where the angle is less than 2 degrees and the pitch less than ½ inch; an error of more than 0.00025 inch should not be exceeded in any case. The effect of the error is apparent in the case of a 6 diametral pitch hob 3 inches in diameter, when the axial lead is taken as the circular pitch of the teeth, as it results in an error of more than one-half degree in the pressure angle of the hobbed tooth. Only in extreme cases should the angle of the hob thread be more than ten degrees.

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WHY A MAN IS PROMOTED

Anyone who has worked in a machine shop is familiar with expressions such as this: "They made him foreman of the tool-room and yet he is not much of a toolmaker. Why, he couldn't turn out the kind of work that Jim Higgins can do; he couldn't begin to touch it." Thus his fellow-workers judge the new foreman's ability as foreman only from the point of view of his manual skill, forgetting entirely that a good foreman must have other qualifications besides skill in his trade. To be a good toolmaker is very desirable for a tool-room foreman, but it by no means follows that every good toolmaker will make a good foreman. In fact, the most skillful toolmakers are likely to make the least successful foremen, for the reason that their development has been altogether along lines of skill in their trade, and other qualifications have remained dormant. A foreman should have executive ability, good judgment, a knowledge of men, and tact; and if he has a fair proportion of these qualifications, he can get along with a comparatively meager toolmaking ability. He is not supposed to *make* the tools; he is supposed to know *how* to make them, and it is a curious fact that people whose hands are not very skilled in doing certain work often possess the ability to tell others how to do it.

The same also holds true in regard to positions above that of foreman. The superintendent need not always be a man versed in all the details of the operations performed in the shop. The more he knows about the details the better, of course, but if his foremen are of the right type, they should be depended upon to look after details. His work should be of a general supervisory and advisory character. He should not be burdened with detail, but should be left free to get a good perspective view of the work in the whole factory; to see that all the departments work in cooperation; that harmonious relations exist; that the methods used are the most modern; that nothing is permitted to get into a rut; that causes for friction between employer and employe are adjusted; that the capacity of the plant is suited to the demands on it; that there is no waste of labor due to inefficient methods; and that systems are not being worked for system's sake. If he is able to look after all of these things efficiently, he will make a pretty good superintendent, even if he should happen to lack information on some of the details relating to the work in camming up an automatic screw machine.

STANDARDIZING ENGINEERING DATA

The confusion that exists in the engineering trades, due to the lack of a standard for straight pipe taps, has caused much trouble to firms making and using taps and dies for producing this class of threads. The various manufacturers of dies and taps each have tables by which these tools are made, and taps, dies and gages bought from different manufacturers differ slightly in their diametral dimensions. In one case a manufacturer threaded three thousand valve stems with dies obtained from one maker, and upon comparing them with a gage obtained from another, found considerable discrepancy in the dimensions.

The American Society of Mechanical Engineers is endeavoring to do some work toward establishing standards, but the methods of doing the work so far adopted are inadequate to produce the results which the engineering world has a right to expect from an association of its reputation. To accomplish the desired results the society should concentrate more on work looking toward standardization of engineering data; there is no field in which more useful work can be done. It is hardly possible, however, for a large engineering society to carry out work of this kind simply by forming committees of members who receive no compensation for their work and give only their spare time to it. Such work must be carried forward in a systematic manner by picked men who are paid for their time, and the society would be warranted in using a portion of its funds for this purpose.

We think the watchword of an engineering society should be "efficiency"; but the efficiency of a society is not apparent unless it can point to some constructive and useful work having been performed, not merely by individual members, but by the society as a body.

* * *

HOLDING FAST TO THE GOOD

During the past few years there has been much said in regard to the narrow guide on machine tools. The narrow guide is undoubtedly an advantageous feature of machine design, whether applied to machine tools or any other type of machinery requiring slides to move in a rectilinear path with a minimum of friction and wear. The binding action of comparatively short slides in wide guides is well illustrated in the drawers of wide furniture, and someone has referred to it as the "bureau drawer" effect—a very expressive term.

The revival of the narrow guide in American machine tool design—for a revival it is—is an illustration of how valuable ideas are sometimes employed and then discarded for no apparently good reason. They seem to fall out of sight. As an illustration, the Gleason gear planer of the former type was built in 1876 with a narrow guide for the housing, but in later designs this admirable feature was not used. The value of the feature was apparently lost sight of for a number of years, when it was revived in the designs now being built.

It is important to originate and progress, but it is equally important to hold onto that which has been proved good. The principle applies not only to machine building, but to every activity of life.

* * *

THE POLICY OF SECRECY

It is hardly conceivable that there are no standard dimensions for so simple a thing as a nut for a 3/16-inch bolt. Yet it appears that no dimensions for nut diameters smaller than ¼ inch have ever been standardized, and it is practically impossible to obtain from manufacturers of nuts any tables giving dimensions for these sizes. In an endeavor to amplify the data we have published relative to standard dimensions of bolts and nuts, we tried to obtain from a number of manufacturers the dimensions used in making this class of nuts; but in all instances the replies were evasive, and we were unable to obtain a list of dimensions for small nuts, although tens of thousands are manufactured annually, and the manufacturers must have some tables or data from which to work. Of course, there is no generally recognized standard for these small machine details, but if manufacturers were not so reluctant above giving out information when secrecy cannot be of the slightest advantage, it would be possible to establish a standard.

Our readers frequently write us asking why we have not published information on this or that subject. To most of these inquiries we must answer that the manufacturers, even of articles which can be bought in the open market and measured, on account of some narrow policy, refuse to give out information which will make it possible to place on record the required data.

* * *

SOME POSSIBILITIES OF MOVING PICTURES

The general possibilities of moving pictures in the industries have been discussed in MACHINERY from time to time, but being a fruitful field we shall undoubtedly have occasion to refer to them frequently in the future. Like many other inventions, the moving picture has been applied to uses not thought of by the originators. The spread of the moving picture theater has been astonishing, and nearly every small town has at least one in operation. The capital investment in these enterprises and in the manufacture of films and machines is enormous. The large profit in the business makes possible more rapid developments than in other lines.

One interesting development is showing the pictures of lost men and women on the screen of theaters all over the country. If these persons are alive the probability of identification is greatly multiplied as compared with the means commonly used. Another development is the dissemination of pictorial news which is shown to thousands, thus spreading knowledge of places, men, historical pageants and notable events more vividly than can be done by the newspapers.

The uses that will be made of moving pictures in the machinery industry have hardly been touched, although their application in marketing machinery is beginning to be appreciated by some manufacturers. That they will become a most important factor in marketing many products is evident to those who have studied the subject.

An aspect of the moving picture which has received little attention so far is the possibility of making drawings "alive." The drawing of a machine can be understood only by a mechanically trained mind, and to one who is not familiar with mechanical drawing an ordinary blueprint means little. Even the trained mechanic experiences some difficulty in imagining all the relations of the parts when in operation, especially if the movements are at all complicated.

The moving picture affords the means of building machinery in the drafting-room—machinery that will "run" and show the functions of the various parts. To secure such results means making many drawings, sufficient to illustrate a complete cycle as observed from any desired viewpoint. Moving pictures requiring several thousand drawings to illustrate the humorous conceptions of famous caricaturists have been successfully produced, the illusion being perfect.

The moving picture has been applied lately to the demonstration of automatic machinery before the patent courts. Few jurors are mechanical men, and it is difficult for them to grasp the principles of operation of automatic machinery, such as is used for making shoes, for example. Recently the moving picture of an automatic shoe machine in full operation was made use of to illustrate its action to a court with great success.

The value of moving pictures is limited as yet in teaching trades, and it is difficult to show clearly the operations of machines on account of intervening parts. In the latter case, the natural position of an operator at work, between his machine and the camera, also interferes with the photographer. In automatic machine work opaque objects may sometimes be replaced by glass parts through which the other parts can be photographed. The operation of pumps for students studying physics and some other operations have been shown in this way, and undoubtedly other developments will be worked out to facilitate the use of moving pictures for such purposes.

To the scientific manager, the possibility of doing experimental work on paper instead of using costly iron and steel will appeal strongly. It will be done cheaper, quicker and more quietly; and if successful, the films will be useful as a means of demonstrating the action to prospective buyers.

STEEL DRIVING BELTS

In a paper on steel-belt power transmission read before the Textile Institute of Manchester, England, February 24, the following information, not previously published, is contained.

A great many of the Lancashire textile mills that in the past have used rope drives are now equipped with steel driving belts. One of the most important advantages of the steel driving belt is the small percentage of loss of power in the power transmission. It has been thought, in general, that steel belts could be used only for comparatively light powers, but, at the present time, there are steel belt drives installed transmitting all the way from 10 to 3650 horsepower. The steel belts—manufactured by the Eloesser Kraftband Gesellschaft, Charlottenburg, Germany—are made from a charcoal steel hardened by a process which is kept secret by the manufacturers. The finished material has a tensile strength of 190,000 pounds per square inch. Owing to its great strength, the belt never need be stretched above its elastic limit, and, hence, the length of the belt is constant and no subsequent adjustment is required. The thickness of the belts varies, but never exceeds 0.040 inch. The widths used at present vary from 1½ to 8 inches, according to the working conditions and the maximum horsepower to be transmitted.

The ends of the belt are joined by a steel joint, so designed that it can be bent to the shape of the pulley when passing around it. The rims of the pulleys in present-day installations are covered with a layer of canvas to which is glued thin sheets of cork that are in contact with the steel belt.

During comparative tests carried out in Germany, and officially confirmed by the German government, it was found that a mill using five rope drives consumed 342 horsepower. When these drives were changed to steel belts the horsepower required was 318. In another case, where rope driving required 643 horsepower, steel belt drives, under similar conditions, consumed but 581 horsepower. At an English spinning mill the average power required with rope drives during a period of two weeks was 1020 horsepower, while with steel belts it was not more than 900 horsepower. Smaller installations have shown even a greater proportion of saving in the power losses.

The following details are given of the comparative cost of steel belting, leather belts and ropes, and also of the comparative size of steel belts required to replace cotton rope drives. In a case where 300 horsepower was transmitted at 250 revolutions per minute, the total cost of a rope drive installation was $1200. With leather belts the cost of installation would be practically the same, while with steel belts the total cost would not be more than $900. It is further stated that the power loss with rope drives would be 6 per cent; with leather belts, 4 per cent; and with steel belts, only ½ per cent. A steel belt 8 inches wide will take the place of eight cotton ropes 2 inches in diameter, or of a double leather belt 22 inches in width. In other instances, an 8-inch belt has been used to replace ten 2-inch ropes, and four 6-inch steel belts have been used to replace twenty-two 2-inch ropes, the horsepower required in the latter case being 900. Experiments made at the Charlottenburg Technical Institute, Germany, indicate that the coefficient of friction between the steel belts and the covered pulley is 0.27. A considerable number of rolling mills have adopted steel-belt drives in Germany.

While there is the advantage that the weight of steel belts is only about one-sixth of the weight of leather belts or ropes suitable for transmitting the same power, and while there seems to be no practical limit to the speed at which they can be run, there are also some disadvantages. So far, it has not been found feasible to use steel belts with fast and loose pulleys on account of the difficulty of shifting; neither are they adapted for cross belts where the distance between the centers of the pulleys is less than eighty times the width of the belt. They are not suitable to be run over very small pulleys on account of the severe bending stresses set up in the steel. In Great Britain this belt is handled by the Power Pulley Co., Ltd., Manchester. This concern claims excellent results from the installation in large cotton mills in the Manchester district.

BORING AND REAMING AUTOMOBILE ENGINE CYLINDERS

The method of machining automobile engine cylinders varies to a considerable extent throughout the automobile industry. In some plants they are rough-bored in a cylinder boring machine and finished by grinding. This is considered by many manufacturers to be the most practical method of finishing a cylinder that has a blind end. However, on engine cylinders of the T-head type where boring-bars having leaders can be used, the method of finishing the bore by boring and reaming is quite generally used. The Sterling Motor Co., Detroit, Mich., uses a Beaman & Smith cylinder boring machine, as illustrated in Fig. 1, and completes the cylinder bores in this machine by boring and reaming.

The bore is machined to the correct size in three cuts. A roughing cut, as shown in the set-up in Fig. 2, is first taken. Boring-bars having leaders that are guided by bushings in the lower part of the jig carry Kelly boring cutters, a better and closer view of which appears in Fig. 3. In the first cut, about 1/4 inch is removed from the diameter of the cylinder

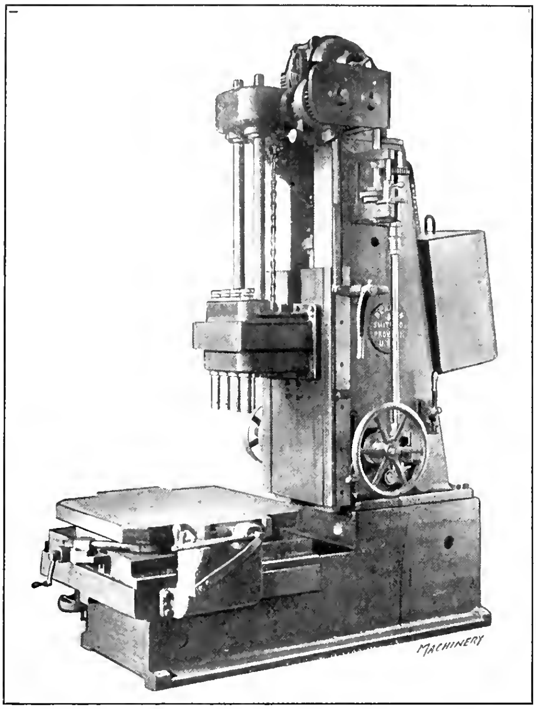

Fig. 1. Beaman & Smith Cylinder Boring Machine used for boring and reaming Engine Cylinders

bore; then the cylinders are annealed, after which they are brought back to the cylinder boring machine and two cuts taken, a finish-boring and a reaming cut. For the final boring and reaming operation a Kelly combination boring and reaming tool is used. This tool is arranged with the boring tool located ahead of the reamer, but set back to leave about 0.010 inch to be removed from the diameter of the cylinder bore by the reamers that follow. It is thus possible to take two cuts in one down travel of the head of the boring machine.

Referring to Fig. 1 it will be seen that the cylinder boring machine has a table of square section on which the work-holding fixture is held. This table is provided with two indexing points, so that a fixture which is capable of handling two pieces of work at the same time can be operated very economically. Fig. 2 shows a closer view of the fixture and gives a good idea of its construction. It will be seen that two castings are held in the fixture by means of swinging clamping straps, which also retain screws for holding the top portion of the cylinder rigidly in position. By having a table that can be indexed, it is possible to be operating the machine while removing and loading the other station on the fixture, so that the machine is kept in practically continuous

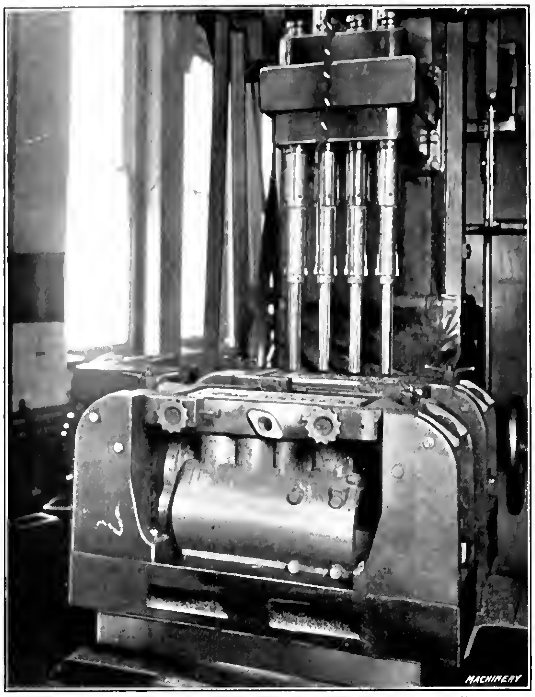

Fig. 2. Type of Fixture used in the Plant of the Sterling Motor Co., Detroit, Mich., for holding Four Cylinder Castings while boring and reaming

operation. This provides a very economical means of operating and greatly increases production. The finished dimensions of the cylinder illustrated are 2 3/4 inches diameter by 6 3/4 inches depth of bore, and a production of forty completed castings or 160 cylinder bores is obtained in ten hours.

D. T. H.

* * *

The lock-gate sills of the Panama Canal are all made from "greenheart," which is a large tree found in the dense jungles of northern South America, especially in British Guiana. The wood will bear, without crushing, a weight of six tons to the square inch, and will remain sound 100 years under water; it is immune to the attacks of the salt water teredo.

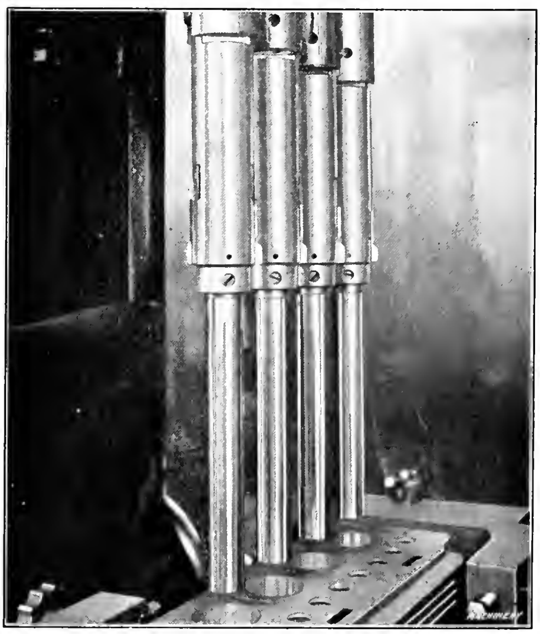

Fig. 3. Close View of the Kelly Boring Tools used for roughing out the Cylinder Bore

GAS AND OIL FIRED FURNACES FOR HEATING STEEL

TYPES OF FURNACES USED, AND IMPORTANT FEATURES OF THEIR CONSTRUCTION

BY E. F. LAKE*

IN the last decade many improvements have been made in furnaces in which steel is heated, to obtain greater accuracy and uniformity in the temperatures. Only a few years ago any temperature that was above that at which steel would harden and below that at which it would become burnt was considered good enough. In most steels this would cover a range of something like 300 degrees F. Recent investigation, however, has shown that only a few degrees of variation in temperature between these two points makes considerable difference in the hardness, the elastic limit, the reduction of area, or the longevity of steel, as shown by fatigue tests. For instance, to heat steel 50 degrees above the transformation or critical point, or the point at which it should be quenched for hardening, shows a loss of something like 15 per cent in these physical properties; and greater variations show correspondingly greater losses. Thus, while large furnaces formerly had a variation of some 50 to 100 degrees in different parts of the heating chamber, the modern furnace must be so designed that the temperature will not vary more than 10 degrees between any two places, when the furnaces are operated at temperatures that are between 1400 and 1800 degrees F.

The interior construction of the furnaces has, therefore, been changed; appliances for pre-heating the fuel have been devised; gas and oil burners have been improved; automatic heat control instruments have been attached; and heat measuring instruments of various kinds have been brought into use to register and record the temperatures. Other improvements have also been made to reduce the fuel consumption; considerable study has been devoted to this part of furnace design.

The consumption of fuels has been studied by the Bureau of Mines, at Washington, D. C. One of the things conclusively proved is that a solid wall is better than a hollow wall, especially if the air space is near the outer side of the furnace. The general belief has been that air spaces built into the walls of a furnace would greatly reduce the amount of heat that was dissipated through the walls. The investigation mentioned proved, however, that while heat would travel slowly through air, because it is a poor conductor, the heat would readily leap the air space by radiation, and thus a considerable percentage was lost that could have been saved if the air space had been filled with some solid non-conductor of heat.

These results caused the Industrial Furnace Co., of Detroit, to design and build furnaces in the manner shown in Fig. 1. In these *A* is the cast-iron shell or outer wall of the furnace; *B* is mineral wool, or asbestos, used as a heat-ing insulator; its thickness varies from 2 to 4 inches according to the size of the furnace; *C* is the inner fire-brick wall of the furnace; and *D*, the fire-brick floor. The burners are located at *E*, and the arrow heads show the direction in which the flames and hot gases circulate. After passing through the heating chamber and giving up their heat, the spent gases pass through the vents *V*. At *F* is a sliding door that is typical of such furnaces, and at *G* the peep-hole in the door, while *H* is a shelf in front of the furnace.

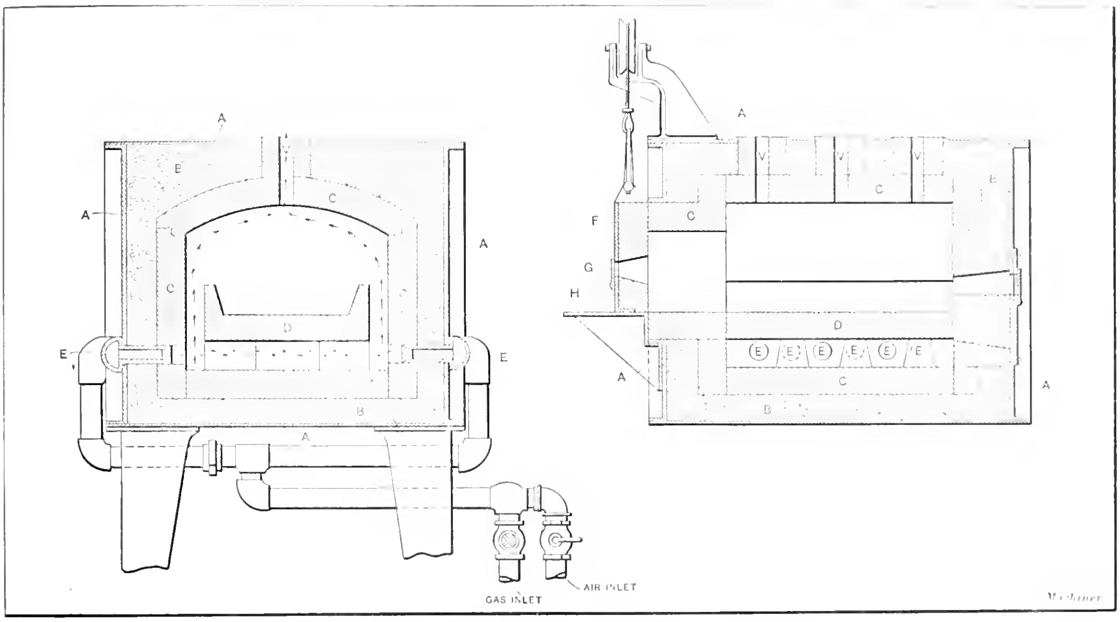

Fig. 1. Heating Furnace heavily lined with Asbestos to retain the Heat

Another method of economizing fuel is shown in Fig. 2. Here the Industrial Furnace Co. has taken two furnaces, similar to the one shown in Fig. 1, and provided a conduit connecting the side of one with the bottom of the other. This conduit is lined with asbestos and fire-brick, the same as the furnace, and can be taken off at any time, so that the furnaces may be used as separate units. In this twin furnace harrow springs are inserted in furnace *I*, to the left, and heated to the correct hardening temperature which is here maintained. After the gases have done their work in furnace *I*, they pass through conduit *J* to furnace *K*, at the right, and heat this to the correct temperature for drawing the temper of the springs. Thus the heat from the fuel is used the second time before it is allowed to escape to the atmosphere. In long furnaces several conduits are necessary to distribute the heat and make the temperature uniform in all parts of the heating chamber. The conduits should then be provided with dampers, so that the heat can easily be controlled. With only one conduit, however, the temperature within the heating chamber of the tempering furnace can be controlled by opening and closing the vent hole.

The same principle has been used by the Garrett-Tilley Furnace Co., of New York, in a three-chambered furnace,

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each part of which is maintained at a different temperature. This is built in a single unit as shown in Fig. 3; that is, the three different heating chambers are built inside of one furnace shell. In one instance this type of furnace has been used for manufacturing leaf springs. In that case, the heating chamber *L* is used to heat the spring plates to the fabricating heat, which is about 1800 degrees F. When taken from this fire the plates are bent to the correct shape to fit the leaf below, on which they have their bearing. After that they are inserted in the middle furnace or heating chamber *M*, to be heated to the hardening temperature, which is around 1500 degrees F. When heated to this temperature they are taken from furnace *M* and quenched in oil. After that they are inserted in the furnace or heating chamber *N*, and heated to the drawing temperature, which is about 750 degrees F. This allows an accurate control of the temperature in the three separate heating chambers, and each is maintained all day at its respective temperature of 1800, 1500, and 750 degrees F. In this case fuel oil is used for heating the furnace, and pyrometers are used to measure the heat in each oven, so that the temperature can be kept at the correct point.

The heating chambers in this furnace are about six feet in length, and it is especially designed to give a uniform temperature in all parts. On the test run the variation between any two places in each of the heating chambers was shown to be less than 10 degrees. This accuracy was obtained by overfiring and passing the heat through a honeycombed arch over the heating chamber, as shown by the sectional view at *O* in furnace *L*. This arch separates the combustion chamber *W* from the heating chamber *L*. The burners are located at *S* and the flames enter the furnace at *T* where they strike a baffle plate *R*. This distributes them to both sides of the heating chamber. After filling the heating chamber, the hot gases pass through the openings in the honeycombed arch, as shown at *U*, and heat the oven in which the work is placed. The spent gases then leave the heating chamber through ports *P*, pass underneath the floor of the furnace and up through the vents *V*. Thus the top, sides and bottom of the heating chamber are kept at the same temperature throughout its entire length. This over-fired principle has been applied to furnaces with a single heating chamber as well as to those that have two and three heating chambers, and has proved very successful.

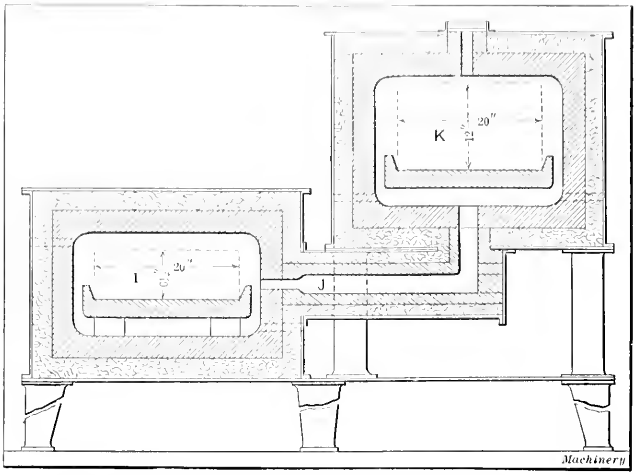

Fig. 2. Twin Furnace connected with a Conduit in order to make Use of the Heated Combustion Gases Twice

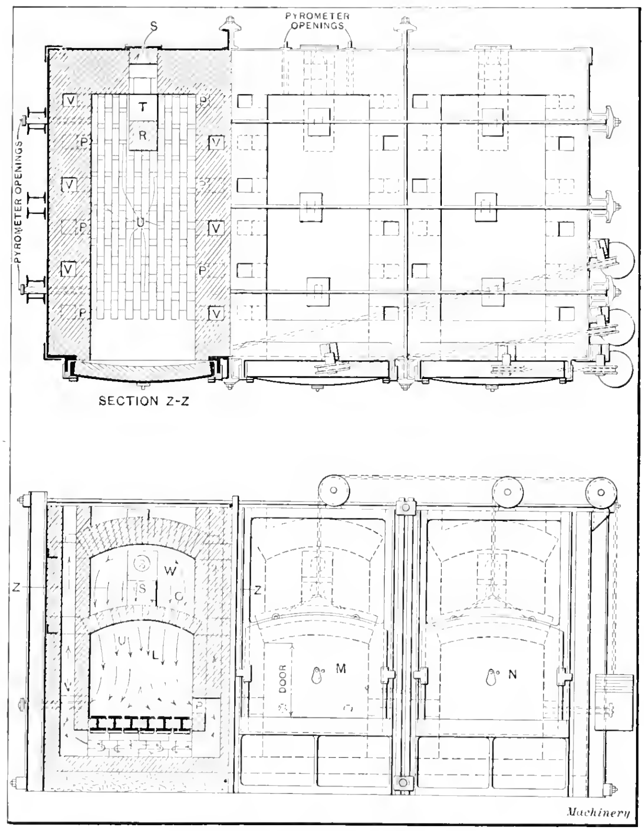

Fig. 3. Over-fired Furnace containing Three Heating Chambers arranged for Accurate Heat Control

Still another improvement in oil fired furnaces was recently patented by Walter S. Rockwell of the Rockwell Co., New York. This is shown in Fig. 4. It consists of a pipe coil through which the air is passed and pre-heated before it reaches the burners, where it is mixed with the fuel oil. This pre-heating coil *A* is located in front of the furnace, directly over door *B*, where it receives the heat which comes through the opening in which the work is inserted into the furnace. The plate *C* in front of the coil serves the purpose of protecting the furnace operator from the heat which comes through door opening *B*. One of these furnaces has been used by the Detroit-Timken Axle Co. for some time; it is claimed that the fuel consumption has been reduced by more than twenty-five per cent over that of furnaces that do not pre-heat the air. All or part of the waste gases can be made to pass through the door opening instead of through vents, and thus pre-heat the air to any desired degree.

The air for combustion enters the coil, under pressure from a pump, through pipe *D*, which is provided with valve *E* to regulate this pressure, so that the air and fuel oil will have the proper mixture. The heated air leaves the coil through pipes *F* and enters burners *H*, where it is mixed with the fuel oil which flows to the burners through pipes *I*, its rate of flow being controlled by valves *K*. The blast of hot gases then passes from burners *H* into heating chamber *L* to raise it to the correct temperature, and out through door *B* to heat the air in coil *A*.

Oil and gas fired furnaces are a great improvement over those that are fired with coal and coke, as with the latter it is impossible to keep the temperature in the furnace at a given point, and much of the heat is lost through the chimney which must be provided to carry away the smoke and gases. A large part of the furnace operator's time is taken up in shoveling in the coal or coke and carrying away the

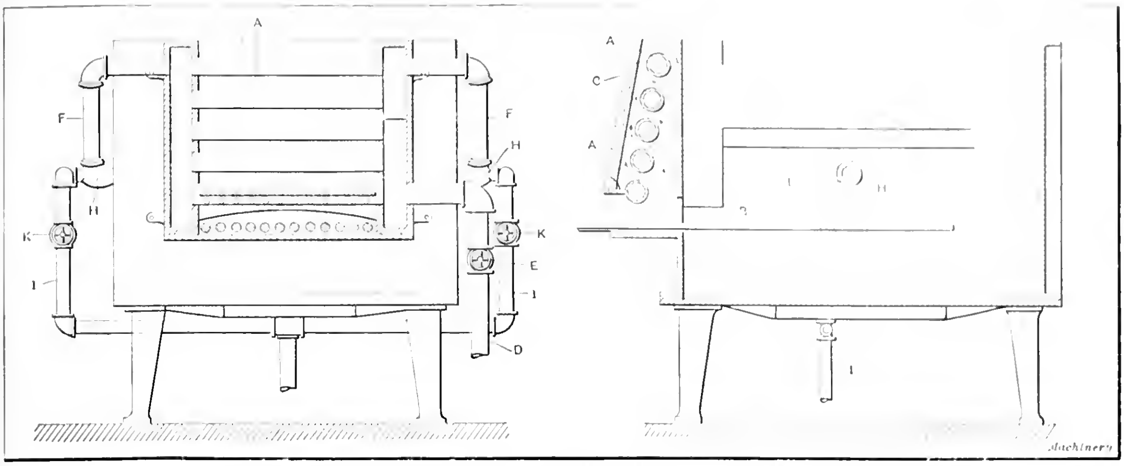

Fig. 4. Recently developed Type of Oil-burning Furnace in which the Air is pre-heated

ashes, while the dust and dirt that accumulates from these operations is, to say the least, very disagreeable. Then again the steels heated in such furnaces are more liable to oxidize and scale, and to absorb some of the sulphur or other injurious elements that arise from the combustion. It is a well known fact that steel absorbs such impurities more readily when heated to the high temperatures required for hardening, forging and welding. For these reasons, furnaces using liquid fuels or gas have improved the quality of metal heated in them, effected a considerable saving in fuel consumption, and saved time by allowing the operator to give more of his attention to the heating of the metal. They have also effected a big improvement in the cleanliness of rooms in which furnaces are located.

When gas and oil furnaces were first installed, a 50-degree variation in the temperature during a day's run or in different parts of the furnace was considered quite good performance, but recent improvements have brought this to a point where a 10-degree variation is all that is allowed in high-class furnaces. This has made it possible to heat-treat steels at more accurate predetermined temperatures, and thus give them greater strength and resistance to fatigue.

One of the greatest improvements that has been made for controlling the heat in the gas furnace is the temperature control instrument that is manufactured and attached to furnaces by the American Gas Furnace Co. This automatically increases and reduces the amount of gas and air that enters the burners, and hence raises and lowers the flame that enters the furnace. It is operated by a mechanism that is attached to the pyrometer. By means of a diaphragm this mechanism raises and lowers a sleeve containing gas and air ports, and thus increases or reduces the size of the port openings. With this instrument the heat inside the furnace can be kept within five degrees of the point at which the instrument is set, and the temperature can be maintained within this narrow limit as long as the gas and air blast keeps flowing into the furnace. The oil-burning furnace must be regulated by an adjustment of the oil and air valves by the furnace operator, as no instrument has yet been perfected that will do this automatically. Several individuals are working on this problem, however, and seem to have arrived at a solution. Thus it will probably be but a short time before a similar instrument will be devised for automatically controlling the temperatures in furnaces using oil for fuel.

Many improvements have also been made in oil- and gas-burning furnaces that heat liquid baths for raising the temperature of steel to the hardening temperatures. One of the improvements made in an oil-burning furnace is shown in Fig. 5. This was designed by W. S. Quigley of the Quigley

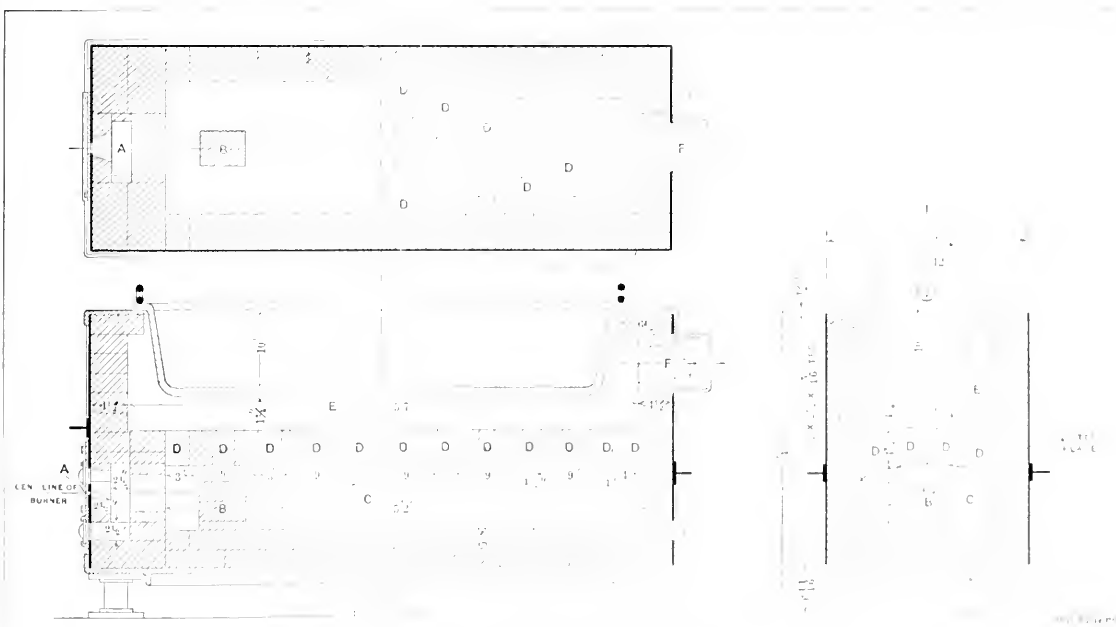

Fig. 5. Furnace for heating Liquid Bath

Furnace & Foundry Co. and uses a honeycombed arch similar to that shown in Fig. 3. The arch is used underneath a lead pot to separate the combustion chamber from the heating chamber and more evenly distribute the heat underneath the entire length of a five-foot lead pot. The flames from the burner enter opening *A* and strike the baffle plate *B* where they are broken up and distributed to both sides of combustion chamber *C*. The hot gases then pass through honeycombed openings *D* into heating chamber *E* and the spent gases leave the furnace through vent *F*. Salt hardening and tempering bath furnaces are finding more users every day,

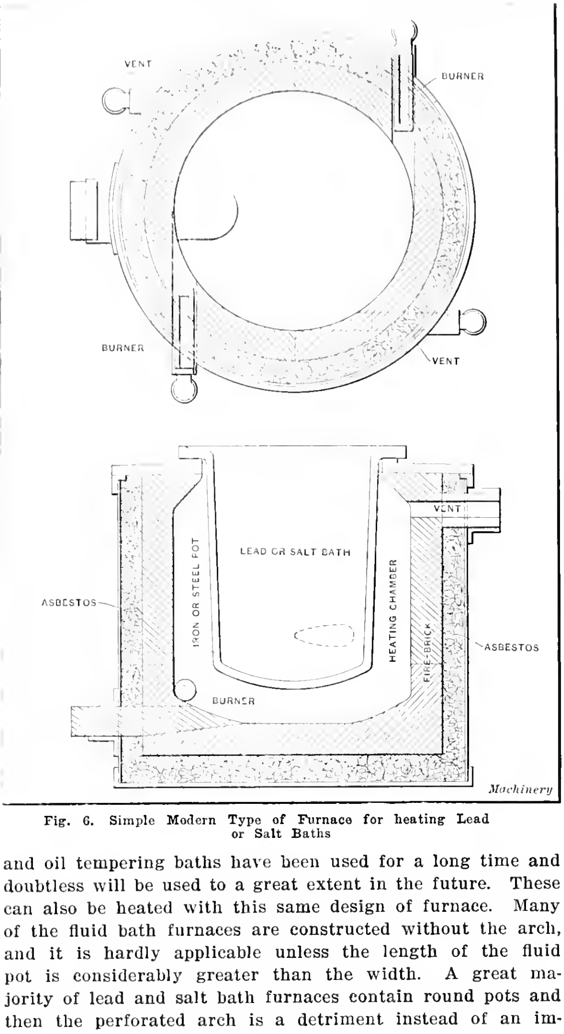

Fig. 6. Simple Modern Type of Furnace for heating Lead or Salt Baths

and oil tempering baths have been used for a long time and doubtless will be used to a great extent in the future. These can also be heated with this same design of furnace. Many of the fluid bath furnaces are constructed without the arch, and it is hardly applicable unless the length of the fluid pot is considerably greater than the width. A great majority of lead and salt bath furnaces contain round pots and then the perforated arch is a detriment instead of an improvement. This type of furnace is shown in Fig. 6.

* * *

LIMITS FOR THE TOOL DEPARTMENT

BY C. KNOWLES*

The tool department in any shop should be put on a commercial basis, *i. e.*, rate of production as well as quality of the work should be considered. It is often said that a toolmaker always uses the slowest speed and feed on his machine. This is not true in many cases, but it is a fact that much time is wasted by working too accurately. It is impossible for a toolmaker in a large shop to know much about the part for which he is making tools; therefore, he has no knowledge of conditions on which to form an opinion of the accuracy that is required. The foreman and inspector who have a great number of jobs to look after are even worse off in this respect. Of course, these men could make inquiries and thus obtain a knowledge of the fundamental facts of each case, but this would mean additional time and expense to charge against the department. The result is that many tool departments establish a standard of their own, which is too accurate for some jobs and not accurate enough for others.

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The proper time to decide on the allowable limits for each tool is at the time it is designed. In planning tools for the manufacture of a given part, the designer should thoroughly investigate the relation of this part to other members of the machine and specify the limit of accuracy accordingly. For example, if the work is a bracket with screw and dowel-pin holes and two bearings for shafts carrying gears in mesh, the following conditions will have to be met. The screw and dowel-pin holes must match the holes in the piece to which the bracket is secured. The designer knows that the stock screws used in the shop are a certain amount small, and that it is the custom to drill dowel-pin holes under size and ream them with the two parts in position. Thus he realizes that the jigs for the two parts do not have to be exactly right, but can vary from each other by the amount that the screws are smaller than the screw holes. The bearing holes for the shafts must not be too short on the center distance, as standard gears would bind under such conditions. On ordinary work, however, if the center distance is a trifle long, the resulting backlash will do no harm. The principal reason for making a jig is to provide interchangeability, and if a considerable number of the parts are to be manufactured, the cost of production will also be reduced. Accuracy is required in the jig for this purpose and it can only be made in a well equipped toolmaking department.

In many cases the jig is used because of the convenience with which it enables the work to be handled, thus reducing production costs. When interchangeability of parts is not a factor, scale measurements would be close enough and the jig could be made by an ordinary workman using manufacturing machines. In order to design tools intelligently, the designer must know all of these conditions, and his work is not complete unless he specifies the allowance limits or permissible variation from standard dimensions in each case. All locating points, studs and bushings, center distances and other dimensions, which, for any reason must be held close, should be given the widest limit that is consistent with the work that is to be produced by the tool. In all cases it should be borne in mind that the last 0.00025 inch means delay and expense. This recommendation in regard to the allowable variations from specified dimensions should be used on gages, cutting tools and all other classes of tool work.

Knowing the accuracy to which each tool must be finished, the tool-room foreman can lay out his work with the view of securing the greatest possible economy. The accurate work can be given to the men best qualified to handle it and these men can be assigned to the best machines in the tool-room. Similarly, the lower grade of work can be given to the less expert mechanics and these men can be given the use of manufacturing machines which can be forced with the view of increasing production. In many cases when the tool department is rushed, this low-grade work can be turned over to the manufacturing department with very satisfactory results. It is often necessary to duplicate a tool which was made at some previous time, and if the proper limits are recorded on the drawing, this can be done without measuring or referring to the old tool in any way.

The recommendations given in this article may be briefly summarized as follows: By having properly established and recorded limits we are able to obtain greater efficiency in the tool-room. Delays caused by investigations made by the foreman or workmen are avoided. The provision of exact information in regard to each tool makes it possible for the work of the tool-room to be put through more rapidly. The tools are adapted in both quality and accuracy for the work for which they are intended and economy is effected by giving the high-grade work to highly skilled mechanics, and less accurate work to men of more meager experience. The work is classified so that, if necessary, work which does not demand a high degree of accuracy may be sent out to the manufacturing departments. Tools may be made in duplicate or existing tools may be matched without involving the expense and delay caused by measuring tools already made.

AUTOMATIC INDEXING FIXTURE FOR CUTTING INTERNAL RATCHET GEARS

BY ALFRED SPANGENBERG*

In considering the design of fixtures for machining small parts in quantities, the introduction of automatic features will often effect a large saving in the cost per piece by cutting down the time between cuts. This applies particularly where the operations involve frequent indexing of the work, since the elimination of hand indexing, with the consequent starting and stopping of the machine, will effect a further economy in labor by enabling the operator to run two machines, thereby securing a material reduction in the cost per piece.

This principle is well illustrated in the accompanying illustrations, which show an automatic indexing fixture for cutting small internal ratchet gears on a Brown & Sharpe No. 3 milling machine equipped with a commercial slotting attachment. The fixture is in use at the Pond Works of the Niles-Bement-Pond Co., Plainfield, N. J. The ratchet gear *A* to be machined has thirty-two internal teeth of 1-inch face width by 1/16 inch depth, while the bore of the hole is 2¾ inches in diameter. A number of other sized gears are cut on this fixture by substituting indexing wheels *B* having the required number of teeth. As will be seen from Fig. 2, the fixture proper consists of a suitable bed-plate *C* that forms a bearing for stud *D*, to which is secured the indexing dial bearing *E*. Rigidity of the index wheel and its bearing *E* against the pressure of the cut is secured by a finished seat of ample diameter on casting *C*.

The index wheel and its members *D* and *E* are free to revolve on the bed-plate *C*, but to prevent over-travel during

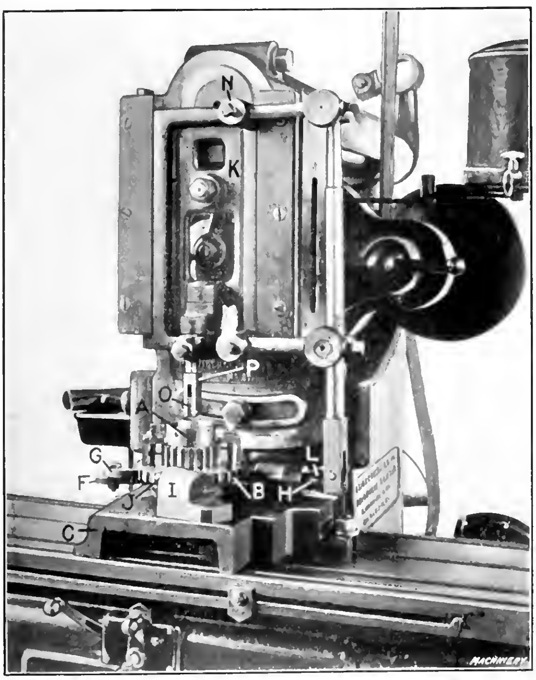

Fig. 1. Automatic Indexing Fixture in Position on Brown & Sharpe Milling Machine

the operation of indexing, a light tension is secured by means of a lock-nut and spring washer carried on the lower end of stud *D*, which imposes an additional friction between the under surface of the bearing *E* and the finished surface of the bed casting. The bearing *E* is turned on its periphery to fit the bore of the rocker *F* which carries a pawl *G* and the link connection to the spring plunger *H*. Cast integral with the bed-plate is a bearing *I* for the dial locating plunger *J* which is operated by a suitable spring contained within the bearing. Power for the automatic indexing is derived from the slotting attachment ram *K*, Fig. 1, to which the pawl *L* is attached by means of supporting rods.

In operation, the stroke of the ram is set to over-travel about one inch above the teeth in the work. This permits pawl *L*, during the over-travel on its upward stroke, to engage plunger *H*, the indexing being effected by means of the rocker *F* and its mechanism. The pawl *L* is hinged as shown, so that no indexing takes place during the downward stroke of the tool. The function of plunger *J* is to locate and hold the index dial *B* during the cutting stroke. Dotted lines at *M*, Fig. 2, show the normal position of plunger *J* against the index dial. The feeding only takes place upon the completion of each revolution of the work. The feeding of the work in to the tool is accomplished by moving the milling machine

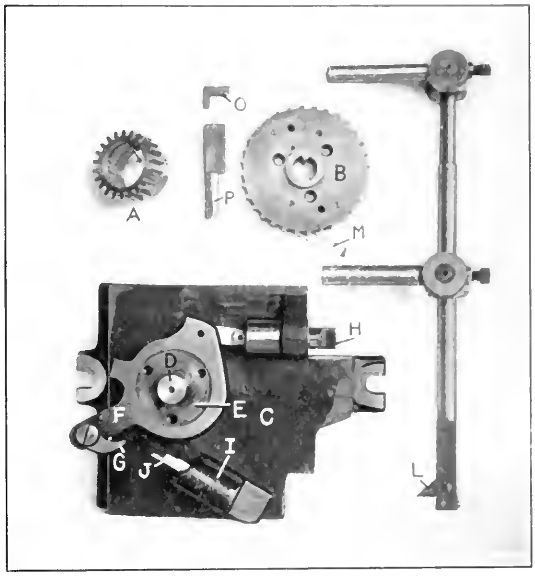

Fig. 2. Details of Fixture illustrated in Fig. 1

table crosswise by hand. At the start, the depth of cut is set at about 0.050 inch and this is gradually decreased at each revolution of the work until the final depth is reached, which requires three revolutions, because each successive cut is heavier.

As was previously stated, ratchet gears of several sizes having different numbers of teeth are cut on this fixture. Consequently, the rocker mechanism must be adjustable in its movement. This is provided for by a horizontal adjustment of the pawl-carrying arms in the studs *N*. The method of centering and clamping the work is made clear by a study of the illustrations. To provide relief for the cutter during its return stroke, the cutter *O* is made L-shaped and is hinged in its holder *P*. The tool-holder is drilled to receive a spring that presses against the heel of the cutter and so keeps it in its normal position.

Previous to the introduction of the fixture described in this article, the ratchet gears in question were cut on a regular slotting machine, using a somewhat similar fixture except that the indexing was accomplished by hand. This method produced about five finished ratchet gears per hour, while with the new method the output averages about twenty-five per hour—an increase of production of 500 per cent. The external gear teeth in these ratchet gears are, of course, previously finished in a regular gear-cutting machine.

* * *

Plans have been filed with the Bureau of Buildings, New York City, for an office building which will be 894 feet high. The structure is proposed to be built on the block bordered by Broadway, Eighth Ave., 57th and 58th Sts., and to be fifty-one stories high. The design is to follow the Gothic style. The building is to be built by the Pan-American State Association, and the tower will be surmounted by an allegorical figure representing the association. The estimated cost is $12,500,000.

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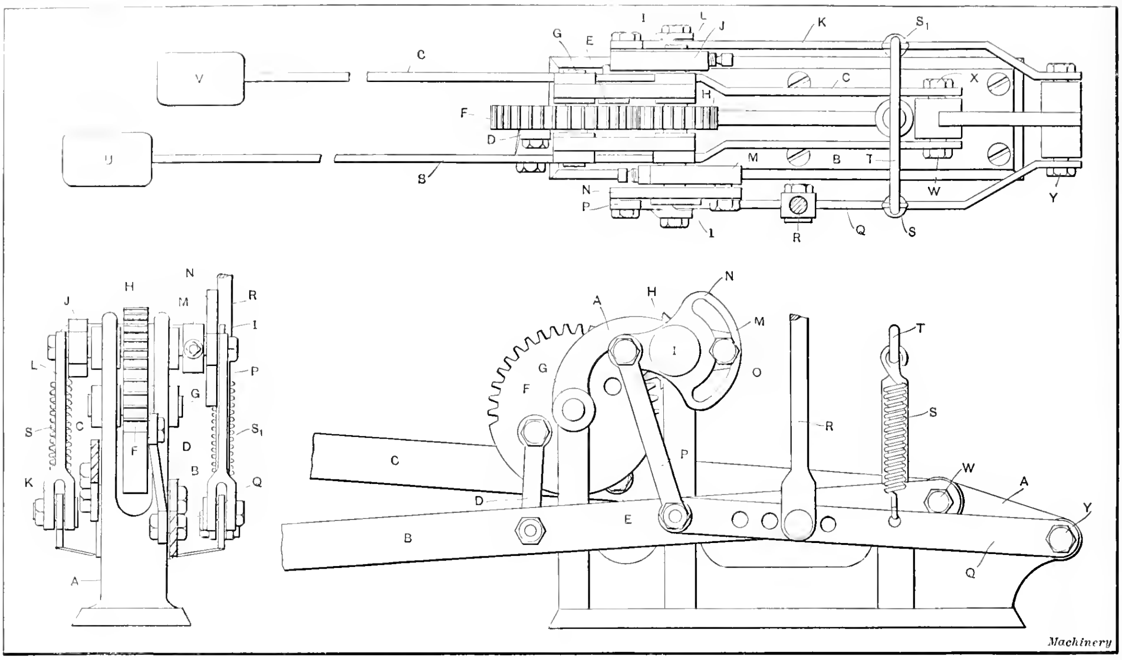
DUPLEX SAFETY TRIPPING DEVICE

BY JAMES H. RODGERS*

The cause of a great number of crippled hands of men employed in the iron or sheet-metal working trades can be traced to the power press, where the starting and stopping depends entirely upon the operator. The starting of a large majority of the different makes of power presses is by depressing the well known form of foot treadle located below the bed of the machine, which releases the latch that holds the clutch out of gear and allows the crankshaft to make one revolution. As soon as the press is in action the foot must be lifted or removed from the treadle to allow the latch to return to its former position. In nine cases out of ten, when an accident takes place, the operator will say that the press "repeated." This may or may not be true; but if the press did repeat, it was due largely—if not entirely—to a lack of caution displayed by the person operating it.

When an operator removes his foot from the treadle each time he trips the press, it requires double the number of movements to perform his work, and where from 10,000 to 30,000 operations a day are performed it involves considerable muscular action in the operator's leg and foot. Where an operator does not remove his foot from the treadle, but allows it to return after releasing the press, he must retain considerable tension upon the muscles of his limb in order to prevent the depression of the operating treadle before the proper time. Now, one not familiar with the operation of power presses has only to imagine what effect this muscular strain would have on a person who is practically holding the weight of his leg up for from seven to ten hours a day. Another objectionable feature of the method of tripping with an ordinary treadle, and one that is deserving of censure, is the custom of a large number of press operators of allowing the treadle to rise just far enough for the latch to operate the clutch-pin. The writer has seen cases where operators allow only one-eighth inch contact when there should be one-half inch. An observer can readily see that this perilous condition of affairs neither facilitates the operation nor increases the rapidity of action. But it does make it possible for the operator, when placing work in position, to unintentionally depress his foot sufficiently to trip the press, owing to his carelessness in not allowing the latch to return to its proper position. It is this condition more than any other that causes the majority of power press accidents.

The accompanying illustration shows a duplex safety tripping device which reduces to a minimum the number of accidents traceable to the carelessness of the operator. In this illustration, *A* is the frame casting that is secured to the floor below the press. Fulcrumed at *W* and *X* are the two treadle levers *B* and *C* which extend to the front of the machine in the ordinary manner. The links *D* and *E* connect the treadles *B* and *C* with the gear *F* at diametrically opposed points. The shaft *G* on which gear *F* is mounted rotates through an angle of about 60 degrees. Meshing with gear *F* and carried by the shaft *I* is the pinion *H*, and secured to the left-hand end of shaft *I* is the crank *J* which is connected to the lever *K* by the link *L*. On the opposite end of the shaft *I*, and secured to it, is another crank *M*. Outside the crank *M* and free to rotate is the slotted disk *N*, which is held in position by the head on the shaft *I* and the stud *O*. The link *P* connects the disk *N* with the auxiliary treadle lever *Q* which is fulcrumed at *Y*. The trip-rod *R* is secured to the auxiliary treadle lever *Q* in the ordinary manner. The teepost *T* carries the two springs *S* and S_1, which makes the action of the mechanism positive after the operator has tripped the press.



Duplex Safety Tripping Device for a Power Press

The foot is placed on the foot-rest *V* and pressed downward, lowering the treadle lever *C* and through the link *E*, rotating gear *F* in a clockwise direction. This causes the pinion *H* and the two cranks *J* and *M* to rotate in the opposite or counterclockwise direction. When the crank *M* has rotated through an angle of from 60 to 90 degrees, governed by the length of the slot in the disk *N*, the stud *O* comes into contact with the end of the slot and begins to rotate the disk *N*. Through the link *P*, auxiliary treadle lever *Q* and trip-rod *R*, the latch is released by the continued downward pressure of the operator's foot and then carried back to position to stop the press after the crankshaft has made one revolution. By lowering the other treadle *U* (which by the above action has been raised ready for the next operation) the movement of the mechanism is again performed in the opposite direction but with the same results. Every time either treadle is pushed down the press is released and automatically locked after making one revolution.

It will be seen from the illustration that the cranks *J* and *M* will have passed the center before the latch releases the clutch, and as the spring S_1 is under greater tension than the other spring *S*, the mechanism will perform the movement independent of the operator. The muscular tension on an operator's limb will, therefore, be reduced to a minimum.

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STEAM POWER PLANT PIPING DETAILS*—8

THE DESIGN AND ERECTION OF EXPANSION BENDS

BY WILLIAM F. FISCHER†

IN previous numbers of MACHINERY, rules and tables were presented from which to estimate the amount of expansion and contraction to be cared for in a steam main of a given length conveying steam at a given pressure. Having determined the amount of expansion to be cared for, the designer should next decide upon the most suitable method of compensation. For low-pressure steam and exhaust mains, expansion joints of any suitable standard make may be used to take up or relieve the strains on the piping system (see MACHINERY, November, 1913), but for high-pressure steam mains, it is customary and advisable to use expansion pipe bends made up of full-weight or extra-heavy steel or wrought-iron pipe. When the steam main is of considerable length it is advisable to divide the expansion between different sections of the piping system, anchor the main rigidly at a point near the middle of each section, and provide an expansion bend in each section, as mentioned and illustrated in a previous number of MACHINERY. Having decided upon the location of the expansion bends, the next question to be determined is the type of bend to be used and its dimensions. The exact amount of expansion that can be taken care of by a wrought-iron or steel pipe bend of given dimensions is a matter of some uncertainty. Distortion of a pipe bend beyond a certain stage throws very heavy bending strains on the pipe joints and outer fibers of the material from which the bend is made. Before excessive bending strains are reached, however, expansion bends, if properly proportioned and suited to the conditions, will prove as flexible as most other methods of caring for expansion and contraction, and will be found much safer in operation. The amount of expansion that can be taken care of by an expansion bend of wrought-iron or steel pipe depends upon the shape of the bend, the mean radius of the bend, the outside diameter of the pipe from which the bend is made, and the amount of straight pipe allowed between the arcs or curved portions of the bend.

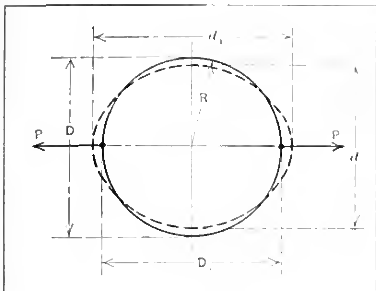

Fig. 61. Deflection in Ring due to Forces P

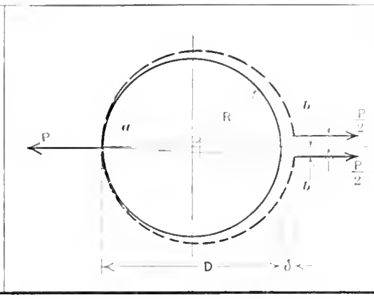

Fig. 62. Diagram used in deriving Formulas

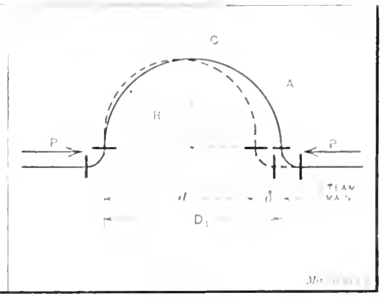

Fig. 63. U-pipe Bend strained by Expansion

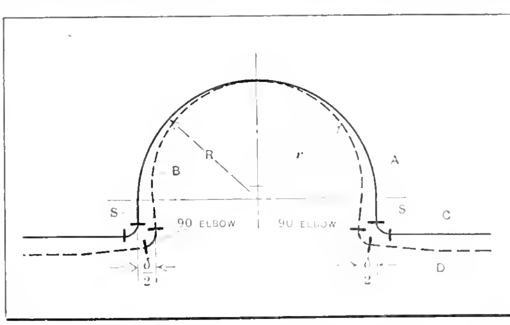

Fig. 64. Single U-expansion Bend connected to 90-degree Elbows

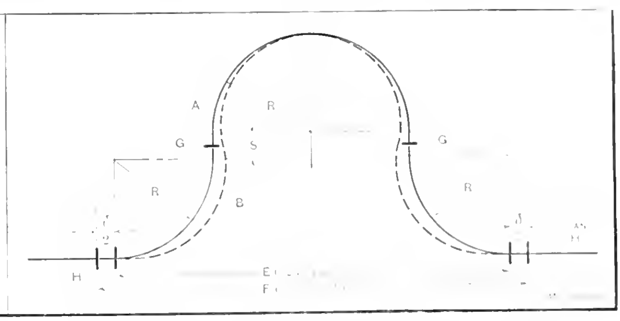

Fig. 65. Expansion Bend that reduces Bending Stress in Main

Practical data relating to the design of expansion bends is rather scarce. The writer has no excuse to offer in presenting the following approximate rules, formulas and tables relating to the design of expansion bends, other than the fact that they will be found well on the safe side for each case considered and that they are to be used as a guide in determining proportions rather than as hard and fast rules. In making up a steel or wrought iron pipe bend, it is necessary to provide a short length of straight pipe at each end where the flanges connect to the bend. It is also advisable to allow a short length of straight pipe between the arcs or curved portions of a bend, especially where the curve is reversed in direction as at S in Figs. 65 and 66. These short lengths of straight pipe will be found to increase the flexibility of the bend, but as it would greatly complicate the formulas, rules and tables, if taken into account, the writer has ignored its effect altogether and only considered the curved portions of the bend in each case. In preparing the formulas and tables for U-shaped expansion bends, the writer used the following rules and formulas for figuring the deflection of circular rings when acted upon by two equal and opposite forces.* Fig. 61 indicates a circular ring of mean radius R acted upon by two equal and opposite forces P. The dotted lines show the form the ring assumes under stress, D and D_1 being the mean vertical and horizontal diameters of the ring before the forces P are applied, and d and d_1 the mean vertical and horizontal diameters after the forces are applied. If we consider the ring to be cut at b and divide P into two equal parts, as indicated in Fig. 62, all motions may be considered to take place about the point a. In this case, the dotted lines show the form each half of the ring will assume under the action of the forces P and $\frac{P}{2}$, D being the original mean diameter of the ring and δ the deflection of the ring when cut and loaded as shown.

Let δ = horizontal deflection of ring in inches.
P = concentrated load, in pounds, acting upon ring;
R = mean radius of ring in inches;
E = modulus of elasticity of the material in ring,
I = moment of inertia of a cross-section of ring,
π = 3.1416.

* The seventh installment of "Steam Power Plant Piping Details" was published in the November number of MACHINERY.
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* See [illegible]

Then, according to Professor Hudson:

$$\delta = \frac{P\pi R^3}{4EI} \tag{11}$$

$$M_b = \frac{PR}{\pi} \tag{12}$$

where M_b = maximum bending moment on ring, in inch-pounds, due to concentrated load P.

In any segment of the ring, the external forces acting on the ring will be held in equilibrium by the internal, or resisting forces acting upon the segment at its two ends. Therefore, in order that the ring may be of sufficient strength, the resisting moment, M_r, in inch-pounds, due to the internal stresses at any section of the ring, should equal the bending moment, M_b, in inch-pounds at that section, due to the external forces. Therefore:

$$M_b = M_r \tag{13}$$

where M_b = maximum bending moment in inch-pounds;
M_r = corresponding resisting moment in inch-pounds.

From Formula (12) we find that $M_b = \frac{PR}{\pi}$. We also know that the resisting moment for a beam of any cross-section is:

$$M_r = \frac{fI}{y}. \tag{14}$$

where f = allowable fiber stress in pounds per square inch;
I = moment of inertia of a cross-section of the beam;
y = distance, in inches, from the neutral axis of beam to outermost fibers.

Therefore, if we substitute the above values in Formula (13) we have:

$$M_b = M_r \text{ or } \frac{PR}{\pi} = \frac{fI}{y}. \tag{15}$$

By transposing in (15) we get:

$$P = \frac{fI\pi}{Ry}. \tag{16}$$

Now if we substitute $\frac{fI\pi}{Ry}$ for P in Formula (11), we have:

$$\delta = P \times \frac{\pi R^3}{4EI} = \frac{fI\pi}{Ry} \times \frac{\pi R^3}{4EI}$$

$$\delta = \frac{f\pi^2 R^2}{4Ey}. \tag{17}$$

This formula gives the deflection δ of the ring in terms of the fiber stress f. See Figs. 61 and 62.

Formulas for Deflection of U-shaped Expansion Bends

In applying the above formulas to expansion bends, the writer assumes the conditions shown in Fig. 63, *i. e.*, a U-shaped expansion bend A, of radius R, acted upon by two equal and opposite forces P. These forces act in the direction of the arrows when the bend is caring for expansion in a steam main, and in the opposite direction when the bend is caring for contraction in a main. It should be noted that the expansion bend A is acted upon by two equal and opposite forces P, while each half of the split ring in Fig. 62 is loaded only one-half as much, being acted upon by two equal and opposite forces $\frac{P}{2}$. Therefore, in order to apply Formula (11) to expansion bends as shown in Fig. 63, the writer has multiplied the formula as it stands, by 2, as follows:

$$\delta = 2 \times \frac{P\pi R^3}{4EI} = \frac{P\pi R^3}{2EI}. \tag{18}$$

Formula (18) is not yet in the desired form for expansion bends, however, for the following reasons: In the case under consideration, the equal and opposite forces P cause the bend to deflect an amount δ. In the case of an expansion bend serving a steam main, however, the force P is unknown and would have to be determined before applying Formula (18). For example, when the steam main (Fig. 63) expands, it lengthens an amount δ, thereby causing the expansion bend A to deflect and close up an equal amount, as shown by the dotted lines. As the force of expansion is practically irresistible, we know that the bend must give sufficiently to take up the expansion in that particular section of the piping system served by the bend. Therefore it is not necessary to compute the magnitude of the thrust P due to expansion of the steam main, but rather to compute the unit fiber stress

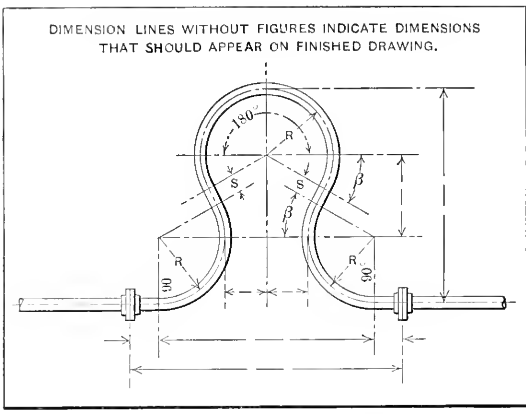

Fig. 66. Double Offset Expansion Bend

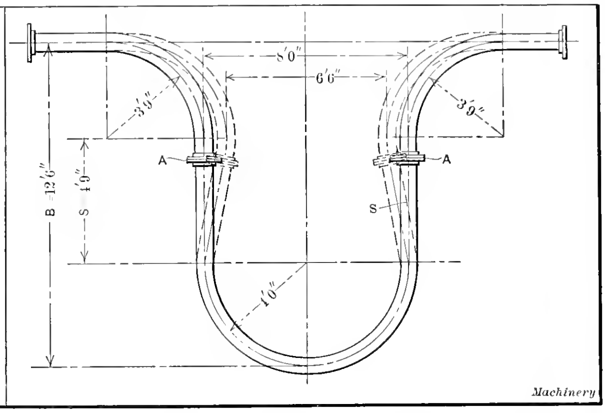

Fig. 67. Kellogg Improved Expansion Bend

f in pounds per square inch in the outer fibers of the material of the bend, due to the bend deflecting an amount δ. From Formula (17) we found $\delta = \frac{f\pi^2 R^2}{4Ey}$, which is the deflection of a ring in terms of the unit fiber stress f. Therefore, if we multiply by 2, we get for the deflection of an expansion bend in terms of the unit fiber stress f:

$$\delta = 2 \times \frac{f\pi^2 R^2}{4Ey} = \frac{f\pi^2 R^2}{2Ey}. \tag{19}$$

Substituting 9.87 for π^2 and transposing gives:

$$\delta = \frac{\pi^2 f R^2}{2Ey} = \frac{9.87 f R^2}{2Ey} = 5 \times \frac{fR^2}{Ey} \tag{20}$$

$$f = \frac{Ey\delta}{5R^2} \tag{21}$$

$$R = \sqrt{\frac{\delta E y}{5f}}. \tag{22}$$

Formulas (20), (21) and (22) are in the final form desired for U-shaped expansion bends—as shown in Figs. 63 and 64. For mild steel and wrought-iron pipe, the modulus of elasticity E may be taken as 29,000,000, in which case Formula (20) may be further simplified as follows:

For an allowable unit fiber stress f = 12,000 pounds per square inch:

$$\delta = \frac{5 \times 12{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.0021\,\frac{R^2}{y} \tag{23}$$

For an allowable unit fiber stress $f = 15{,}000$ pounds per square inch

$$\delta = \frac{5 \times 15{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.0026\,\frac{R^2}{y}. \qquad (24)$$

For an allowable unit fiber stress $f = 18{,}000$ pounds per square inch

$$\delta = \frac{5 \times 18{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.0031\,\frac{R^2}{y} \qquad (25)$$

and for an allowable unit fiber stress $f = 20{,}000$ pounds per square inch

$$\delta = \frac{5 \times 20{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.00345\,\frac{R^2}{y}. \qquad (26)$$

Formulas (23) to (26), inclusive, were used by the writer in estimating the values of δ in Tables X to XIII inclusive.

Formulas (20) to (26), inclusive, may be applied to U-shaped expansion bends as illustrated in Figs. 63 and 64, where the short lengths of straight pipe at each end of the bend are not considered. Values of y, for the different standard sized pipes will be found in the fifth column of Table IX, and in the sixth column of this table will be found values of the moment of inertia I, to be used in connection with Formula (18) in cases where the concentrated load P is known. To illustrate the use of Formulas (20), (21) and (22), and Tables IX to XIII the following examples are given:

Example 1:—The expansion δ of a 6-inch steam main is found by calculation to be 1.44 inch and it is desired to care for this expansion by installing a 6-inch U-bend as illustrated in Fig. 63. To what radius should the bend be curved in order that the extreme fiber stress f on the material of the bend will not exceed 12,000 pounds per square inch? By Formula (22) we find that the value of the radius is:

$$R = \sqrt{\frac{\delta E y}{5f}}. \qquad (22)$$

From the above:

$\delta = 1.44$ inch;

$E = 29{,}000{,}000$;

$f = 12{,}000$ pounds per square inch;

$y = 3.3125$ (see Table IX).

Substituting these values in Formula (22) gives:

$$R = \sqrt{\frac{1.44 \times 29{,}000{,}000 \times 3.3125}{5 \times 12{,}000}} = \sqrt{2305.5} = 48 \text{ inches}$$

This will be found to check with Table X. Under 6-inch pipe and opposite 48-inch radius will be found $\delta = 1.44$, the expansion cared for by a 6-inch U-bend at a fiber stress of 12,000 pounds per square inch.

Example 2:—It is desired to estimate the unit fiber stress f on the material of the 6-inch U-bend if curved to a radius of 42 inches instead of 48 inches, all other conditions being the same as in Example 1. By Formula (21), we find that $f = \frac{Ey\delta}{5R^2}$ and with $R = 42$ inches:

$$f = \frac{29{,}000{,}000 \times 3.3125 \times 1.44}{5 \times 42 \times 42} = \frac{138{,}330{,}000}{8820} = 15{,}680 \text{ pounds}$$

per square inch.

As a check on this result consult Table XI. Under 6-inch pipe and opposite 42-inch radius will be found 1.39 inch, the expansion cared for by a 6-inch U-bend of 42-inch radius, at a fiber stress of 15,000 pounds per square inch. The same bend when caring for 1.44 inch expansion is subjected to a fiber stress of 15,680 pounds per square inch, as per Example 2.

Example 3:—As an example showing the use of the tables assume the following conditions: The expansion of an 8-inch steam main is found by calculation to be 1.65 inch $= \delta$. To what radius should an 8-inch U-bend be curved in order to care for this expansion without stressing the material of the bend beyond 12,000 pounds per square inch? Table X gives the expansion cared for by U-bends of different sizes of pipe bent to various radii. Under the column headed 8-inch pipe, 1.65 is found to lie between 1.40 with a corresponding radius of 54 inches, and 1.73 with a corresponding radius of 60 inches. To determine the radius required to care for 1.65 inch expansion, proceed as follows:

Let e = expansion to be cared for = 1.65 inch;

X = radius required for this expansion;

δ = next lowest known deflection (from table);

R = radius corresponding to known deflection (from table).

Then, as the deflection of a U-bend (or the expansion cared for) varies as the square of the radius—see Formula (20)—we have:

$$X^2 = \frac{R^2 \times e}{\delta} \text{ or } X = \sqrt{\frac{R^2 \times e}{\delta}}$$

The expansion e to be cared for = 1.65 inch and the next lowest known deflection from table = 1.40 inch, with the corresponding radius R = 54 inches. The required radius X is then found to be:

$$X = \sqrt{\frac{54^2 \times 1.65}{1.40}} = \sqrt{\frac{4811.4}{1.40}} = \sqrt{3437} = 58.63 \text{ inches—say } 59$$

inches. These results may be checked by Formula (22)

$$R = \sqrt{\frac{\delta E y}{5f}} \qquad (22)$$

where $E = 29{,}000{,}000$;

$f = 12{,}000$ pounds per square inch;

$\delta = 1.65$ inch;

y = for an 8-inch pipe 4.3125. (See Table IX.)

Substituting these values in Formula (22) gives:

$$R = \sqrt{\frac{1.65 \times 29{,}000{,}000 \times 4.3125}{5 \times 12{,}000}} = \sqrt{3439} = 59 \text{ inches approximately.}$$

When designing expansion bends, it is not advisable to allow much over 15,000 pounds per square inch for the fiber stress f on the material of the bend, as the material has already been strained to some extent in heating and curving the bend to the required form. Fig. 64 illustrates the action of a single U-shaped expansion bend as used in connection with two 90-degree elbows for taking care of expansion and contraction in a steam main. The full lines A and C show the position of the bend and part of the steam main before steam is turned into the piping system, and the dotted lines B show the approximate position of the bend when caring for expansion after steam is turned into the piping system. As the 90-degree, cast-iron elbows at each end of the bend make a very rigid connection at this point, a more or less severe bending strain is thrown on the steam main at D as the bend deflects in caring for the expansion of the main. Increasing the length of straight pipe at each end of the bend, as at S in Fig. 64, tends to increase the strain at this point to some extent because the bending moment increases with any increase of length S. For this reason it is advis-

TABLE IX. PROPERTIES OF STANDARD WEIGHT STEEL AND WROUGHT IRON PIPE*

1	2	3	4	5	6	7	8
Standard Pipe Size	Inside Diameter d Inches	Outside Diameter D Inches	Thickness of Metal t Inches	Distance from Neutral Axis to Outermost Fiber, in Inches $y = \frac{D}{2}$	Moment of Inertia I	Section Modulus $Z = \frac{I}{y}$	Area of Metal in Square Inches
1	1.049	1.315	0.133	0.6575	0.08734	0.1328	0.4936
$1\frac{1}{4}$	1.380	1.660	0.140	0.830	0.1947	0.2346	0.6685
$1\frac{1}{2}$	1.610	1.900	0.145	0.950	0.3099	0.3262	0.7995
2	2.067	2.375	0.154	1.1875	0.6657	0.5606	1.075
$2\frac{1}{2}$	2.469	2.875	0.203	1.4375	1.530	1.064	1.704
3	3.068	3.500	0.216	1.750	3.017	1.724	2.228
$3\frac{1}{2}$	3.548	4.00	0.226	2.000	4.788	2.394	2.680
4	4.026	4.50	0.237	2.250	7.233	3.214	3.174
$4\frac{1}{2}$	4.506	5.00	0.247	2.500	10.440	4.177	3.688
5	5.047	5.563	0.258	2.7815	15.160	5.451	4.300
6	6.065	6.625	0.280	3.3125	28.140	8.496	5.581
8	8.071	8.625	0.277	4.3125	68.350	14.690	7.265
10	10.192	10.750	0.279	5.375	125.90	23.420	9.178
12	12.090	12.750	0.330	6.375	248.50	38.970	12.880
14	14.250	15.000	0.375	7.500	461.00	61.460	17.230
15	15.250	16.000	0.375	8.000	562.10	70.260	18.410

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* Condensed from National Tube Co.'s Handbook—1913 Edition

TABLE X. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress 12,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches: 1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D.	16 O. D.
	Expansion cared for by U-bend (δ) in Inches													
12	0.465	0.25	0.21	0.18	......	......	......	......	......	......	......	......	......	......
18	1.300	0.57	0.47	0.38	0.34	0.30	0.27	0.24	0.22	......	......	......	......	......
24	1.830	1.00	0.83	0.68	0.60	0.53	0.48	0.43	0.36	0.28	......	......	......	......
30	2.840	1.57	1.30	1.07	0.94	0.83	0.75	0.67	0.56	0.43	0.35	......	......	......
36	4.075	2.26	1.86	1.53	1.34	1.20	1.07	0.97	0.81	0.62	0.50	0.42	......	......
42	5.553	3.06	2.54	2.08	1.83	1.63	1.46	1.31	1.10	0.85	0.68	0.57	0.49	......
48	.....	4.00	3.31	2.72	2.38	2.12	1.91	1.72	1.44	1.11	0.89	0.75	0.64	0.60
54	.....	5.08	4.20	3.45	3.00	2.68	2.41	2.17	1.83	1.40	1.22	0.95	0.81	0.76
60	......	6.25	5.18	4.25	3.72	3.30	2.98	2.68	2.25	1.73	1.39	1.17	1.00	0.93
66	......	7.58	6.25	5.16	4.50	4.00	3.61	3.23	2.73	2.09	1.68	1.42	1.21	1.13
72	......	9.05	7.48	6.15	5.38	4.78	4.30	3.87	3.26	2.50	2.00	1.69	1.44	1.35
78	......	10.60	8.75	7.20	6.30	5.60	5.05	4.53	3.81	2.92	2.34	1.98	1.68	1.58
84	.....	......	10.02	8.35	7.32	6.50	5.85	5.27	4.42	3.40	2.72	2.30	1.95	1.83
90	......	......	......	9.60	8.40	7.45	6.70	6.00	5.07	3.90	3.13	2.63	2.25	2.10
96	......	......	......	......	9.56	8.50	7.65	6.88	5.78	4.43	3.55	3.00	2.55	2.39
102	......	......	......	......	......	9.75	8.62	7.75	6.50	5.00	4.00	3.38	2.87	2.70
108	.....	......	......	......	......	......	9.66	8.70	7.30	5.60	4.50	3.80	3.22	3.02
114	.....	....	......	......	......	......	......	9.68	8.15	6.25	5.00	4.22	3.59	3.36
120	....	......	......	......	......	......	......	......	9.00	6.92	5.55	4.68	4.00	3.73

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* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

$$\delta_1 = 2 \times \frac{5fR^2}{Ey} = 10 \times \frac{fR^2}{Ey}. \qquad (26)$$

Transposing in Formula (26):

$$f = \frac{Ey\delta_1}{10R^2} \qquad (27)$$

$$R = \sqrt{\frac{\delta_1 Ey}{10f}} \qquad (28)$$

where δ_1 = expansion in inches, cared for by bends;
f = allowable unit fiber stress in pounds per square inch;
R = mean radius of bend in inches;
E = modulus of elasticity of material;
y = outside diameter of pipe ÷ 2 (see Table IX).

In the preceding formula the length of straight pipe at S is not considered.

able to increase the radius of the bend rather than to increase the length of straight pipe at each end of the bend to obtain the same results.

The use of expansion bends of the form shown in Figs. 65 and 66 does away with the bending action on the steam main as the strain at this point (D, Fig. 64) is then taken care of by the reverse curve of the bend, as indicated in Fig. 65 by the dotted lines. In the latter illustration, the full lines A show the position of the bend when the steam main is cold and dotted lines B show the position of the bend when caring for expansion, in which case the bend is caused to deflect or close up an amount $\delta = F - E$, where dimension F is the original length of the bend, and dimension E is the length of the bend when caring for expansion. Very large bends of this form may be made in one piece if so desired (omitting flanges G) by welding two or more pieces of pipe together. This is now being done successfully by several of the large manufacturers of piping materials. The bend shown in Fig. 65 is made of three pieces of pipe as indicated, with flanges at the points G. In order to prevent the pipe from buckling and to insure a more perfect bend, it is always advisable to allow a short length of pipe between reverse curves, as shown at S. Expansion bends of this form will take care of at least twice as much expansion as the single U-bend shown in Figs. 63 and 64, as the bending action is distributed over twice the length of curved pipe. Therefore, in estimating the amount of expansion cared for by a bend of this type, the values for δ, as given in Tables X to XIII, inclusive, should be multiplied by 2.

Formulas for Expansion cared for by Bends of the Type shown in Fig. 65

In order to apply Formula (20) to expansion bends of the type shown in Fig. 65, it is necessary to multiply by 2, in which case we have:

Expansion cared for by Bends of the Type shown in Fig. 66

Fig. 66 shows a "double offset expansion bend." When considerable expansion is to be cared for this is the best form of bend to use. Where the angle β is not made less than 22½ degrees, bends of this type will care for at least 2½ times as much expansion as the single U-bend illustrated in Figs. 63 and 64, as in this case the bending action is distributed over 2½ times the length of curved pipe. Therefore, in estimating the amount of expansion cared for by bends of this type, the values of δ given in Tables X to XIII, inclusive, should be multiplied by 2.5. In making up bends of this type, it is always advisable to allow a short length of straight pipe (at least equivalent to the outside diameter of the pipe from which the bend is made) between reverse curves, as shown at S. It should be understood that any increase in the length of straight pipe at S (Figs. 65 and 66) will add to the flexibility of the bend. In order to apply Formula (20) to ex-

TABLE XI. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress = 15,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches: 1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D.	15 O. D.
	Expansion cared for by U-bend, in Inches													
12	0.58	0.32	0.26	0.22	......	......	......	......	......	......	......	......	......	......
18	1.28	0.71	0.59	0.48	0.42	0.38	0.34	0.31	0.26	......	......	......	......	......
24	2.28	1.26	1.04	0.86	0.75	0.67	0.60	0.54	0.46	0.35	......	......	......	......
30	3.56	1.97	1.63	1.34	1.17	1.04	0.94	0.84	0.71	0.54	0.44	......	......	......
36	5.13	2.83	2.34	1.93	1.69	1.50	1.35	1.21	1.02	0.78	0.63	0.53	......	......
42	7.00	3.86	3.18	2.62	2.30	2.04	1.84	1.65	1.39	1.07	0.85	0.72	0.61	......
48	......	5.03	4.16	3.42	3.00	2.66	2.40	2.17	1.81	1.39	1.12	0.94	0.80	0.75
54	......	6.37	5.25	4.33	3.79	3.37	3.03	2.73	2.29	1.76	1.41	1.19	1.01	0.95
60	......	7.35	6.50	5.35	4.68	4.15	3.74	3.36	2.83	2.17	1.74	1.47	1.25	1.17
66	......	9.53	7.88	6.49	5.68	5.04	4.53	4.08	3.43	2.63	2.11	1.78	1.52	1.42
72	......	11.35	9.40	7.73	6.75	6.00	5.40	4.86	4.08	3.14	2.50	2.14	1.80	1.69
78	......	13.30	11.00	9.05	7.93	7.05	6.35	5.70	4.80	3.68	2.95	2.50	2.12	1.98
84	......	......	12.75	10.05	9.20	8.18	7.35	6.62	5.56	4.25	3.42	2.89	2.45	2.30
90	......	......	......	12.00	10.55	9.40	8.45	7.60	6.38	4.90	3.93	3.31	2.82	2.64
96	......	......	......	......	12.00	10.65	9.60	8.65	7.25	5.58	4.48	3.78	3.20	3.00
102	......	......	......	......	......	12.00	10.80	9.72	8.15	6.27	5.03	4.24	3.60	3.38
108	......	......	......	......	......	......	12.15	10.90	9.18	7.05	5.65	4.76	4.05	3.80
114	......	......	......	......	......	......	......	12.15	10.02	7.85	6.30	5.30	4.50	4.23
120	......	......	......	......	......	......	......	......	11.35	8.70	7.00	5.88	5.00	4.70

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

pansion bends of the type shown in Fig. 66, we must multiply by 2.5, in which case we have:

$$\delta_2 = 2.5 \times \frac{5fR^2}{Ey} = 12.5 \times \frac{fR^2}{Ey}. \quad (29)$$

Transposing in Formula (29) we get:

$$f = \frac{Ey\delta_2}{12.5 \times R^2} \quad (30)$$

$$R = \sqrt{\frac{\delta_2 Ey}{12.5f}} \quad (31)$$

where δ_2 = expansion in inches cared for by expansion bends of the type shown in Fig. 66; f, R, E and y are the same as in the previous case.

In the preceding formula, the length of straight pipe at S (Fig. 66) is not considered, and it is further assumed that angle β is not made less than 22½ degrees when making up the bend in the pipe shop.

TABLE XIII. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress 20,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches: 1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D	15 O. D
	Expansion cared for by U-bend, in Inches													
12	0.77	0.42	0.35	0.29	......	......	......	......	......	......	......	......	......	......
18	1.73	0.96	0.76	0.65	0.57	0.51	0.46	0.41	0.31	......	......	......	......	......
24	3.07	1.70	1.40	1.16	1.01	0.90	0.81	0.73	0.61	0.47	......	......	......	......
30	4.80	2.65	2.19	1.80	1.58	1.10	1.26	1.13	0.96	0.73	0.59	......	......	......
36	6.90	3.81	3.15	2.60	2.27	2.02	1.82	1.64	1.37	1.05	0.85	0.71	......	......
42	9.42	5.20	4.30	3.53	3.09	2.71	2.47	2.22	1.87	1.43	1.15	0.97	0.83	......
48	......	6.78	5.60	4.60	4.03	3.58	3.22	2.90	2.44	1.87	1.50	1.27	1.08	1.00
54	......	8.65	7.13	5.86	5.14	4.57	4.10	3.70	3.10	2.38	1.91	1.61	1.37	1.29
60	......	10.60	8.75	7.20	6.30	5.60	5.05	4.53	3.81	2.93	2.34	1.98	1.68	1.58
66	......	12.80	10.06	8.73	7.63	6.78	6.10	5.50	4.60	3.51	2.84	2.40	2.01	1.91
72	......	15.25	12.60	10.04	9.10	8.08	7.27	6.53	5.50	4.23	3.38	2.85	2.42	2.27
78	......	17.90	14.80	12.20	10.65	9.50	8.50	7.68	6.45	4.95	3.97	3.31	2.81	2.67
84	......	......	17.15	14.10	12.35	11.00	9.88	8.88	7.47	5.74	4.60	3.88	3.30	3.09
90	......	......	......	16.40	14.35	12.75	11.48	10.30	8.70	6.65	5.35	4.50	3.83	3.60
96	......	......	......	......	16.15	14.35	12.90	11.60	9.75	7.50	6.00	5.07	4.30	4.03
102	......	......	......	......	......	16.20	11.60	13.10	11.00	8.56	6.80	5.72	4.87	4.56
108	......	......	......	......	......	......	16.35	14.70	12.35	9.50	7.60	6.40	5.45	5.10
114	......	......	......	......	......	......	......	16.40	13.75	10.55	8.50	7.15	6.08	5.70
120	......	......	......	......	......	......	......	......	15.25	11.70	9.40	7.90	6.73	6.30

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

Expansion cared for by a Six-inch Bend in Actual Service

A study of Fig. 67 will give the reader some idea of the amount of expansion that can be taken care of by a flexible pipe bend when properly made and installed. This expansion bend was made up of two right-angle or square bends, curved to a mean radius of 45 inches; and one U-bend curved to a mean radius of 48 inches, that is approximately eight times the diameter of the pipe from which the bend was made. A length of straight pipe, 4 feet 9 inches long, was allowed between the curved portions of the bend, as shown at S, making the center-to-center dimension of the bend 12 feet 6 inches, as shown at B. These expansion bends were made by the M. W. Kellogg Co., of Jersey City, N. J., and installed in a steam main in the yards of the Delaware, Lackawanna & Western R. R. at Hoboken, N. J. The bend was carefully measured after erection, when cold, and again after steam at 150 pounds gage pressure was turned into the 6-inch main. The full lines show the position and dimensions of the bend taken after erection, and the dotted lines show the position of the bend when caring for the expansion. The expansion of the 6-inch steam main caused the bend to close up, or deflect about 18 inches, without causing leakage at any of the pipe joints or without unduly straining the connections. Although the flanged joints A received most of the strain, due to the severe bending action at these points, the joints, upon careful inspection, showed no signs of weakness or failure. The steam main in which this bend was installed was equipped throughout with what is known as the "Kellogg improved Van Stone joint" with rolled steel flanges. When designing the bend, the long length of straight pipe was allowed at S (Fig. 67) in order to make the bend more flexible. On a bend of this type any increase in the length S adds greatly to the flexibility of the bend when caring for expansion or contraction. As far as the writer knows, no attempt was made to ascertain the unit fiber stress f due to the contraction of the bend, but from all indications the bend was not unduly strained at any time. As this bend has been in use for a number of years without giving trouble of any kind, it may be safely used as a guide in determining the dimensions and proportions of expansion bends for similar service. Expansion bends should never be curved to a radius of less than six times the diameter of the pipe from which the bend is made, and when greater flexibility is desired the radius of the bend should be increased as much as the conditions will allow.

TABLE XII. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress 18,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches: 1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D	15 O. D
	Expansion cared for by U-bend, in Inches													
12	0.68	0.38	0.31	0.26	......	......	......	......	......	......	......	......	......	......
18	1.52	0.84	0.70	0.57	0.50	0.45	0.40	0.36	0.30	......	......	......	......	......
24	2.73	1.50	1.24	1.02	0.90	0.79	0.72	0.64	0.51	0.42	......	......	......	......
30	4.26	2.34	1.94	1.60	1.40	1.24	1.17	1.00	0.85	0.65	0.52	......	......	......
36	6.09	3.38	2.80	2.30	2.01	1.79	1.61	1.45	1.21	0.94	0.75	0.63	......	......
42	8.35	4.60	3.80	3.12	2.74	2.43	2.19	1.97	1.65	1.27	1.02	0.86	0.73	......
48	......	6.00	4.96	4.08	3.57	3.17	2.86	2.57	2.16	1.66	1.33	1.12	0.95	0.89
54	......	7.60	6.28	5.17	4.50	4.00	3.61	3.25	2.73	2.10	1.68	1.12	1.21	1.13
60	......	9.40	7.75	6.38	5.58	4.97	4.47	4.00	3.37	2.59	2.08	1.75	1.49	1.40
66	......	11.35	9.38	7.73	6.75	6.00	5.40	4.86	4.08	3.14	2.50	2.12	1.80	1.69
72	......	13.50	11.25	9.20	8.05	7.16	6.45	5.80	4.87	3.75	3.00	2.65	2.15	2.01
78	......	15.85	13.10	10.80	9.45	8.40	7.55	6.80	5.70	4.38	3.50	2.96	2.50	2.36
84	......	......	15.20	12.50	10.10	9.75	8.68	7.90	6.63	5.08	4.08	3.42	2.92	2.74
90	......	......	......	14.35	12.55	11.15	10.00	9.00	7.60	5.83	4.68	3.91	3.35	3.14
96	......	......	......	......	11.30	12.70	11.42	10.30	8.65	6.65	5.33	4.50	3.82	3.58
102	......	......	......	......	......	14.35	12.95	11.60	9.78	7.50	6.00	5.08	4.32	4.03
108	......	......	......	......	......	......	14.50	13.00	10.95	8.40	6.75	5.68	4.83	4.53
114	......	......	......	......	......	......	......	14.50	12.20	9.35	7.50	6.33	5.31	5.05
120	......	......	......	......	......	......	......	......	13.50	10.35	8.32	7.00	6.00	5.60

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

Erecting Expansion Bends

If one-half the calculated amount of expansion in a steam main is allowed for when cutting the pipe to length, as mentioned in a preceding installment of this article, the steam fitter, when erecting the piping system, should stretch or spring the expansion bends sufficiently to make up the connections in the main without the use of filler pieces, or "Dutch-

men," as they are called. After steam is turned into the main, the expansion removes the cold strain put on the bend by the steam fitter and in this way the bend is strained only half as much as it would be if no allowance were made in the length of the main when cutting the pipes. In all cases where one-half the expansion is allowed for in the length of the main, the expansion bends shown in the illustrations Figs. 63 to 66, inclusive, will care for twice as much expansion as calculated by aid of the formulas and tables presented in this article, or what amounts to the same thing, an expansion bend should be designed to take care of only half the calculated amount of expansion, as half has already been allowed for in the length of the main.

* * *

CAUSE OF "ALLIGATOR SKIN" EFFECT ON DRAWN SHEET METAL

The peculiar mottled effect on the drawn sheet metal cup shown in the accompanying illustration is known in the sheet metal industry as "alligator skin." This marking is noticeable only when the metal is drawn or stretched to a considerable extent, as in the formation of a deep cup. There have been many reasons given for this effect.

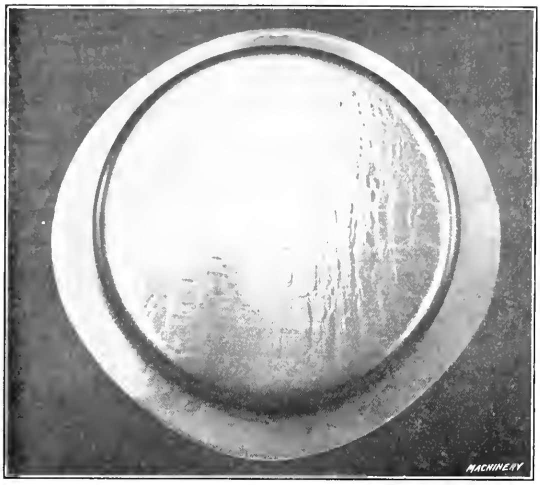


Illustration showing "Alligator Skin" Effect on a Cup drawn from Strip Steel that has a "Skin Hard" Surface

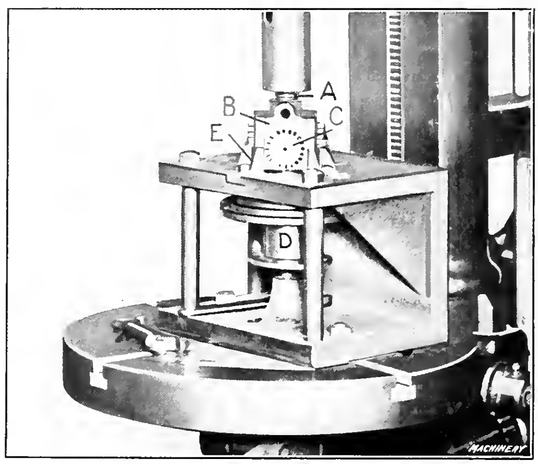
In producing cold-rolled strip steel, the material is annealed previous to the last rolling operation, so as to eliminate brittleness as much as possible. The last rolling operation serves to brighten the metal and bring it to the correct thickness. For some work, however, it is necessary to secure a grade of sheet metal known as "skin hard." This cold-rolled strip steel has a comparatively hard surface, and when the skin is not too deep produces bright and nicely finished cold-drawn work. However, it is much more difficult to work than the softer grades of steel, and is used only when a hardened surface on the material is desired. It is when "skin hard" strip metal is being drawn up that the "alligator skin" effect is produced. If the metal, after annealing, is reduced too much in thickness in the final rolling operation, a hard surface is formed on the exterior which is much tougher than the interior. Then when the metal, in being worked up to the desired shape, is drawn to a considerable extent, the interior or center portion of the cup draws much more than the outer surface; hence the outer surface, or hard skin, pulls apart, as it will not stretch anywhere nearly as much as the inside. This leaves a peculiar looking surface slightly depressed in those portions where the skin has broken away. In this particular cup which was drawn up from 0.037 inch sheet steel to a depth of 1½ inch and a diameter of 3 5/16 inches, the partings of the skin vary from 1/16 to 3/32 inch in width in those portions where the metal has broken away to the greatest extent. It will be noticed in looking closely at this illustration that the markings are much finer at certain points than others. This, no doubt, was due to imperfect alignment of the die and punch, which caused the metal to be drawn more on one side than on the other; consequently, the markings vary around the bottom of the cup.

It might be mentioned here that this "alligator skin" effect very seldom appears on soft sheet steel but is quite often present on "skin hard" steel. Manufacturers often find that this "skin hard" metal comes mixed up with soft stock, indicating that the rolling mill is at fault in allowing too much reduction in the final rolling operation. There is no possible way of eliminating this defect in the metal after it starts to appear. Of course "skin hard" metal can be drawn without producing this "alligator skin" effect if it is not reduced too much in thickness nor stretched to a considerable extent, but it cannot be removed by stamping or redrawing if it has once appeared. D. T. H.

* * *

INTERNAL MILLING ON DIFFERENTIAL GEAR CASES

For finishing the four inside faces of a differential gear housing, the New Process Gear Corporation of Syracuse, N. Y., uses the device shown on the drill press spindle in the illustration. The casting for the housing is first put through the different lathe operations, and then comes to the drill press for the finishing of the four internal panels that act as side supports for the bevel pinions of the differential mechanism. The housing is held in the jig shown on the table of the drill press, and the milling fixture is held in the spindle of the drill press. The milling fixture is held and driven by arbor *A*, about which is the square framework *B* which supports the four milling cutters *C*. These milling cutters are mounted on short shafts extending through the faces of frame *B*. On the inner ends of these four shafts are bevel pinions, in turn driven by a central bevel gear on the lower end of spindle *A*. The outer ends of the shafts or studs do not extend beyond the cutter faces. When the spindle is lowered so that the cutters enter the differential housing casting *D*, the corners of the frame *B* are engaged by brackets *E* and prevent the frame from turning. Continued down feeding permits the revolving cutters to finish the four faces. The amount of metal to be removed is about 1/32 inch from each face, and the principal work that has to be done is the sizing and finishing of the four faces. This method of milling takes care of what would otherwise be a troublesome job. C. L. L.



Fixture for Internal Milling on a Differential Gear-case

* * *

In the industries today, the one fundamental demand is for cooperation. There are men of rare technical knowledge, ripe experience and sterling honesty who have been total failures because they were always in a turmoil. They threw sand in the wheels of progress. Tact is the lubricant without which no efficient transmission of cooperative energy can be achieved.—*J. M. Eaton in the Journal of the Worcester Polytechnic Institute.*

LOADING AND "CLIPPING" CARTRIDGES*

TOOLS AND METHODS IN USE AT THE FRANKFORD ARSENAL

BY DOUGLAS T. HAMILTON†

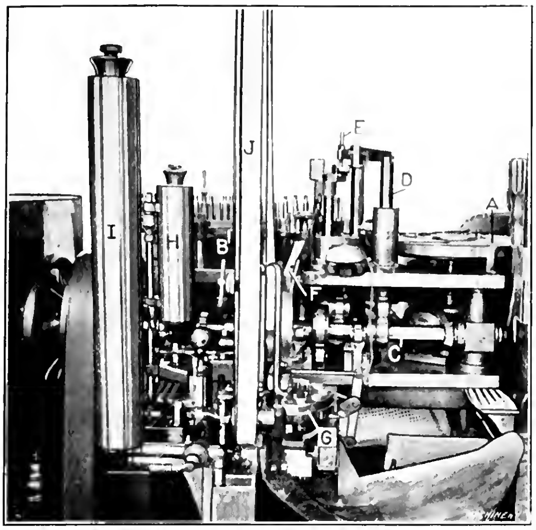


Fig. 1. Priming and waterproofing 0.30-Caliber Cartridge Cases

In the March number of MACHINERY the development of 0.30-caliber cartridge cases from the sheet to the finished shell was described. The operations taken up were blanking, cupping, drawing and trimming. The heading of these cases has been described in a previous article (see the April, 1911, number of MACHINERY), so it will be unnecessary to go into this subject here. The method of priming 0.30-caliber cartridge cases in the Frankford Arsenal is different from that described in the article mentioned, so we will start from the priming of the cartridge, or in other words, placing the detonating cap in the head of the cartridge case.

Priming—Inserting the Detonating Cap

The head of the cartridge case, when being formed in the heading machine, is provided with a pocket, which is made by a teat on the end of the heading bunter. This pocket is approximately the same size—slightly smaller—than the diameter of the primer, and the inserting of the primer in this pocket is called priming. It is accomplished in the machine shown in Fig. 1. The primers are located, fifty or more at a time, on the dial *A* by the operator, and the shells are located on the dial *B* as illustrated. Both the dials are rotated, dial *A* being driven at a constant speed, while dial *B* is indexed by means of a ratchet dial in the usual manner. Over dial *A* is a spring that constantly vibrates, due to the friction of the dial rotating under it, so that the primers are agitated and gradually pass into a narrow channel, one at a time. As the shell reaches the priming point, a primer is carried out by a finger, held in line with the pocket in the shell, and then a punch operated from a cam-shaft forces the primer into the pocket. At the same time that the primer is being inserted the cam on shaft *C* operates plunger *D*, which through a fulcrumed lever actuates a padded punch *E* that holds the shells down while the primer is being inserted. After the primer is inserted, a finger knocks the shell from the dial down the chute *F*. From this chute it is deposited in a dial *G* which is also of the ratchet type.

The dial *G* is used as a medium for holding the shells while the mouth and primer end is being lacquered or waterproofed. The lacquer is held in tanks *H* and *I*, one tank supplying lacquer to a swab that enters into the mouth of the shell, whereas the other supplies lacquer to the swab that lacquers the primer and head of the shell. These swabs, of course, are operated in opposite directions, one going into the mouth of the shell and the other coming up against the head. Then as the dial indexes around, a ribbon *J* rotated on pulleys passes across the head of the shell and wipes the surplus lacquer from the head. The shell then drops out of the dial and is deposited in a box under the machine. The lacquer used for waterproofing the mouth and head of the shell is composed of shellac cut with alcohol and resin. The cartridge case is waterproofed so that it cannot become non-explosive if it should be dropped into water. The shellac that is applied is distributed around the rim of the primer and

* For information previously published on cartridge making see "Making Spitzer Bullets" in MACHINERY for April, 1914, and other articles there referred to.

† Associate Editor of MACHINERY.

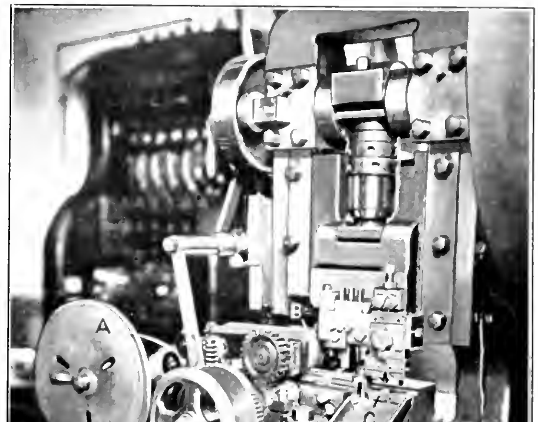


Fig. 3. A Machine used for making the Springs used in Cartridge Clips

Fig. 2. Inserting the Powder and Bullets and crimping—loading 0.30-Caliber Cartridges

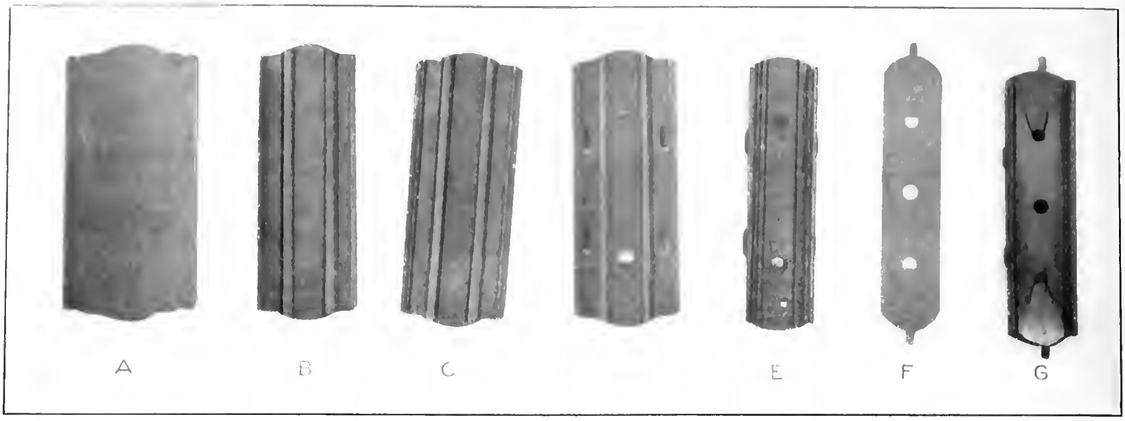


Fig. 4. Evolution of the Cartridge Clip that is used for holding Five 0.30-Caliber Cartridges

provides a protective coating. The lacquer deposited in the mouth of the shell after the nickel jacket bullet has been inserted serves the same purpose.

Loading

After the primers have been inserted in the cartridge cases, they are ready for loading. This consists in inserting the correct charge of powder and the bullet in the case, and then crimping the bullet into place. The cases are held in the box *A*, Fig. 2, from which they are removed by the operator and placed on a dial of the plain type. This dial carries the shells to the ratchet dial *B*, which, in turn, is indexed and presents the shells mouth up to the various loading containers and punches. The first action on the shell is to set it down properly. This is accomplished by a spring punch. Then the proper powder charge is inserted. The powder is held in the funnel-shaped container *C* and is removed from it by a slide operated by a crank motion. This slide comprises a small container that carries the correct charge of powder and deposits it in the shell in which it is packed by means of a punch. Then as the shell indexes around to the next position, a second charge of powder is inserted.

At the time that the operator is placing shells on the plain dial, he is also placing nickel jacketed bullets in the dial *D* with the points up. This dial is also of the ratchet type and after the powder has been put into the shell it is transferred from dial *B* to a position under dial *D*. Then a punch operated from a cam-shaft under the machine comes down on top of the bullet and inserts it in the shell. As the shell indexes to the next position, a crimping device turns in the top edge, holding the bullet in position. It is then ejected from the machine loaded.

Making Cartridge Clips

The device for quickly inserting cartridges in the magazine of a 0.30-caliber rifle consists of a clip which holds five cartridges sufficiently tight to prevent them from falling out. As soon as the clip is placed over the breech and the top cartridge pressed, they are ejected and pass into the magazine. The clips are thrown away after they have been emptied, so it is absolutely necessary that they be made very cheaply and at the same time in such a manner that they will not fail to perform their function. The main body of the clip is made from a sheet of brass stock about 0.021 inch thick by 2 7/16 inches wide. The sequence of operations necessary to complete this clip is illustrated from *A* to *G* in Fig. 4, and the machine for making the body of the clip is shown in Figs. 5 and 6.

Referring now to Fig. 5, which shows a front view of the press, the strip stock is held on a roll located at the right-hand end of the machine. The stock is fed into the machine by the ordinary type of feeding rolls, and the first operation is to cut out a blank as illustrated at *A* in Fig. 4. This is accomplished by the punch and die *B*, see Fig. 6. The blank is then ejected from the die and carried on to the next punch and die *D* and *E* by means of a transfer slide *C* similar to that employed in a multiple plunger press, that receives its motion from a crank mechanism at the left-hand end of the machine. The next operation, performed by the punch *D* and die *E*, is to form two ribs in the center of the blank, and turn up the two edges as shown at *B* in Fig. 4. The formed blank is then ejected and the transfer arrangement carries it on to the next operation, where punch and die *F* and *G* crimp the two outer edges into the condition shown at *C*. The edges of the blank are flattened down and at the same time turned up a distance about 3/64 inch above the top surface of the blank. The blank is then ejected from the die and is carried forward over die *H*. As punch *I* descends it forces the blank out of the transfer fingers and into the die *H*. This operation forms four projections which are shown at *D* in Fig. 4 that act as retainers for the spring to be inserted in later. The next punch and die *J* and *K* draw up the sides of the clip into box shape as shown at *E*. Then as the blank is passed on to the last punch and die *L* and *M* it is slightly curved and is ejected from the machine by a crank mechanism *N*, Fig. 5, which actuates the last die. This sequence of operations is carried on entirely automatically,

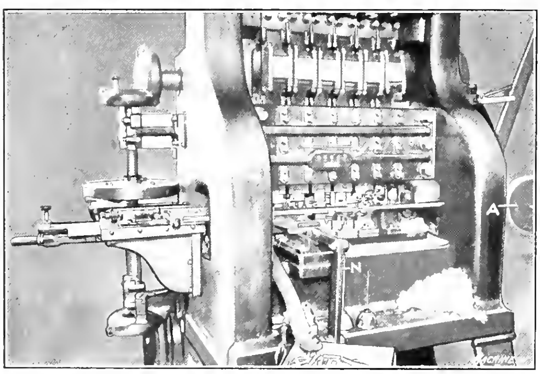


Fig. 5. The Cartridge Clip Machine—A Special Machine that completes the Body of the Clip in Six Distinct Operations

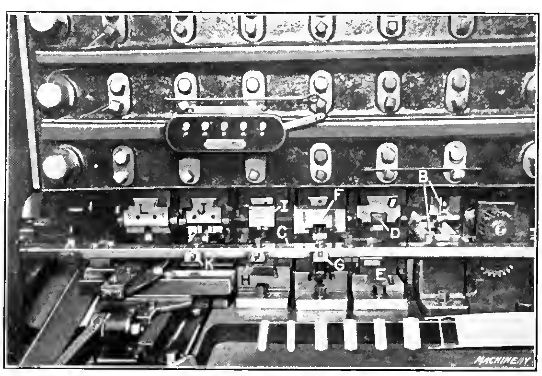


Fig. 6. A Close View of the Dies and Punches used in the Cartridge Clip Machine shown in Fig. 5

Fig. 7. Assembling the Spring in the Cartridge Clip

Fig. 8. Inspecting and weighing 0.30-Caliber Cartridges

and, in fact, the machine will run without any attention whatever until the roll has been exhausted. The operator then starts up the machine and the sequence of operations continues.

Making the Spring for the Cartridge Clip

In order to hold the cartridge in place in the clip, a curved flat spring *F*, Fig. 4, is used. This spring, which is made from a sheet of half hard brass stock 0.510 inch wide by 0.010 inch thick, is blanked out and bent to shape in the press shown in Fig. 3. The stock is held on a roll *A* shown to the left of the machine, and is drawn in by a pair of ordinary feeding rolls *B* operated by a ratchet mechanism receiving power from the crankshaft of the machine. The first operation is to cut off a strip to the required length, form the ends and pierce the three holes. This blank, by means of a carrier, is then transferred to the punch and die *C*. Here the blank is bent up into a curved shape and the spring prongs at each end are formed, after which it is ejected. These prongs are used in assembling the clips for holding the spring in place; they catch on a projection formed in the base of the clip. This machine is also entirely automatic in its operation, and when it is started will run until the roll of stock has been exhausted.

Assembling the Spring in the Cartridge Clip

The assembling of the springs in the cartridge clip is accomplished in the small bench machine shown in Fig. 7. The operator places the clip in a nest, then inserts the spring in a slide which carries it forward and inserts it in the clip. The spring is held on this slide and is pushed into the clip automatically by the prongs which fit into the raised catches in the clip. The clip is carried forward into the assembling position by another slide, which works beside the spring inserting plunger, and operates a carrier *D*.

In order to show the working mechanism of this machine, the top lid or plate that covers the mechanism has been removed, and is shown to the right of the illustration. The clip is inserted through the hole *A*, and the spring in the hole *B*. When the operator pulls the handle *C*, the slide advances carrying the spring and assembles it in the clip. After assembling, the clip is ejected from the machine and drops into a box placed beneath it. The assembled clip appears at *G* in Fig. 1.

Gaging, Weighing and Inspecting Loaded Cartridges

Before locating the cartridges in the clip, they are inspected, gaged and weighed. These three operations are all accomplished in one machine, which is shown in Fig. 8. The dies held in the dial *A* in which the cartridges are placed by the operator act as a gage for the body of the cartridge; that is, the contour of the holes in these dies is similar to the chamber of the rifle. As the dial passes around, the cartridges are carried beneath an electrically operated plunger which inspects them to see that each one has a primer in it. Should a cartridge be encountered that has no primer, this punch drops down into the pocket and breaks the electric circuit, which causes a bell to ring, thus notifying the operator that a cartridge with no primer has passed. When the primer is located upside down, the same action takes place.

The weighing of the cartridge is accomplished in a unique and interesting manner. As the dial *A* passes around, the cartridge is lifted up and caught by the ejector *B*. This transfers the cartridges to the scoops *C* which are carried on the weighing dial *D*. The weighing is done by balances *E* in which the cartridges are deposited by the scoops *C*. The bullet comes up to a stop in these balances and a wire hook attached to the balance catches on the wire *F* when the cartridge carries the correct charge of powder and dumps the cartridge into the box *G*. When the charge of powder in the cartridge is light the hook on the weighing balance *E* rides up over wire *F*, but as the dial passes around still further the hook catches on a wire located higher than wire *F*, and dumps the cartridge into the light charge box. It is therefore evident that cartridges which are light in weight pass the first box, but cannot go completely around, as they are ejected by the second wire, thus making certain of dumping the weighing balance and throwing the cartridge out. This mechanism successfully eliminates all light charge cartridges, and keeps them uniform in shooting quality.

Inserting Cartridges in the Clips

The machine used for inserting the cartridges in the clips is shown in Figs. 9 and 10. A dial *A*, which accommodates

Fig. 9. Cartridge Clipping Machine—assembling the Cartridges in the Clip

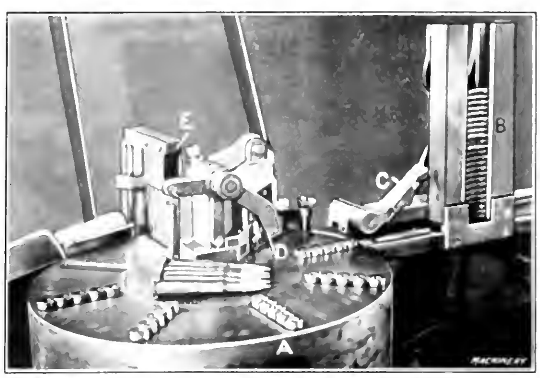


Fig. 10. A Closer View of the Machine shown in Fig. 9, illustrating the Operating Mechanism

five cartridges in a row, carries the cartridges around to where the clip is inserted over them. This dial is rotated by means of a crank motion, pawl and ratchet in the ordinary manner, the ratchet dial being located beneath the dial carrying the cartridges. The assembled clips are placed in the proper position in the magazine *B* by an operator; two operators are engaged in keeping the cartridge dial full. The clip is carried out from the bottom of the magazine by means of a carrier operated by an eccentric shaft, and is located over the five cartridges in the dial *A*. The "latch" *C* which is shown thrown back in the illustration runs under a roller held in bellcrank *D* and seats the clip properly on the heads of the cartridges. The dial then indexes to the next position, where a bending tool comes into action and bends down the prong projections on the ends of the spring in the clip, thus preventing the cartridges from dropping out. As the dial then indexes around to the next position, the cartridges that have been inserted in the clips are picked up out of the dial by means of a swinging transferring arm that drops them in a box. 65,000 of these cartridges are inserted in the clips per day of eight hours. Fig. 10 shows a closer view of the machine illustrated in Fig. 9, and gives a better view of its construction and operation. Here it will be seen that the ejecting or work-removing fixture is composed of two pieces of sheet steel, spring tempered, which grip the clip by the lower surface.

* * *

FROM THE CELLAR UP*

When a small boy, not yet in my "teens," I sought and obtained employment in an old Connecticut "hame" factory. I had visions of wealth that I would gain from my industry, and entered the employ of an old-time contractor, who, among other things, did the polishing of the metal work on hames. He used wooden wheels covered with leather and coated with glue and emery. A large part of my work was to "wash" or soak off the glue and emery from the worn wheels preparatory to re-coating.

I wish it were possible to show a photograph of the place and the facilities—a low, dark cellar, among rats and mice, where never a ray of sunlight entered. A small leak in the old waterwheel flume furnished the water supply. I had to hold the wheels and turn them gradually so that the coating of glue and emery might soak away. It was a tedious and ambition-killing process for a boy—holding one wheel at a time and slowly turning it to bring all parts of the circumference under the stream.

I can recall how injured my feelings were when I believed I was competent to perform the skillful mechanical work up in the shop above, and how I planned various protests, the language of which I readjusted from hour to hour, that it might be convincing when the auspicious moment for its utterance should arrive.

At last the injustice of my treatment became so great in my mind, and the foolishness and wastefulness of such labor so plain to me, that the invention of a machine for doing the soaking automatically kept rising uppermost in my brain, until I forgot my eloquent protest and fell to studying out the great invention. I forgot all about the fact that I was slowly turning in my hands the wheel that was soaking. I forgot all about the darkness and loneliness of my workshop in the mental visions of the machine that was to wash a dozen or more wheels in the time that I was washing one, and was to do this while I was employed at more useful and more interesting work above.

At last, when my vision was complete, full of hope and visions of progress, I summoned up my courage to explain it all to my employer. Alas! I did not know that I was then to learn my first lesson in opposition to progress. My employer laughed and several others with him. The impossibility of washing a dozen wheels at once and without labor was too clear to them to admit a doubt. Little did I realize then that this opposition was only the beginning of what my life should encounter in the introduction of new designs and processes. Little did I then understand that all progress must be made in the face of opposition from those who, it would be natural to suppose, would be most interested in it.

I then also learned my first lesson in false economics. I was informed that if such a machine could be made to work, I would be out of a job. I replied that I could be employed at some of the more interesting work in the shop. I was informed that there would then be no work for someone else. They were too much for me then, but I could not get over the belief that, with the washing machine in operation, I could be more profitable and my work more interesting. I was crestfallen. My invention was turned down by my employer. I was laughed at. I stole away quietly and waded in the pool under the waterwheel that was then still for the noon hour.

Time and change have wrought their wonders since then. The old "hame shop" is gone. A fire destroyed it years after, and the place where I worked, alone in the darkness, is now uncovered to the sunlight and the wild flowers bloom there. Fifty years have passed since then, and my washing machine has become a reality. Today there are many of these machines in use, and no boys are washing buffing wheels by hand.

In view of this, the facts I would impress upon young men are: First: That while the first struggles determine it afar off, final success in life comes not at the beginning of life, when one is young, but only after years of hard, patient work. Second: To succeed as a leader and creator of useful things, that help the world to a higher and better life, whether it be the designing and invention of machinery, methods, ideas or changes in any form, one must always encounter the opposition of both high and low, the educated and the ignorant. Third: The greatest reward comes by the way of one's own inner consciousness of having accomplished something to help the very world that has opposed him. For it is true that few men who really create the ideas and improvements that make the world better, receive frank recognition from those that their efforts have helped most.

* Abstract of an address delivered before the Boys' Vocational Club, Worcester, Mass., by Charles H. Norton.

* * *

LOAD CAPACITY OF BALL BEARINGS

In a lecture recently delivered before the Institution of Automobile Engineers (Great Britain), Prof. John Goodman, of Leeds University, dealt with the design of ball bearings. The lecturer has given the subject considerable attention for the past fifteen years, during which time he has conducted many experiments on this type of bearings. One result of his investigations has led to the establishment of the following formula which gives the maximum working load in pounds to be allowed for any given ball bearing:

$$\frac{Kmd^3}{ND + Cd}$$

where

m = the number of balls in the bearing;
d = the diameter of the balls in inches;
N = revolutions per minute;
D = diameter of ball race, taken from the point of contact of the ball with the outer race (for a thrust bearing D = the diameter taken from the centers of the balls).

The constants C and K are as follows:

For thrust bearings:

	C	K	
Flat races	200	500,000	
Hollow races	200	1,000,000	when the radius of the race is about twice that of the ball;
		1,250,000	when the radius of the race is about 9/16 that of the ball.

For journal bearings:

	C	K	
Flat races	2000	1,000,000	
Hollow races	2000	2,000,000	when the radius of the race is about twice that of the ball;
		2,500,000	when the radius of the race is about 9/16 that of the ball.

THE INSIDE OF THE MAGNETIC CHUCK—2

CHUCKS FOR VARIOUS PURPOSES AND PRINCIPLES OF DESIGN

BY HERBERT L. THOMPSON*

THE chuck shown in Fig. 8 is a simple rotary chuck for use in the lathe. Soft Swedish iron should be used in its construction, and if well made it will hold strongly enough for grinding, light drilling, boring and facing on such work as master plate blanks or sub-press dies. If provided with tapped holes in the face, it becomes what might be called a semi-magnetic faceplate which is very convenient for any work that must be indicated for location. The piece to be machined is held on the chuck by the magnetism and tapped with a soft hammer until located, after which clamping straps are applied so that severe machining operations can be performed. The general shape of the magnetic circuit in this chuck is similar to that of the one in Fig. 5, though, of course, this chuck is cylindrical while the one in Fig. 5 is rectangular; but the single coil and enclosing iron carry out the same idea. The hub, base and core are one piece, while the cover *A* comprises the outside magnetic circuit, both poles, the gap and filler. The cover *A* is pressed onto the shoulder of the base at *B*, and held in position by the screw *C*, which must bring the center pole piece and the end of the core into close contact at the same time that the rim of the cover completely engages the shoulder at *B*. The gap line is shown square, and the anchor spots *E* are milled into the edges of both pole pieces to retain the filler alloy. It will be noticed that the polar gap is wider at *F* than it is on the active face of the chuck; this is to increase the magnetic resistance of the gap, and prevent the magnetic current returning across the inner side of the gap as far as possible. This widening of the gap on the unused side of the poles is good practice with any chuck, and will materially increase the holding power of the chucking surface.

The coil for this chuck is not form wound. Being adapted for attachment to the lathe spindle, it is a simple matter to wind the coil directly onto the paper insulating sleeve *G* on the core *H*. The paper washer *I* prevents the wire in the coil from coming in contact with the base of the chuck; and the fiber washer *J*, which must be glued to sleeve *G*, holds the winding in place until the cover is attached. As a rotary chuck must revolve, it is impossible to attach it to the electric supply in as simple a manner as could be used for any kind of a stationary chuck. Some kind of moving contact must be provided, and nothing could be much simpler nor more efficient than the brushes and collecting rings shown in the illustration. The piece *K* is a fiber bushing bored to press snugly onto the hub of the chuck, and shouldered at each end to accommodate the two brass rings *L* and *M*. At diametrically opposite sides of the bushing *K* are milled the channels *O* and *P*, through which the ends of the coil wires are brought for attachment to their respective rings. The fiber bushings *Q* and *R* are provided to insulate the wires where they pass through the base of the chuck. The service wires are attached under the heads of the binding screws *S* and *T*, and current enters the coil through the brass brush *U*, the ring *M* and the wire through bushing *Q*. It leaves by the wire through the bushing *R*, the ring *L* and the brush *V*, after passing through the coil. The fiber base *W* may be of very different shape, and can be attached to the bed or the headstock of the lathe, depending upon which is most convenient.

Winding a Rotary Magnetic Chuck

To wind this chuck, it is necessary to remove the cover and have the insulating washers and sleeve in place with the glue dry. A short piece of single strand lamp cord is soldered into a hole through the ring *M* and passed through the bushing *Q*. The other end of the lamp cord is then firmly soldered to the end of the magnet wire of which the coil will be made. The reason for using the lamp cord is to provide a strong lead to the inside wire of the coil, as a slight slipping of the ring would probably break the frail magnet wire, which would make it necessary to entirely unwind the coil for repairs. For the same reason the lamp cord should be left as loose as possible, as a little slack may be necessary later on if the cord should become disconnected from the ring. The soldered connection between the magnet wire and the cord should be taped to insulate it from the rest of the wire, and the lamp cord should have at least one turn about the core to prevent any outside pull from bringing a strain directly upon the end of the magnet wire.

Magnet wire is always sold on a wooden spool, and this greatly facilitates the winding of coils in the lathe. A piece of half-inch rod should be fastened in a horizontal position, so that the wire spool can revolve freely upon it. After taping the junction of the lamp cord and magnet wire, the first few turns of the wire should be wound while turning the lathe by hand, so that the wire will bind the core and not slip when the speed is increased. The lathe can now be started by power, and the operator should feed the wire to the core as evenly as possible, in the same way that an old fashioned sewing machine bobbin is wound. It is far from necessary to lay each layer of wire exactly even, but it must be borne in mind that it is very advantageous to have as much wire as possible in the available space. For this reason, the coil should be revolved with considerable speed, and care should be used to prevent too much crossing of the successive convolutions. The winding should be continued until the wire is even with the opening in the bushing *R*, after which it is cut and passed through the bushing to be soldered into a slot in the edge of the ring *L*. No lamp cord is used on this terminal, as a break could easily be found and remedied without unwinding, and one turn of wire from the coil is sufficient to repair any break. After all connections are made, the coil should be wound with a layer of friction tape to prevent unevenness in the winding, and to keep centrifugal force from causing the wire to touch the inside of the cover and short-circuit the coil when the chuck is running.

If the chuck shown in Fig. 8 is wound for service on a voltage as low as twenty or lower, it is possible to simplify the construction to some extent by using the frame of the chuck and lathe as one of the electric terminals. Instead of using the ring *M* and brush *U*, the inside coil-end is simply fastened under a screw head anywhere on the iron part of the chuck, and the service wire that would be attached at binding screw *T* can be fastened under any screw head on the lathe. This arrangement brings the lathe and chuck into the electric circuit, and for this reason would be extremely dangerous on the higher voltages; but as a severe shock is impossible on twenty volts, it is here permissible and a real economy. The brushes and rings should always be kept clean, and especially free from chips or soldering acid, as either will be apt to short-circuit the chuck. A guard or shield of some kind protecting the rings and brushes is desirable if the voltage is high, as even 110 volts is unpleasant to handle with perspiring hands. It is a good idea to paint the exposed electrical connections with asphaltum, as a measure of insulation, but of course, this cannot be applied to the rings and under sides of the brushes.

Magnetic Lathe Chuck for Severe Service

For lathe work of a kind requiring fairly severe machining, it is possible to secure excellent results by the use of a chuck like that shown in Fig. 9. This differs from all the previous chucks in that it is strictly multipolar, having six independent cores and coils of alternate polarity, each attached to its own individual pole piece. A chuck of this description has many advantages over one provided with any form of bi-polar magnet, but is so much more expensive to make that it would be extravagant to use it on any work that

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could be handled on the cheaper and less complicated forms previously described. For master plate and fine die work, such as is commonly done on the bench lathe faceplate, this chuck is ideal. It will hold very strongly, and will give absolutely accurate results because there is no distortion due to clamping, as is invariably the case to some extent with the ordinary faceplate. Needless to say, it will save an enormous amount of time in setting up and locating.

If one considered the expense of making this chuck entirely of Swedish iron too great, the base *A* and enclosing frame *B* could be made of gray iron to good advantage, but in any case it is necessary to machine every part all over and very accurately. The cores *C* and the pole pieces *D* should be made of Swedish iron, and as they are by far the most important part of the magnetic circuits, the gray iron base will have but slight influence upon the holding power. The center piece *E* is a brass bushing provided with a tapered hole to hold a center pin for master plate work. It is threaded into the polar face of the chuck so that the tapers can be driven in or out without danger of dislodging the bushing. The cores *C* are firmly pressed into the holes in the base of the chuck, and it is very essential that these holes should be carefully indexed and bored, to insure a nice running poise for the finished chuck. The pole pieces *D* should all be made exactly alike, special care being taken to have the screw hole very accurately located. As the filler alloy is quite a factor in the strength of the polar face of this chuck, anchor spots similar to those illustrated at *E* in Fig. 8 should be milled into the edges of both the pole pieces and the enclosing frame. To apply the filler to this chuck, it is necessary to completely assemble the iron parts, locating the pole pieces with reference to the frame and each other as carefully as possible. The whole chuck can now be laid on its polar face while the molten alloy is poured in from the back through the threaded hole *F*. This binds the seven pieces of iron composing the cover together, so that the pole piece screws now hold the frame in place as well.

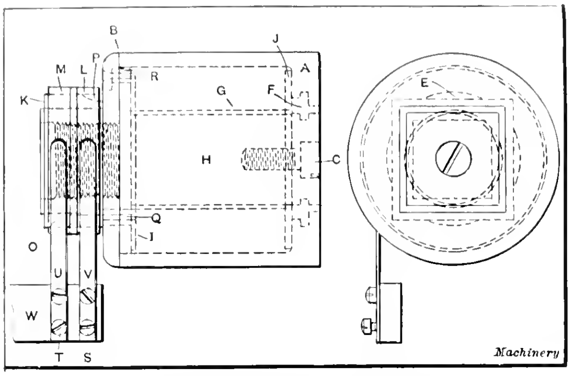


Fig. 8. A Semi-magnetic Chuck for Use on the Lathe

The coils for this chuck may be form wound, or they might be wound on separate wooden or paper spools, but in any case the finished coils must weigh the same. In connecting them up it is important for the electric current to pass around each in alternate directions, as shown in the illustration. In a multipolar magnet there are a number of separate magnetic circuits, and to secure the best results adjacent poles should always have alternate polarity. If a piece of work were laid across a gap between two poles of like polarity, it would be repelled instead of attracted; but if it also covered part of even one pole of opposite polarity, the attraction would become intense from all three. For this reason it is wise to make small sized pole pieces, so that very small work will be able to cover part at least of several of them. This is one of the excellencies of this chuck; it has a gap of intricate shape, but not of undue length for each pole piece, and it is possible for a small piece of work at the center to cover part of all six of the pole pieces. A magnetic circuit is also established if work is laid across the gap between the frame *B* and any of the poles; this is a valuable feature, as it makes the whole face of the chuck active. Its worth would be appreciated by anyone who finds it necessary to counterpoise a faceplate job on this chuck. What was said about the rings, brushes and terminal connections of the chuck in Fig. 8 applies equally to this case, as they are identical for any rotary chuck. The bushings *G* and *H* in Fig. 9 serve the same purpose that those shown at *Q* and *R* do for the chuck in Fig. 8, and as all of the coils in Fig. 9 are connected in series, there are but the same two terminals, though there are six coils.

Fig. 10 represents a multipolar chuck somewhat similar to that in Fig. 9, but made for use on the planer or milling machine. It is considerably easier to make than the chuck illustrated in Fig. 9, because it is not necessary to poise it. Gray iron can be used entirely in its construction, or the cores and pole pieces may be composed of Swedish iron to some advantage if exceptional holding power is desired. If made of gray iron only ten pieces are necessary, while if Swedish iron is used for the cores and pole pieces, it will take eighteen pieces of iron all told. This chuck differs from the one in Fig. 9 in that the frame *A* of the top plate extends between each pole piece, so that each pole is separated from its neighbor by two thicknesses of filler and a section of the frame. This adds something to the magnetic resistance of the gaps, and as the frame is active to work that is in contact with any one of the poles and to thin pieces that cover any number of poles, there is some advantage in this construction.

A chuck of this kind is particularly adapted for general tool work when large and small pieces of various shapes are to be held. It will hold extremely thin pieces better than any other kind of magnet would, and the active surface of the chuck face is so well distributed that work can be held upon any part of it. This chuck will stand the roughest kind of use, and being entirely iron bound, neither water nor oil will harm it if well made. It can be made in various shapes and sizes to accommodate special work, and though it is more expensive than some of the simpler shapes, it will also hold some forms of work for operations that would be impossible with a cheaper kind of magnet. Form wound coils can be used on this chuck, and they should be connected in series in such a way that alternate polarity will result in each successive pole. In attaching the coil terminals to the leading-in lamp cord, great care must be exercised to have both connections well taped for insulation; and to prevent accidental pulls on the cord from breaking the magnet wire, a knot should be tied in the cord large enough to prevent its being pulled through the bushing. Care in this particular will prevent frequent trouble from broken connections inside the chuck. This applies to any of the chucks described, as well as the one shown in Fig. 10.

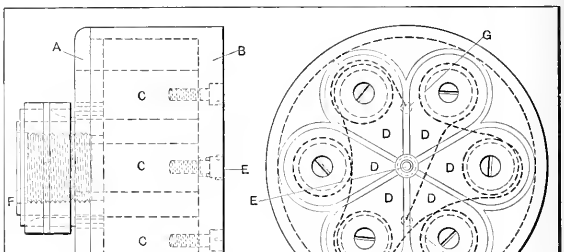


Fig. 9. Multipolar Magnetic Chuck for Heavy Lathe Work

Making Form-wound Coils

For winding the coils of any of these chucks, except the ones shown in Figs. 8 and 9, some kind of form is necessary, and Fig. 11 shows one made of wood that is quite satisfactory. It is about the right shape for the coils of the chuck in Fig. 6, but of course could as well be made any other shape. To use this form, place it between the centers

of the lathe and arrange a small dog or a stud on the face-plate to drive it. Support the spool of supply wire in front of the lathe, as when winding the coil for the chuck in Fig. 8. Insert three or four inches of the magnet wire under guide *A* at *B*, and wind several turns of it about the form, by hand, to prevent slipping. The winding can now be continued by power until the coil is brought to size. After stopping the lathe, and before cutting the wire, the coil should be wound with friction tape on both sides, so that it will retain its shape after being removed from the form. The slots in the form and guides permit this to be done very readily, after which the wire is cut and the form removed from the lathe. The pins *C*, *D*, *E* and *F* are now withdrawn from the guides *A* and *G*, and the coil can be pressed off the form with the guides. The form being tapered somewhat,

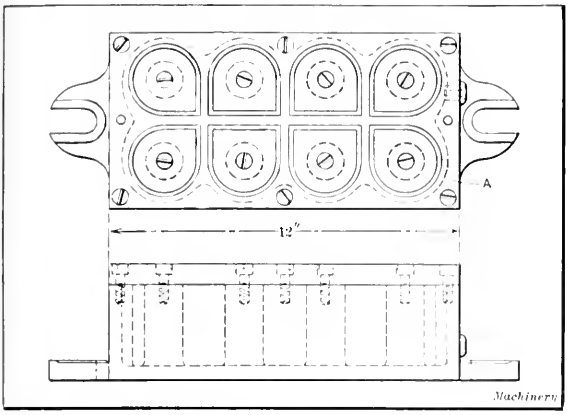


Fig. 10. Multipolar Chuck for Use on the Planer or Milling Machine

allows this to be accomplished quite easily without harming the insulation of the wire. Tape should now be applied to the whole coil until no wire is exposed except at the terminals, which should be left long enough to make connecting an easy matter. If all the coils are always wound in the same way, the terminals will issue from the coil in the same relative positions. This will facilitate connecting, as the direction in which the coil is wound can always be seen at a glance by the position of the terminals. Enameled wire is to be recommended for winding magnetic chuck coils, as it has many advantages over fabric insulation.

Principles used in Designing

In the foregoing descriptions of magnetic chucks, no mention was made of the reasons for the proportions used, nor were any rules given for establishing the size and quantity of wire to employ. These are, of course, matters of the greatest importance, and while experiment will often show opportunities for improvement in any predetermined winding, it is an easy matter to establish at least the size of the wire.

To secure maximum holding power, the cores for any magnet should be at least equal in cross-section to the work to be held. This means that the magnetic circuit should never be constricted to a smaller cross-section than the maximum of that part of the work through which the magnetic current flows when in place on the chuck. In case of a bi-polar chuck having cores on each side of the gap, it would mean one half of the cores. With a single coil chuck it would mean the total cross-section of the one core, and in the case of a multipolar it would mean one half as many of the cores as were actually engaged with the work, though in most cases such chucks are made for general purposes, and the core sizes become more a matter of judgment than of rule. The cross-section of the remainder of the magnetic circuit should exceed this, if weight or size is not an objection, as the lowest possible magnetic resistance is to be desired. Considerable latitude is permissible in the shape of the cores for any magnet. The greatest magnetic effect is obtained from the wire nearest the core, and for this reason a long core which would allow of a great quantity of wire in the first few layers would have this advantage, but as it would have the disadvantage of increased magnetic resistance due to its greater length, no real gain would result. A cylindrical core of a length greater than six or eight times its diameter will leak magnetism badly through the air, and the length can be carried to such extremes that practically all of the current will be absorbed in this way. On the other hand, a core could be so short that there would not be enough room for sufficient wire adjacent to it to magnetize it to any extent. Generally speaking, it is well to make cylindrical cores about twice as long as their diameters, and they should be energized by a coil not larger than three times the diameter of the core. That is, the winding must not be thicker around the core than the core diameter. If a greater cross-section is needed than can be secured by a cylindrical core of correct proportions in the space available, it is advisable to use an oblong shape as in Figs. 5, 6 and 7, and the windings should not be thicker on one side than the smaller diameter of the core.

Weight of the Required Wire

When the iron parts of the chuck are finished, and the size of the coils has been determined, it becomes necessary to discover the proper size of magnet wire to use in the coils to accommodate the voltage of the circuit upon which the chuck will be used. The weight of wire necessary to make one coil must first be found. To do this, pick any large size wire from a table of dimensions of copper wire, which can be found in almost any electrical or mechanical handbook. Find the diameter of the wire from the table, and see how many times the diameter is contained in the length of the core to be wound. This will give the number of turns to one layer, and the thickness of the coil divided by the diameter of the wire will give the number of layers. Multiply the number of layers by the number of turns in one layer and we have the total number of turns. Find the length of one turn of the wire in the middle layer; this will approximate the average length of all the turns, and the total length of the wire on one coil can be found by multiplying the average length of one turn by the number of turns. Having arrived at the total length of the wire, its weight can be found from the table under the heading "Weight and Length." The actual weight of the coil will be about three-fourths of that found, as some allowance must be made for insulation and the crossing of the wires in winding. The weight of a coil of given size will be the same, regardless of the size of the wire

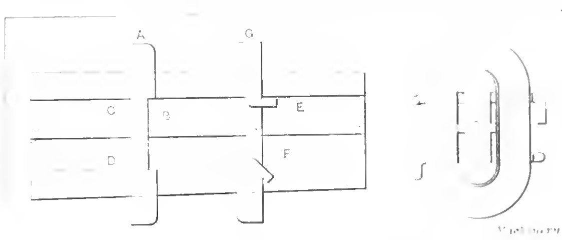


Fig. 11. Form on which the Coils for Electromagnetic Chucks are wound

used, so a haphazard choice of a size for experiment is permissible. Having the weight of one coil, the weight of all of the wire on the chuck can be found by simply multiplying by the number of coils.

The passage of an electric current through a wire is always attended by some heat, and too much current will cause a rise of temperature sufficient to ruin the insulation of the wire. For this reason, the wire to be used on any magnet must be of such size that the quantity required for the coils will have sufficient resistance to prevent the voltage used from forcing more than a safe amount of current through it. Ohm's law states that the current in amperes in any circuit is equal to the number of volts acting on it divided by its resistance in ohms. From this, it is an easy matter to find the amount of current that any voltage will force through the chuck coils after the wire size is established, so that its re-

sistance can be found from the table. Small magnet wire should carry from 1500 to 2000 amperes per square inch of cross-section without undue heating. Knowing the safe carrying capacity of the wire per unit of cross-sectional area, the weight of wire required for the coils and the voltage upon which the chuck is to be used, no further data is required for finding the wire size.

In the "Ohms per pound" column of the wire table, find such a resistance that, when the voltage to be used is divided by it, the result will give a quotient in amperes close to the safe carrying capacity of the wire which it represents. The cross-sectional area of the wire is always given in the table. There will be considerable difference between the results obtained from wire sizes next to each other, and it may not be possible to find a size that will be just right for the size coils in hand. If this is the case it will generally be safe to use the next size larger, because if the coils did heat to some extent, it would be an easy matter to add a few extra layers of wire to the coil, which would bring the resistance up to that required.

WIRE TABLE OF SIZES SUITABLE FOR MAGNETIC CHUCKS

Number B. & S. Gage	Diameter in Inches	Area	Capacity in Amperes	Feet per Pound	Ohms per Pound
11	0.090742	0.00646706	9.7 –9.12	40.11	0.05054
12	0.080808	0.00512860	7.6 –9.7	50.58	0.08036
13	0.071961	0.00406709	6.1 –7.6	63.78	0.12778
14	0.064084	0.00322544	4.8 –6.1	80.42	0.20318
15	0.057068	0.00255785	3.8 –4.8	101.40	0.32307
16	0.050820	0.00202843	3.2 –3.8	127.87	0.51373
17	0.045257	0.00160865	2.5 –3.2	161.24	0.81683
18	0.040303	0.00127575	2.0 –2.5	203.31	1.29876
19	0.035890	0.00101166	1.6 –2.0	256.39	2.06531
20	0.031961	0.00080224	1.2 –1.6	323.32	3.28437
21	0.028462	0.00063624	1.0 –1.2	407.67	5.22177
22	0.025347	0.00050460	0.85–1.0	514.03	8.30181
23	0.022571	0.00040012	0.68–0.85	648.25	13.20312
24	0.020100	0.00031731	0.53–0.68	817.43	20.99405
25	0.017900	0.00025165	0.42–0.53	1030.71	33.37780
26	0.015940	0.00019976	0.33-0.42	1299.77	53.07946
27	0.014195	0.00015826	0.26-0.33	1638.97	84.39916
28	0.012641	0.00012550	0.21-0.26	2066.71	134.2005
29	0.011257	0.00009952	0.17-0.21	2606.13	213.3973
30	0.010025	0.00007893	0.13–0.17	3286.04	339.2673

Machinery

Method of Determining Wire for a Given Voltage

As an aid in figuring the wire sizes for different voltages the table above is given for the range of sizes most likely to be used in magnetic chuck work; and in addition to the usual data, it includes a "capacity column" in which the safe range of load for each size wire is given. To illustrate the method of finding the wire size for a given voltage, take for example a chuck designed with four coils, the cores of which are to be cylindrical in shape, 1½ inch in diameter and 2½ inches long. Space should be provided for a depth of winding of ¾ inch and this is to be filled with wire of the proper size to accommodate 20 volts. Referring to the wire table, find a wire of rather large size whose diameter will be nearly evenly contained in the depth of the coil winding ¾ inch. No. 15 answers very well in this case, as it has a diameter of 0.057068 inch bare and with the insulating enamel on would come very near to 1/16 inch. This is contained in the winding depth ¾ inch twelve times, so it will take twelve layers of No. 15 wire to complete a coil, and as 1/16 is contained in the core length 2½ inches forty times, there will be that many turns of wire in each layer. If there are twelve layers of forty turns, each coil with contain $12 \times 40 = 480$ turns in all.

As there is to be a depth of wire on the cores of ¾ inch, a turn of wire that lies at half this depth or ⅜ inch from the core will have an average length. This length can be readily found by multiplying the diameter of the turn in question, which is 2¼ inches, by 3.1416. This gives a length for one turn of 7.0686 inches, and multiplied by the number of turns, 480, gives a total length for the No. 15 wire on one coil of 3393 inches, or practically 283 feet. Referring again to the wire table, No. 15 wire is found to run 101.40 feet to the pound, so dividing 283 feet by this value gives approximately 2.8 pounds as the weight of wire of any size that one coil will contain. As the chuck in question has four coils, the total amount of wire required will be 11.2 pounds. Having determined the weight of the wire for the entire chuck, it remains to find a size of wire that will have the correct resistance for the voltage. This resistance must be such that 20 volts will have just sufficient pressure to force the safe carrying capacity of the wire through it. Taking as an experiment the same No. 15 wire, 0.32307 is found in the wire table to be its resistance in ohms for one pound. Multiplying this by 11.2 gives 3.6 ohms as the resistance for the entire chuck. To find the current this will allow to pass, it is only necessary to divide the voltage, 20, by the resistance, 3.6. The result is 5.5 amperes, and as the wire table gives the capacity of No. 15 wire at from 3.8 to 4.8 amperes it is plain that a smaller wire will be needed for this chuck. Taking No. 16 as next choice, 0.51373 is given in the table as its resistance for one pound, or 5.7 ohms for 11.2 pounds. Dividing the 20 volts by this resistance gives 3.5 amperes, which is well within the capacity 3.2–3.8 given in the table for No. 16 wire. Therefore this chuck will require a winding of 11.2 pounds of No. 16 wire, to operate at 20 volts.

If the chuck were to be used on any other voltage, proceed in the same way to find the wire size, but it must be understood that these sizes, as found, can often be improved upon by experiment. For instance, a chuck having oblong cores of large size and a heavy base in close contact with some heavy machine platen could stand a heavier load on its wire than a light weight enclosed chuck for use on a lathe. In the first case, the excess heat would be rapidly carried away by the heavy parts, while in the light chuck it would simply accumulate. Again, some chucks may be made for very short operations with longer idle intervals. In such cases, lighter wire than called for by the load may be employed with good results, as insufficient time will be allowed for dangerous heating. No rule can be given for securing a certain holding down pressure, as conditions vary considerably in every case. A chuck that would hold a 6 by 12 by 2 inch block of iron with a pressure of 200 pounds to the square inch would not hold a piece the size of a dollar with nearly that strength. It can be said, however, that any of the chucks illustrated should hold a flat piece 1 by ½ by 6 inches strongly enough so that a very strong man could not move it with his hands.

It is very unlikely that perfect results are ever secured in winding coils for a certain voltage without some experimenting. The amount of current a coil of a given sized wire will stand varies with different conditions. The shape and size of the coil, the weight and shape of the core, the kind of insulation used and the opportunity given for air circulation are some of the factors in determining the heating properties of any chuck. A mild warmth after the chuck has been in use continually for an hour or so is not objectionable; in fact, this would indicate good results.

Method of Connection to Circuit

For connecting the finished chuck to the current supply, ordinary drop cord is very satisfactory. It should be soldered to the coil terminals and very carefully taped at the splice. Some sort of switch must be provided, preferably one that will allow reversing of the current to demagnetize the chuck when large work is being held, as the temporary residual magnetism is likely to be very strong in a gray iron chuck. A double-pole, double-throw, knife switch fulfills these requirements nicely; such switches are easily obtained and quite inexpensive. There are six binding posts on these switches, two in the center to which the blades are attached, and two at each end into which the blades engage when thrown in either direction. The drop cord from the chuck should be attached to all four of the end poles, each separate conductor being scraped and fastened to one binding post on the near end of the switch, and then brought diagonally across to the post on the extreme opposite end and attached. The service wires enter the binding posts in the center of

the switch—the same ones to which the blades are pivoted. Closing the switch into one pair of the end posts allows current to flow through the chuck coils in one direction, and reversing to the other end changes the current flow to the opposite direction, thus changing the polarity of each pole in the chuck. This cannot be accomplished instantaneously, and it is plain that there must be one point in its progression at which there will be no polarity and consequently no magnetism. If the switch is opened from the second contact at this precise instant, both the chuck and work being held will be found to be completely free from magnetism. Of course in practice one could not hope to perform this operation accurately enough to demagnetize the chuck perfectly each time, but a sufficient reduction in holding power for the easy removal of work can always be accomplished.

Objection to magnetic chucks for milling and planing is often raised by inexperienced people, on account of the chips sticking to the chuck, work and tools. This is largely fallacious, as a moment's consideration would show. Each individual chip in a magnetic current becomes a separate bar magnet, having a polarity the same as the main current. It can stand only lengthwise with the current, and is only attractive to the ends of opposite polarity of its lengthwise standing neighbors. For this reason, chips will always be found standing on end on the chuck, work and tools, except where they cross a polar gap directly. In this position, they are less likely to crowd between the cutter and the work than if lying free, and as their actual attraction to the magnet is very slight, it is scarcely a factor. When the chuck is demagnetized, the chips can be removed more easily than from the average clamping fixture, as there are no clamps, straps, screws nor dogs for them to gather under; and if cast iron is being worked, the workman will appreciate the fact that the dust is all sticking to the chuck where he can carefully remove it with an oily cloth, instead of filling the surrounding atmosphere, his nostrils, lungs and clothes. On tool work that must be closely watched, if the cut is very heavy the accumulation of chips on the cutter may be somewhat of a nuisance, and it will be necessary to remove them from time to time with a bristle brush. Again, where oil is used in working steel, it is often impossible to get good results without brushing off the chips as they are formed. However, it is doubtful if these difficulties are increased to any extent by the magnetism, and the fact that it does not cure them is not a good argument against the magnetic chuck.

It is to be regretted that an alternating current will not operate a magnetic chuck satisfactorily, as this requires a special direct-current dynamo to be driven from the lineshaft in those factories equipped with alternating-current lighting systems. It is often the case, though, that the dynamo can be purchased and installed and the chuck built at less expense than would be necessary in making one clamping fixture for the work in hand. If there are a number of chucks to be supplied with current, the dynamo expense becomes but an item, and the possibility of using a much lower voltage than that supplied for lighting is at times a decided advantage, especially when rotary chucks are to be used. The life of a magnetic chuck is very long, as there are no working parts to wear or become deranged. The active face can be refinished at times to keep it true, and beyond this nothing is needed except possibly a new piece of lamp cord when the old one becomes badly frayed. Magnetic chucks are cheaper to design, build, operate and maintain than most fixtures of any other kind; and though it is true that they cannot be used in a great many cases, still there are so many kinds of work that could be successfully held by them that they are bound to become vastly more popular as their many merits are realized.

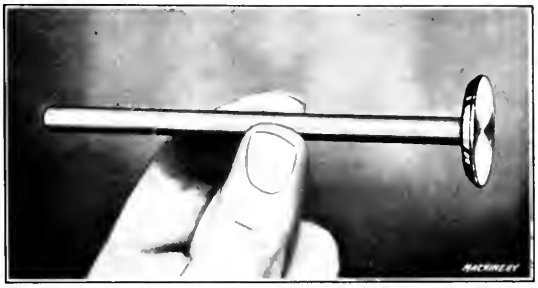
* * *

One of the most dangerous common objects and one frequently seen is a board lying on the floor or ground with nails projecting upward. Many serious accidents have resulted from such obstructions. Workmen stepping on sharp-pointed nails run the risk of puncturing their feet. A wound caused by dirty, rusty nails may cause lockjaw and death.

RAPID WORK ON THE CLEVELAND AUTOMATIC

The illustration shows a gas engine poppet valve 4 1/4 inches long over-all, having a head diameter of 1 1/16 inch, which was made on one of the Cleveland Automatic Machine Co.'s 7/8-inch machines, built for the Fairbanks-Morse Co., of Beloit, Wis., at the rate of 24 an hour, or 2 1/2 minutes each. The forming is a separate operation from the milling of the stem, because two tools cannot work in conjunction with each other on this part.

The valve stem was reduced with a single box-tool equipped with roller supports in one cut. The size of the stock is 1 1/16 inch and the diameter of the stem 1/4 inch. This means that



Gas Engine Poppet Valve produced at the Rate of Twenty-four an Hour on the Cleveland Automatic

the diameter of the stem part is reduced 13/16 inch in one cut. Notwithstanding this great reduction of the diameter the stem is parallel within 0.00025 inch.

This job indicates that the Cleveland roller-rest box-tools are of first-class design, because in removing so much stock in one cut and reducing the stem to such a small diameter it is done with such close approach to exact parallelism. To be able to produce machine parts so accurately and rapidly is indeed a triumph for the automatic machine.

* * *

At the last annual meeting of the Association of German Machine Tool Manufacturers, it was stated that the reaction in the general machine building field, which manifested itself toward the end of last year, had also made itself felt in the machine tool business. The works of the various machine tool builders, however, continue to be fairly busy, although in some branches the business on hand is not sufficient. This is especially true of the works where medium and small machines for general purposes are manufactured, as the demand for this class of machinery has materially diminished. As far as large and special machine tools are concerned, the position is quite favorable, although several works, which as a rule could promise delivery only after several months, are now able to fill orders at short notice. A point of great importance to the makers of large and special machine tools in Germany is that the comprehensive extension to the works of many large concerns, and the extraordinary demands for the equipment required by the railway shops during the last few years, have now come to an end. In the same way, many works manufacturing arms have been equipped during the last few years and new equipment in this line is not required at the present time. Export business has also suffered somewhat, except the export trade to Russia, where, owing to the increased industrial activity which at present manifests itself in that country, the trade conditions are favorable.

It was stated that wages and salaries are on the increase in the machine building trades and that the ever-increasing tax burdens tend to make the cost of production greater. The competition from America and lately from England has also made itself felt in the international market. The discharge of labor has, on the whole, been avoided by the German machine tool builders, but if the trade conditions are not altered within the near future, it will be necessary to somewhat reduce the number of men in the industry. On the whole, the prospects for the present year were considered rather gloomy. It will thus be seen that the present depression in the machine tool trade in the United States is by no means a local condition.

JIGS FOR MACHINING PISTONS

BY I. W. SPRINK*

The jig shown in Fig. 1 is used successfully in cross-drilling pistons. It possesses a few novel features that may be of interest to readers of MACHINERY who have work of a similar nature to perform. In the first place it will be seen that the piston is drilled from both sides and not all the way through from one side, which is the common practice, especially when the work is done on some style of lathe. It is not an easy matter to drill and ream a true hole by starting on one side of the piston, drilling through one boss and then advancing the tool across the opening between the bosses and expecting the tool to get a true start in the second boss.

This jig was made in the following manner to insure accuracy. A block of cast iron was milled square and the large hole rough-bored to within 1/16 inch of size. This block was then milled across one end to receive the stop-bar *A*. After fitting the stop-bar, it was removed and the seat for the clamp-bar *B* was bored by using a fly-cutter in the milling machine. This clamp-bar was a piece of two-inch cold-rolled stock, milled flat to form a little more than a half round. During the succeeding boring and grinding operations the clamp-bar was held to its seat by the two screws *C* which had washers under their heads instead of the springs shown in the illustration. A piece of 0.005-inch stock was placed between the clamp-bar and seat while boring and grinding; this shim was taken out later to allow for a little clearance. After the clamp-bar was fitted and bored, the holes for the hardened bushings *D* were bored and the bushings fitted. These bushings were long enough to reach through the large bore so that they could be ground flush with the inside of the jig.

The jig was next set up on the table of a Heald cylinder grinder and the holes in the bushings ground in line and true to size. The jig was then placed on one side with the bushings in a horizontal plane and the large hole finished to size by grinding. To be sure that the holes in the bushings would be perfectly central with the large bore, an arbor was ground to a snug fit for the bushings and the large hole was gaged from it, measuring from the wall of the large hole to the arbor until both sides were exactly the same. The hole

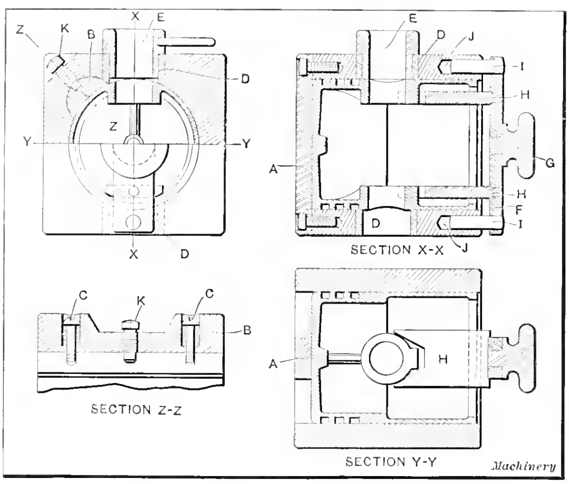


Fig. 1. Jig used for cross-drilling Pistons

was then finished 0.003 inch larger than the piston to be worked on. Two slip bushings *E* were made to fit the bushings in the jig, one for the three-lipped drill and the other for the reamer. The reamer used was 0.0015 inch under size, so that the holes could be finished with a long hand reamer that reached through both holes of the piston.

To locate the piston in the jig so that the bosses would line up with the holes being drilled, the "locater" shown at the open end of the piston was made and used in the following manner. The locater consists of the cross-bar *F*, into which are fitted the knob *G* that is used for a handle, two flat bars *H* with V-slots in the ends, and the two pilot pins *I*. The pilot pins fit into holes *J*, bored in the face of the jig in line with the bushings. In using this locater the piston was first put into the jig and then the locater was pushed in until the V-slots came in contact with the bosses. This put the piston in such a position that the bosses were in line with the drill bushings. After locating, the piston was gripped by the clamp-bar by tightening the set-screw *K*.

In this case the pistons were rough-drilled 3/32 inch under size before turning, so that in this jig it was only necessary to use one drill and reamer. The drilling operations were as follows: The drill bushing was put in and the drill run through one side. The bushing was then taken out, the jig turned over, and the bushing put in the other side, after

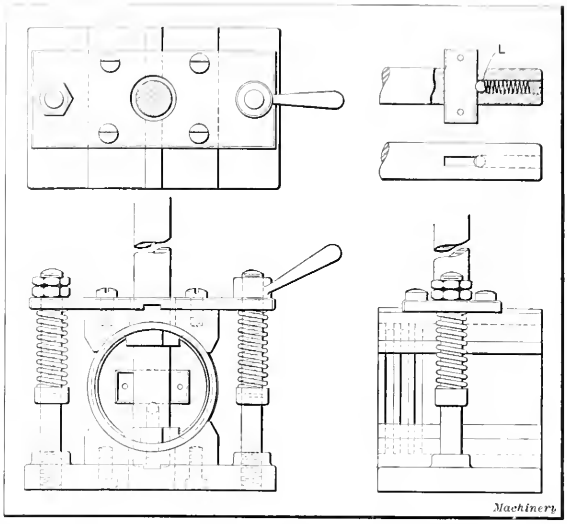


Fig. 2. Jig used for facing the Bosses in Pistons

which the second boss was drilled. The drill bushing was now replaced by the reamer bushing and the hole reamed; the bushing was then taken out, the jig turned over, the bushing replaced and the second hole reamed. It may be well to mention that when using this jig two strips were fastened to the drill press table forming a channel in which the jig could slide and which would also hold the jig in line with the machine spindle.

Jig for Facing Bosses in Pistons

Fig. 2 shows the jig and facing bar used for facing the bosses in the piston after it leaves the cross-drilling jig. It was found advantageous to do this operation in a separate jig because it consisted of top and bottom facing and also because the machine spindle had to be set to a stop. This jig proved to be a very handy and rapid tool. The base and the adjustable top are provided with a pair of jaws bored to the proper size to fit the piston to be worked on. The springs on the upright studs hold the upper or clamping jaw up while the work is being put in or taken out.

In operation, a piston is slipped between the jaws, the facing bar run down through the cross-drilled holes, the cutter fitted into the bar, and the top jaw set by a half turn of the lever handled nut. A novel feature of the facing bar is the manner in which the cutter is held. It will be seen that the cutter has a half round notch in the center of the bottom edge that registers with a steel ball *L* in the center of the cutter slot. A stiff spring holds the ball to its seat in the bar. The cutter is also provided with two holes near each end that are used for pulling it out of the bar with a stout wire hook. It is double edged, so that both bosses can be faced without reversing it or stopping the machine. This method of holding the cutter would not do in the case of a boring tool but for a facing tool it serves very well. Of course the cutter must be a nice fit in the bar. The illustrations are so plain that a detailed description is hardly necessary except to mention that when the facing jig is used it can be clamped to the machine table, while the cross-drilling jig is not clamped, because it is necessary to turn it over and over.

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MACHINING AUTOMOBILE WHEEL HUBS ON BARDONS & OLIVER TURRET LATHE

Fig. 1 shows an automobile wheel hub that is made from a malleable casting and is machined in a Bardons & Oliver turret lathe in the plant of the Kelsey Wheel Co., Detroit, Mich. The method of handling this work and the sequence of operations performed upon it are interesting, and no doubt

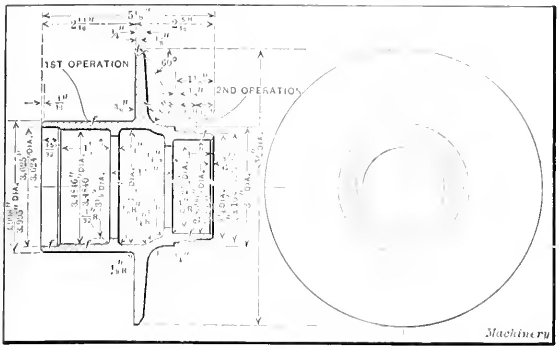


Fig. 1. Automobile Wheel Hub made from a Malleable Iron Casting and machined Complete in 7½ Minutes

will be appreciated by mechanics in general. Fig. 2 shows the machine used, which is a No. 9 Bardons & Oliver turret lathe, and gives a good idea of the tool set-up. Figs. 3 and 4 show diagrams of the tool equipment used for performing the first and second series of operations.

The first series of operations is shown in the plan view Fig. 3. The casting *A* is held in a three-jawed chuck *B*. First tool No. 1 equipped with two cutters rough-faces the flange, while the inner and outer surfaces of the cylindrical part are rough-bored and turned by the combination turning and boring tool No. 2. This tool has, in addition to a regular bar, a bracket or tool-holder projecting above the work and carrying cutters that operate on the top or outer surface of the work. Tools Nos. 3 and 4 come into action next, tool No. 3 finishing the surfaces roughed out by tool No. 2, and tool No. 4 finish-facing the flange and end of the hub. The detailed side view of tool No. 3, which is practically the same as No. 2, shows the arrangement of the cutters *C* and *D*. One of the cutters turns the cylindrical surface of the body of the hub and the other bevels the end of the hub. The hole in the hub is next finished by tool No. 5, which is a stepped reamer that machines the bore and counterbore to the required size within close limits. The surfaces machined by the different tools referred to are indicated by the sectional view *E* of the hub, that shows which tools are used on each surface.

For the second series of operations the position of the automobile hub is reversed; in this case it is held in a spring collet, as shown in the plan view Fig. 4. The finished cylindrical end of the hub is inserted in the split collet *F* which is drawn back into the tapered collet ring by rod *G* operated by the turnstile handle *H*, Fig. 2. This closes the collet tightly around the casting. The first operation is that of facing the side of the flange and end of the hub with tool No. 6, which is held on the cross-slide in the working position shown in the illustration Fig. 4. A broad cutter *H* is used for facing the flange and finishing the large fillet, and the end is faced by a smaller cutter *I*. When these tools have been withdrawn, tool No. 7 is moved up to take the roughing cut from the outside of the cylindrical end (preparatory to cutting a thread) and rough-bore the hole. These same surfaces are then finished by tool No. 8. The arrangement of tools Nos. 7 and 8 is shown by the detailed view. Tool *J* turns the part to be threaded, while tool *K* turns the end beyond the threaded part, and tool *L* bevels the corner or edge.

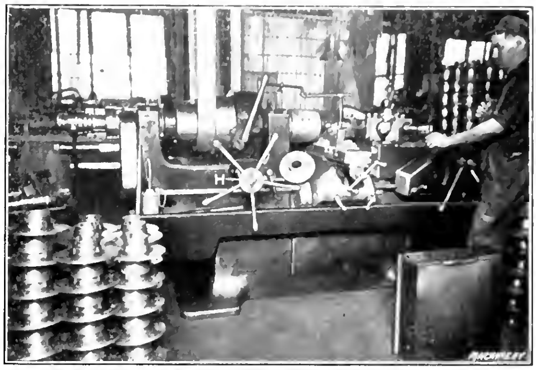


Fig. 2. No. 9 Bardons & Oliver Turret Lathe used for machining Automobile Wheel Hubs

The reaming tool No. 9 is then indexed to the working position for finishing the hole and beveling the outer edge slightly. At the same time the form tool No. 10, held on the rear of the cross-slide, is brought up for beveling the flange to an angle of 60 degrees and turning the outside of the flange

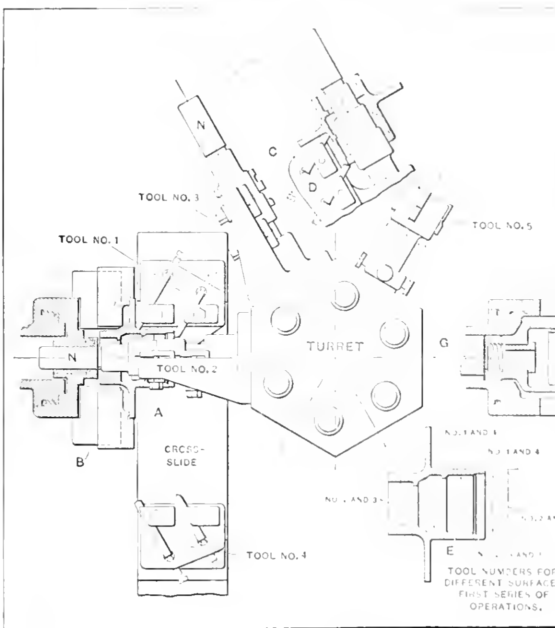


Fig. 3. Diagram showing Layout of Tools for performing First Series of Operations on Automobile Wheel Hubs

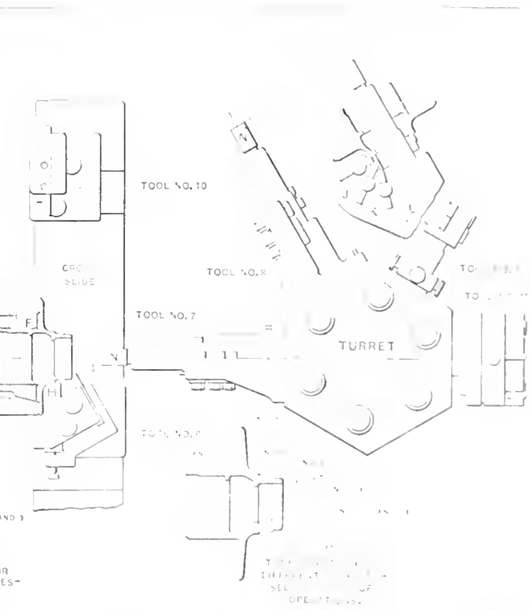


Fig. 4. Diagram of Layout of Tools for performing Second Series of Operations on Automobile Wheel Hubs

to size. The final operation to be accomplished is that of threading the end, which is done with die No. 11. The boring bars of tools Nos. 2, 3, 7 and 8 are all provided with pilots A which enter close fitting bushings held in the spindle to steady the bar while the cuts are being taken—this is a common method of supporting the tools.

The feed of the turret for both the first and second series of operations is 1/27 inch per revolution of the work, and the work is rotated at 60 revolutions per minute for taking the roughing cuts, and 90 revolutions per minute for taking the finishing cuts. The total calculated time for machining one of these castings is about $7\frac{1}{2}$ minutes, which includes the time required for placing the work in the chuck, but a product of 85 to 95 completed hubs is secured in ten hours. The following gives in detail the actual time required for each operation and indicates the ease and rapidity with which this work is handled.

Time for first series of operations on hub: chucking, holding work in a three-jawed chuck—20 seconds;

Tools Nos. 1 and 2: rough-facing, turning and boring, 1 minute, 45 seconds;

Tools Nos. 3 and 4: finish-facing, turning and boring, 1 minute;

Tool No. 5: finish-reaming, 37 seconds;

Total time for first operation, 3 minutes, 42 seconds.

Time for second series of operations: chucking, 10 seconds;

Tool No. 6: facing, 45 seconds;

Tool No. 7: rough-turning thread end and rough-boring, 1 minute, 3 seconds;

Tool No. 8: finish-turning thread end and finish-boring, 37 seconds;

Tools Nos. 9 and 10: finish-reaming and forming, 45 seconds;

Tool No. 11; threading, 25 seconds;

Total time for second series of operations, 3 minutes, 45 seconds.

D. T. H.

* * *

TOY CONSTRUCTIONS FOR ENGINEERS

Two or three concerns have lately placed on sale construction materials for boys, amateurs and others interested in the making of models, etc. These devices were first offered as toys pure and simple, but later developments apparently have shown their value for engineers, inventors and others desiring to make working models of bridges, towers, frames, cranes, etc. Models can be quickly and cheaply made to illustrate constructions much more graphically than drawings.

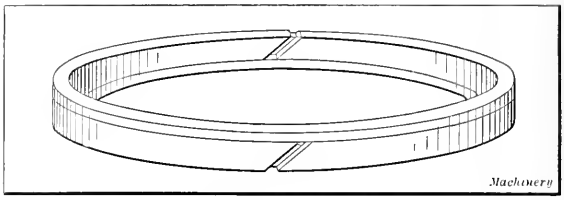
The illustration shows models built of "Bill Deezy" materials, made by the Bill Deezy Co., Boston, Mass. The basic principle of this construction is very simple, consisting of so-called flexible joints and coppered steel constructive rods. The flexible joints are in the form of a tinned sheet metal cross. The arms of the cross are curled, forming four sockets for the construction rods. These joints can be used in a variety of ways. When only three wires are to be joined, the fourth arm is removed with pliers. If only two arms at an angle are required, the other two are removed, etc. The material is sufficiently flexible to allow the arms to be bent to other angles than 90 degrees. Bracing wire, pulleys, car wheels, cable, are also supplied for working models of crane mechanism, etc.

Contractors should often find these construction materials useful when figuring on estimates of work out of the ordinary. Models on a small scale can be made and a better idea of the constructive difficulties can be obtained in many cases, no doubt, than where everything is laid out on paper.

* * *

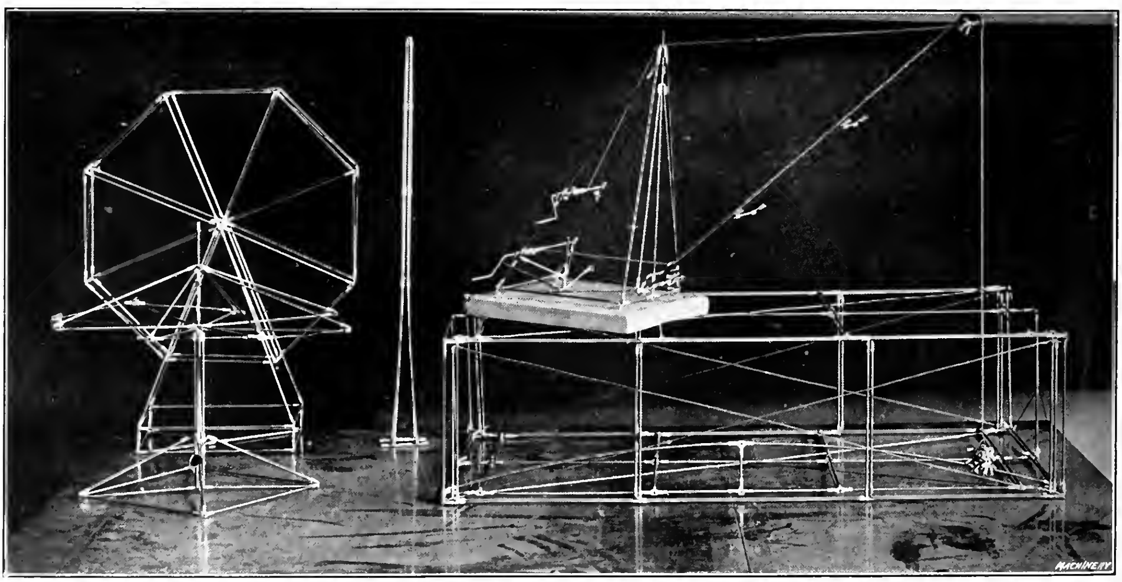
"LEAK-PROOF" PISTON RING

It is a curious fact that the common piston rings of steam and gas engine pistons are makeshift contrivances for which no greatly superior substitutes have been invented. Probably none of the piston rings in use are leak-proof except when the cylinder, piston and rings are newly fitted. As soon as



A "Leak-proof" Piston Ring

wear takes place the steam and gases can escape through the opening in the rings past the piston. Different forms of piston rings have been devised to overcome the fault, but none have been completely successful. They have succeeded in fooling users perhaps, but not the fluids that they were intended to restrain. The illustration shows a double piston ring designed for gas engines that is advertised as "leak-proof." It is a double ring consisting of two concentric angle rings split in the usual manner and fitted together so that the openings in the rings are opposite. No doubt this is an efficient design, but obviously it cannot be leak-proof when the cylinder and piston grooves are worn. When the gases can freely enter the groove beneath the rings from the pressure chamber, they escape readily through the opening in the ring next to the exhaust chamber.



Ferris Wheel and Derrick Models made of "Bill Deezy" Joints and Rods

RECESSING TOOLS*

TOOLS, ARRANGEMENTS AND FIXTURES USED FOR RECESSING IN LATHES AND BORING MILLS

BY ALBERT A. DOWD†

MANY varieties of cylindrical work call for the machining of an annular recess or groove in a place which may be inaccessible to the cutting tools. The form of recess varies greatly and the accuracy required is likewise variable. The form may be either narrow or wide, deep or shallow, while the accuracy called for may be either within narrow or liberal limits, as, for instance, when the recess is for clearance only. In fact, in the majority of cases the purpose of the relief or recess is merely to obtain clearance for some moving part or for tools when machining an adjacent surface. Very frequently a groove is cut to serve as an oil-pocket or to provide a space which can be filled with packing to act as a gland. It is evident that great accuracy is not essential when the work is of this nature. There are occasionally conditions which require more accurate work, as, for instance, when another piece is to be sprung into place, such as a spring ring or something of a similar nature, but even in a case of this kind a certain amount of inaccuracy is permissible. The machines to which recessing tools are most frequently fitted are the engine lathe, the horizontal turret lathe, the vertical turret lathe, the vertical drilling machine and the horizontal boring mill. Other machines are occasionally equipped with tools for the same purpose, but those mentioned are most frequently used.

In many cases the position of the relief or groove is such that it cannot be readily seen by the operator, nor can it be easily calipered. The workman, therefore, must tell how the tool is cutting by the "feeling" of it and by the character of the chips. He is really "working in the dark," and for that very reason every precaution must be taken, in regard to position of tools, diameter and shoulder stops, etc., so that the machining can be done without withdrawing the tool to note the progress of the work. In this connection it is well to bear in mind that the action of any kind of grooving tool is much the same as a cutting-off tool. It must be kept very sharp and set so that the cutting edge is slightly above center, when it is used for internal work. It will be seen that if the tool is slightly above center the springing down of the cutting edge (due to the pressure of the cut) will have a tendency to keep it from "digging in," and will therefore assist in the prevention of chatter. Some of the important points in the design of recessing tools are given herewith.

* For previous articles on this and kindred subjects, see MACHINERY, March, 1914, "Design and Construction of Boring Tools"; February, 1914, "Adjustable and Multi-cutting Turning Tools."
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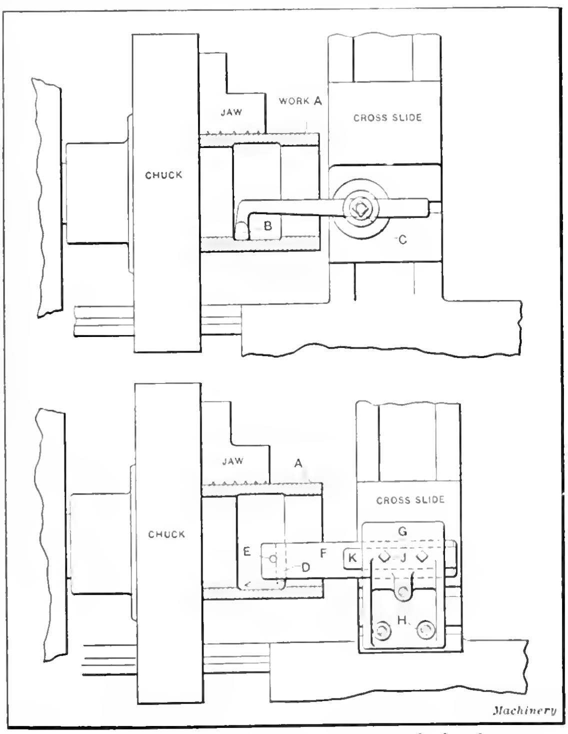


Fig. 1. Two Simple Types of Recessing Tools for the Engine Lathe

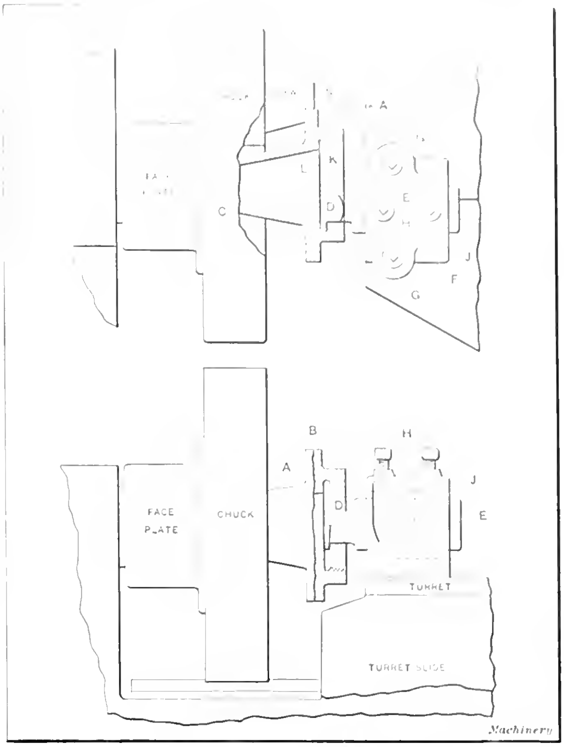


Fig. 2. Recessing Tool used in a Turret Lathe

Points in Design of Recessing Tools

1. Rigidity is of the greatest importance and every precaution should be taken to insure as substantial a holder as possible. The tool itself should be of as great a section as the conditions and the space will permit. Some method of supporting the overhanging end should be provided, either by means of a pilot or in some other way which may suggest itself. Moving parts should have a means of adjustment for wear, and gibs should be set up as snugly as possible and still allow free movement.

2. The feed motion should be carefully considered. Screw feed is best, and may be contained in the tool itself or may be operated by the cut-off slide. Lever feed is uncertain and produces uneven cutting unless the work upon which it is used runs at high speed. When this is the case and if the cut is not too heavy, it can be used with satisfactory results. The work to be done is a factor in determining the method most satisfactory for the feed motion.

3. Means are needed for determining the depth of the cut. There are several ways in which the depth of the cut can be positively determined: a positive stop can be provided; the dial on the cut-off slide can be used when the feed motion of the slide is the operating force; an indicator or a graduated dial on the tool-holder itself may be provided.

4. Rapidity of operation is essential.

5. Adjustment for the cutting tool should be provided.

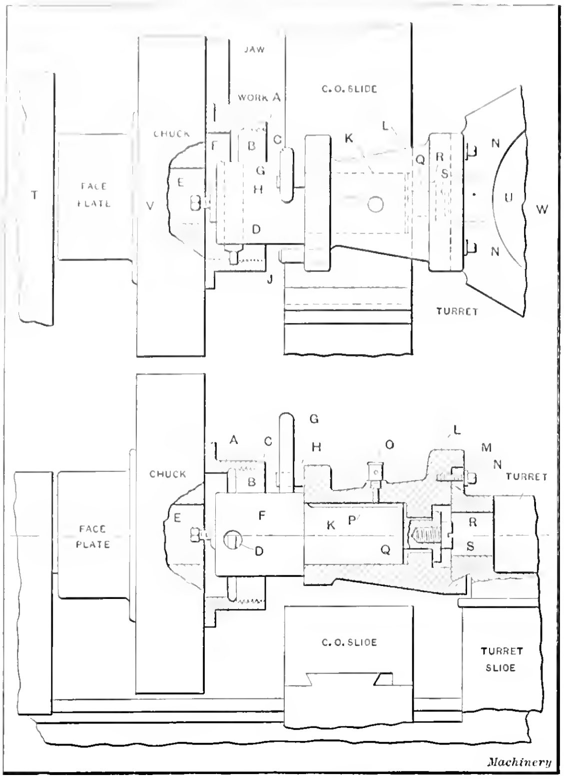


Fig. 3. An Eccentric Recessing Tool for the Turret Lathe

This adjustment may be made either by manipulating the tool by hand or by means of a backing-up screw. The latter method is the better one and should be used whenever practicable. The upkeep of the tool is important, and for that reason inserted tools are preferable to those which form a part of the mechanism itself. In confined situations it is occasionally necessary to make the tool of special shape. This should be done only as a last resort, when necessitated by the conditions governing the work. In cases of this kind several tools should be made to provide for emergencies.

Recessing Tools for the Engine Lathe

The upper illustration in Fig. 1 shows a bushing *A* which is held by the outside in regular chuck jaws. This work is to be done on the engine lathe, and the recess is to be cut at the same setting. A forged tool *B* is held in the regular toolpost *C* on the cross-slide of the lathe, and is forced into the required depth by hand. After this the longitudinal feed is started and the remainder of the recess cut. This type of tool is much used for lathe work when only one or two pieces are to be machined. Its advantages are that it can be easily made and quickly adjusted. Its disadvantage is that it has a tendency to chatter, and is, therefore, suitable only for very light cutting.

The device shown in the lower portion of the same illustration is much more rigid, but is not nearly so adaptable to various conditions. In this arrangement, the tool *D* is of round section and is held in place by taper pin *E*. The bar *F* is of steel and is secured in the holder *G* by the two screws *J* which bear against a flat *K* on the bar. Three screws *H* enter shoes in the cross-slide T-slots and secure the holder firmly to the slide.

Recessing Tool for a Horizontal Turret Lathe

The work *A* shown in Fig. 2 is a steel forging of an automobile hub which is held in a three-jawed chuck by the flange *B*, the tapered portion entering the hole *C* in the chuck body. The inside of the hub is to be threaded at *K* with a collapsing tap. A recess is therefore needed at *L* in order to obtain a clean thread. The machine selected for the work is a Pratt & Whitney turret lathe having a cross-sliding turret of the flat type. The recessing tool is of high-speed steel, with the shank turned and ground cylindrical at *E*. The front end is also turned to form the flange *D*, and is afterward cut away and finished to the shape required, as clearly shown in the lower part of the illustration. The tool-holder *F* is of cast iron and contains a steel split bushing *J* which is compressed by two screws *H* in the top of the holder. The action of this tool was satisfactory, but the upkeep is obviously rather expensive.

Eccentric Recessing Tool for a Horizontal Turret Lathe

The work *A* shown in Fig. 3 is a steel flange which is to be recessed at *B* in order to provide the necessary clearance for the threaded portion *C*. In this instance the cut-off slide was used during the progress of the work, so that a considerable overhang from the turret was required. Strictly speaking, this is not an eccentric tool, for the various parts of the body are concentric, but by a reference to the upper part of the illustration it will be seen that the center-line *VW* of the recessing tool does not coincide with the center-line *TU* of the spindle. Now as the tool-holder *F* revolves on the center-line *VW*, it is evident that the path of the tool *D*, as it swings, will be eccentric to the center-line of the spindle. The body *L* is of cast iron and is mounted on the dovetailed turret face, being securely held in position by the gib *M* and the screws *N*. The tool-holder *F* is of tool steel and is turned down at *K* to a running fit in the body. The end *Q*, with the screw and washer *S* and *R*, acts as a retainer to keep the tool-holder in position. The tool *D* is of round section with the cutting end so shaped that it will cut the recess properly. A set-screw *E* holds it in position. An oiler *O* is located in the body and distributes the oil to the bearing through the oil groove *P*. An operating handle *G* is driven into the holder, and is located between the pins *H* and *J* which act as stops. As the lever *G* is operated, the tool *D*, starting with slight clearance at the bottom of the hole, moves gradually upward and outward until the full depth of cut has been reached. At the completion of the cut the tool stands in the position shown in the illustration. The action of this tool was perfectly satisfactory, and as it is comparatively simple in construction, the cost of building was not excessive.

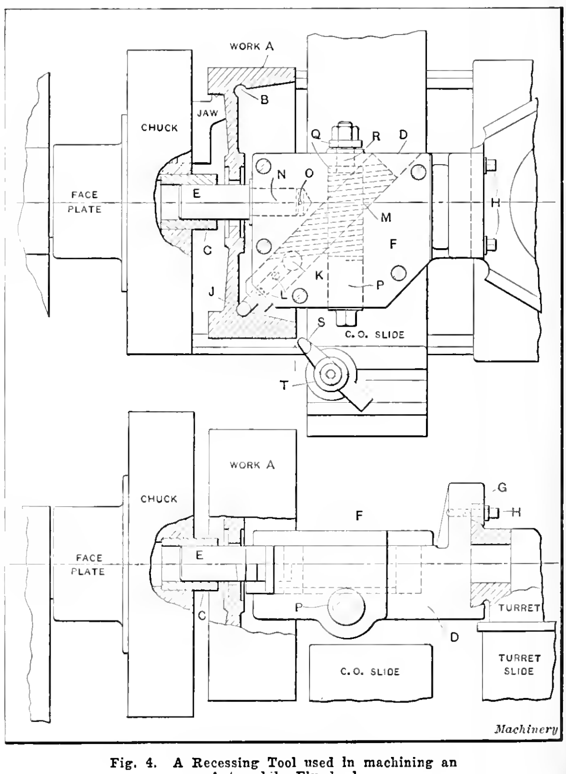


Fig. 4. A Recessing Tool used in machining an Automobile Flywheel

Piloted Recessing Tool for an Automobile Flywheel

A rather peculiar condition is shown in Fig. 4, the work *A* being an automobile flywheel having a semicircular recess at *B*. Attention is called to the fact that this recess is put in at an angle of 45 degrees with the center-line. It is evidently only a clearance groove for the male clutch member, and it is not known to the writer why some other style of groove would not have answered the purpose just as well.

The work *A* is held by the inside of the rim in special jaws. The body of tool *D* is made of cast steel and is fitted to the dovetailed face of the turret, the gib *G* securing it firmly by means of the collar-head screws *H*. A tool-steel pilot *E* enters the bushing *C* in the chuck and assists in supporting the body against the pressure of the cut. This pilot *E* is shouldered and forced into the body at *N*. A small hole *O* is drilled to avoid air compression when forcing in the pilot. If this is not done the fitter may be deceived into thinking that he has secured a good fit at this point when in reality it is the air compression which causes the stem to fit tightly. A cover plate *F* tends to strengthen the body and overcome the weakening effect caused by the cutting of the angular slot, and also assists in preventing the entrance of dirt and chips. Tool *J* is of square section and is held in the sliding block *M* by two screws *L*. Hole *K* is for machining purposes only. The operating screw *P* is squared up on one end to receive a wrench, while the other end is shouldered at *R* and threaded to receive a hexagon nut. There are two thrust washers shown at *Q*. The screw has four Acme threads per inch, right-hand, and meshes with the angular rack cut on the under side of the tool-carrying slide *M*. It is evident that the rotary motion of screw *P* will cause movement of the block, in its longitudinal direction, thus feeding the tool into the work at the desired angle. The forged tool *S*, held in the tool-holder *T* on the cut-off slide, is slowly fed across the rim while the recessing operation is taking place.

Double Recessing Bar for a Rear Axle Housing

The work *A* shown in Fig. 5 is a bronze rear axle housing for an automobile, and the recessing bar is only one of a group of tools used at the same setting of the work. Previous to this setting the finished annular rings at the two ends *D* and *E* of the casting were machined so that they might be used

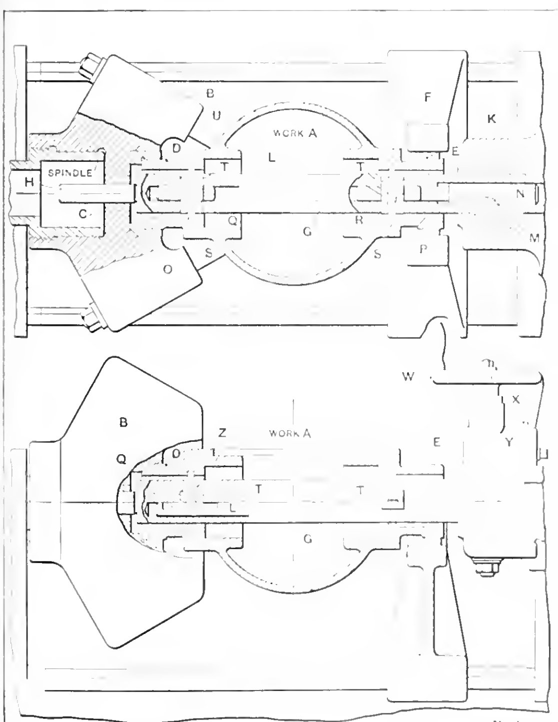


Fig. 5. A Double Recessing Tool Arrangement for a Rear Axle Housing

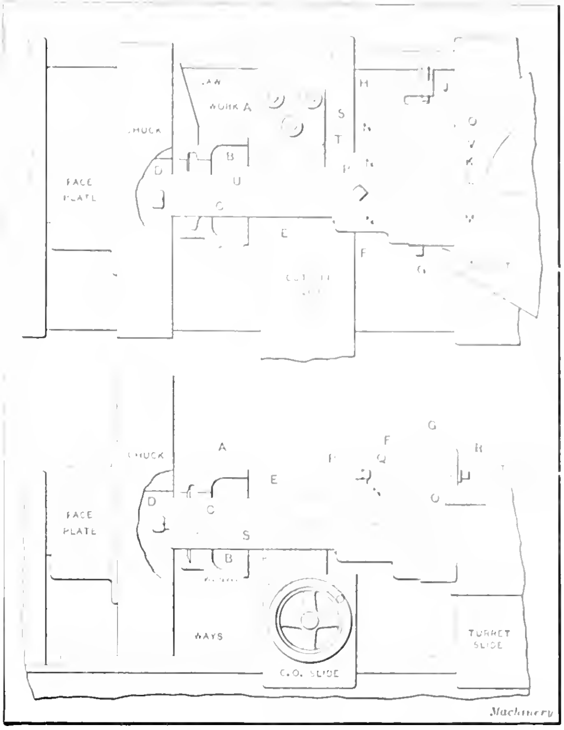


Fig. 6. A Recessing Tool for an Automobile Bearing Retainer

as locating points in this setting. The ring *D* slips into the split bushing in the holding device *B*. The other end *E* revolves in a roller back-rest *F* which is placed on the ways of the turret lathe. This back-rest is not shown in detail, as its construction is not essential in connection with the recessing tool. The two grooves in the work at *S* were to be spaced an exact distance apart and it was partly to insure accurate spacing that this bar was designed, although rapidity of operation was also a factor. A cast-iron bracket *K* is fastened to the dovetailed face of the turret by means of gib *Y*, shown in the lower view. The handwheel *W* is connected to a shaft which drives the pinion *M*. A steel pointer *X* is fastened to the bracket and acts as an indicator on the graduated rim of the wheel. It will be seen that this arrangement makes it very easy to determine the depth of the cut.

The pinion *M* meshes with a rack cut upon the enlarged end *N* of the operating rod *L*. This rod is considerably below the center of the bar and is flatted at *O* and *P*. The tongues *Q* and *R* are angularly cut on these surfaces, and they engage with grooves on the under side of the tool-carrying blocks *T*, so that any longitudinal movement of the rod *L* is transformed into a radial movement of the blocks. The grooving tools *S* are of round section and are held in position by the headless screws *Z*. The backing-up screws *U* permit accurate adjustments to be made with ease. The pilot *H* enters the steel bushing *C* in the body of the holding device and assists in preventing chatter. An added refinement to this tool was an oil-groove from which oil was led directly to the cutting tools. This was supplied with oil through a special piping system and a distributing collar on the turret. In order to avoid confusion in the drawing, this has not been shown. This device gave very satisfactory results.

Recessing Tool for an Automobile Bearing Retainer

The work shown at *A* in Fig. 6 is a malleable iron bearing retainer for an automobile. The casting is held by the outside in a three-jawed chuck; the machine on which the operations are performed is a horizontal turret lathe. The piece is completely finished in one setting. As the cut-off slide front tool carrier was used during the progress of the work, it was found necessary to design the recessing tool so that it extended out over the slide. It is evident that an overhang as great as this would cause trouble unless some means of intermediate

support were provided. The bracket S was therefore used on the rear of the cut-off slide, the portion T being cut out to the radius of the bar so as to act as a support and at the same time provide the feed motion necessary (through the reverse feed of the slide) to force the tool into the work. The cutting tool C is of round section properly shaped at the end to form the required groove B. It is secured in place in the bar E by the set-screw D; radial adjustment is secured through screw U. The rear end of the bar is shouldered and fitted to the sliding bracket F; the set-screw P holds it in place. The slide F is dovetailed and is gibbed to the fixed bracket G by the gib Q which is adjusted for wear by the screws N. The lug H at the end of the slide is provided with a stop-screw J which permits close adjustments to be made for the depth of cut. This lug is not shown in the lower view, but it is set slightly to one side of the cored groove O so that the screw will bear against the solid portion. The bracket G is mounted on the dovetail of the turret and is held in place by the gib R. The special screw M is shouldered to receive the coil spring L which thrusts against it and against lug K on the slide. The strength of the spring may be easily adjusted by the screw to the desired compression. The screw V is simply used to limit the reverse movement of the slide, so that it will not move back too far before or after the work has been done. This device was used for three different pieces by simply changing the tool and regulating the stop-screw. Its performance was thoroughly satisfactory.

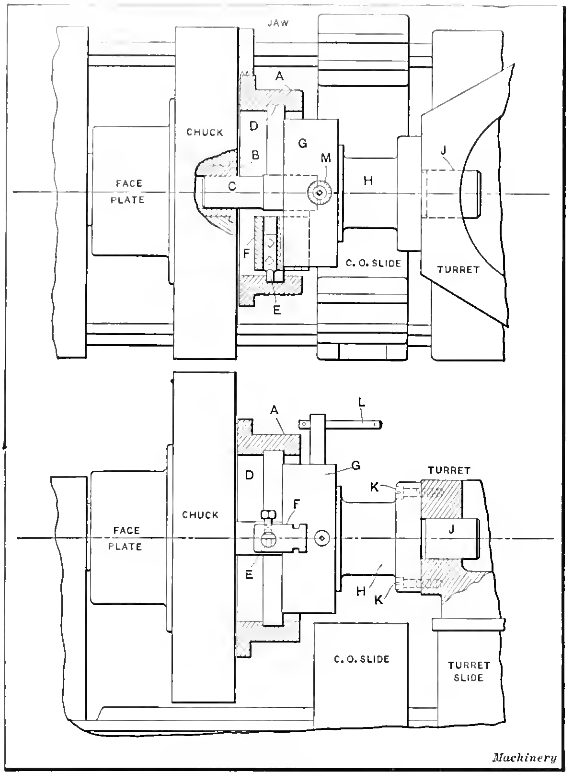


Fig. 7. A Recessing Tool for a Large Collar, used in a Turret Lathe

Recessing Tool for a Large Collar

The large collar A in Fig. 7 was held by the outside of the flange in a three-jawed chuck on a horizontal turret lathe. The internal groove D was to be cut during this setting of the work, and as a small geared scroll chuck was conveniently available, it was arranged as a recessing device for this casting. The cast-iron bracket H was fitted to the faceplate recess at the rear of the chuck body. The stem J was turned down to fit the hole in the turret face, and the four screws K secured it thereto. One of the standard chuck jaws F was annealed and shaped up as shown. It was then drilled to receive the tool E, and tapped out so that two set-screws could be used to hold the tool. The jaw was then rehardened and a small amount of fitting done so that it worked smoothly. A graduated collar was applied at M, and a special wrench L, having a slip handle, served to operate the scroll and thereby caused the tool to move radially as required. A tool-steel pilot C was forced into the center hole in the chuck body G, and a bushing B in the spindle chuck body served as a guide and support for it, thereby greatly increasing the efficiency of the tool and doing away with the chance for chatter.

Recessing Bar for a Triple Groove

In all of the examples which have so far been given, the work has been done in a horizontal plane, but we shall describe a few cases which are handled in a vertical plane on the vertical turret lathe. As this machine has a turret slide which can be traversed horizontally, it is evident that no special attachments are required for plain recessing or grooving, but there are conditions which may be decidedly out of the ordinary, under which a special arrangement for recessing may be used to advantage, for example, any sort of groove which is deep down in a hole, multiple grooving at a considerable depth, or any other condition of a similar nature. When the groove is very deep there is naturally a considerable overhang of any tool which may be used for the work. If the overhang is excessive, it follows that there is apt to be more or less vibration, and vibration means chatter. If, however, a tool or bar having an excessive overhang from the turret is supported at its lower end, the tendency to chatter is at once overcome; but, if support is provided at this point, the horizontal movement of the turret slide cannot be used. Therefore, some method which will give a radial movement to the grooving tool must be used when the bar is to be supported at its lower end.

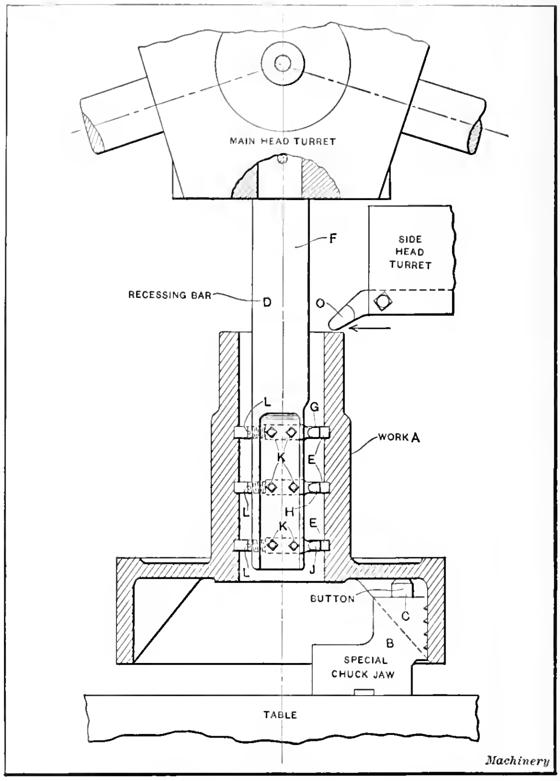


Fig. 8. A Multiple Recessing Tool used in a Vertical Turret Lathe

Fig. 8 shows a piece of work at A which is set up so that it can be machined complete in one setting. The casting is held by the inside of the rim in special chuck jaws B, and is supported at three points on the steel buttons C which rest in pockets in the jaws. The inner ribs of the casting act as drivers against the sides of the jaws. The three grooves E

are to be machined and the tools G, H, and J are correctly spaced to perform the work. These are secured in the bar D by means of the set-screws K, and accurate adjustment is provided by screws L. The bar D is shouldered at the turret face and is driven by a pin in the turret in the usual manner. The tool O in the side head turret is used for facing while the inside work is being done, as this brings the cutting action of the outside and inside tools in opposition and therefore tends to overcome vibration. If a very fine feed is used on the turret traverse, good results may be obtained with this method, although there is a tendency to chatter due to the excessive overhang. Slight variations in the depth of the grooves may also be found on account of the spring of the bar.

Piloted Recessing Bar for a Triple Internal Groove

The cast-iron valve cap shown in Fig. 9 is another example of a piece of work having three grooves equally spaced, and in which the lower groove is at a considerable distance from the turret. This piece is finished complete in one setting and is held by the outside of the flange in the standard chuck jaws C, being supported at three points by the buttons D. This tool is somewhat similar in its operation to that shown in Fig. 5, except that it is arranged in a vertical instead of in a horizontal plane. A heavy cast-iron bracket is bolted against the turret face K by screws L, and a locating plug J centers the device in the turret. The bar H is of steel and has a pilot G at its lower end. This pilot is hardened and ground to fit the bushing E which is inserted in the center of the table. The top of the bushing is milled out to leave three projecting pads F. These pads form a positive stop to insure the correct height; it will be noted that the tendency, when in action, would be to keep these pads clean and free from chips or dirt. The upper end of the bar is shouldered and is fastened to the bracket. As in the former instance the operating rod Z is flatted at certain places and angular tongues P are provided.

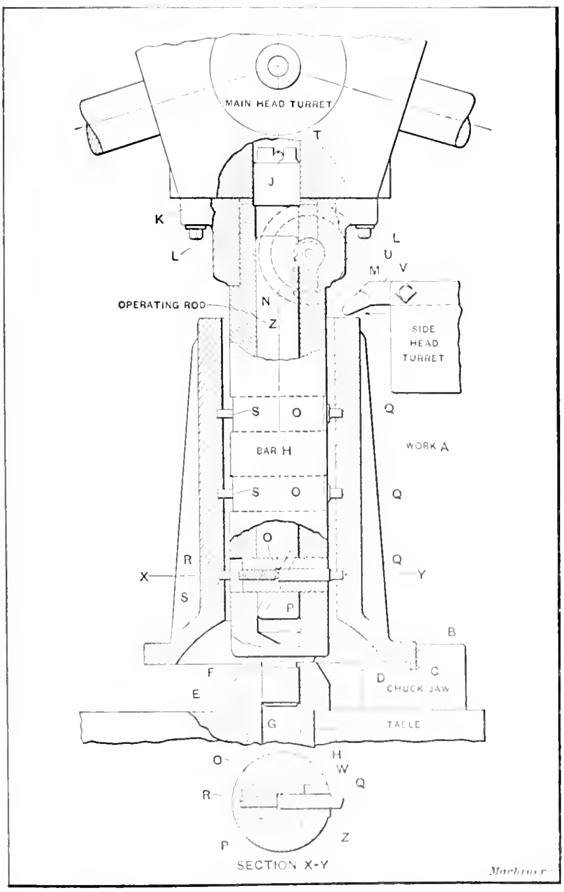


Fig. 9. Another Multiple Recessing Tool used in a Vertical Trrret Lathe

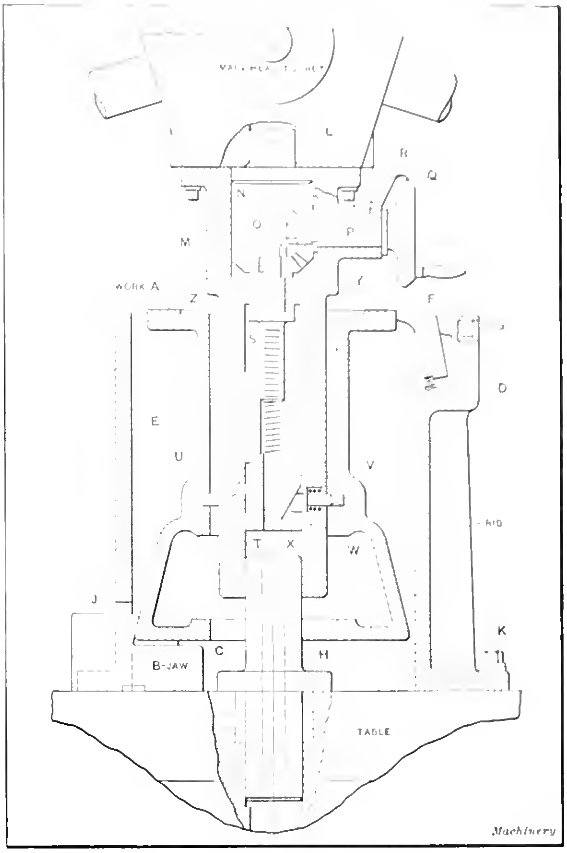


Fig. 10. A Tool for recessing in a Difficult Position, in Use in a Vertical Turret Lathe

These tongues mesh with corresponding grooves in the tool carrying blocks O. The section X-Y gives a good idea of the construction.

The tools Q are held in place by the short set-screws W in the square steel blocks O. The backing-up screws R permit of rapid and easy adjustment. At the upper end of the operating rod the rack N is cut and the pinion M meshes with it and operates the rod. The handwheel through which the pinion is operated is indicated at U by the dotted lines. This portion of the mechanism is identical with that described in Fig. 5. The tool V in the side head turret is used for facing the end of the casting during the progress of the recessing operation.

Recessing Tool Operated by Bevel Gears

A somewhat unusual condition is shown in Fig. 10, this arrangement having been suggested for the work A in order to rapidly perform the grooving operation deep down in the interior of the casting at V. It was desired to machine this casting complete at one setting. The chuck jaws B were of special form, having a slight angle on the inside of the jaw which drew the casting down onto the three points C. A cast-iron pot E was fastened to the table by screws K, and cored openings J were left at the points where the jaws gripped the work. Midway between the jaws, the pot casting took the form shown at D and the dogs F were sunk into the edges of the flange by means of the hollow set-screws G. The bar M is a steel casting which bolts against the turret face at its upper end; it is located by the plug L. The operating sleeve T is of tool steel, hardened and ground, and having an angular slot X at its lower end, which bears against the tool Y. It is well to make up several of these tools, so that replacements can be quickly made in case of breakage. A steel plate W is let into the casting at this point to form a cover plate for the tool and spring pocket. A teat screw I fits a slot in the operating sleeve and prevents it from turning.

The left hand threaded shaft S is journaled at its upper end

Z and the miter gear O is keyed in place. The shaft P carries another gear which meshes with the former, and the entire mechanism is operated by the handwheel Q. (This handwheel, in reality, is located 45 degrees toward the front of the machine from the position shown). A pointer R assists in making accurate readings from the graduated bevel on the handwheel. Steel thrust collars Y are provided for wear. The tool-steel pintle H is fitted to the center of the table and is held down by the screws shown. This pintle acts as a guide upon which the mechanism is located and greatly assists in making it rigid.

Arrangement for External Grooving

A thin piece of work for electrical machinery, shown at A in Fig. 11, has been completely machined with the exception of the groove B. At the time when the operation of grooving takes place, a revolving steel pilot G fits the previously reamed hole C and is held in its position on H by the nut and washer J and K. The upper portion of the bar F is shouldered at E and fits the turret hole, being kept from turning by pin D. A round bar N is flatted on two sides at O and is held in the side-head turret by the three screws R. The lower portion of the bar carries the grooving tool P which is held in place by the two screws Q. A tool-steel pin M is forced into the bar N and forms a sliding tie between the pilot bar F and the side-head bar N. The bushing L is inserted in the pilot bar to receive the pin. It will be readily seen that this method overcomes the vibration which would naturally be caused by the grooving tool acting on the thin and unsupported hub.

Recessing Tool for a Dovetail

The casting shown at A in Fig. 12 is a portion of the clutch mechanism for a farm engine, and it was desired to machine

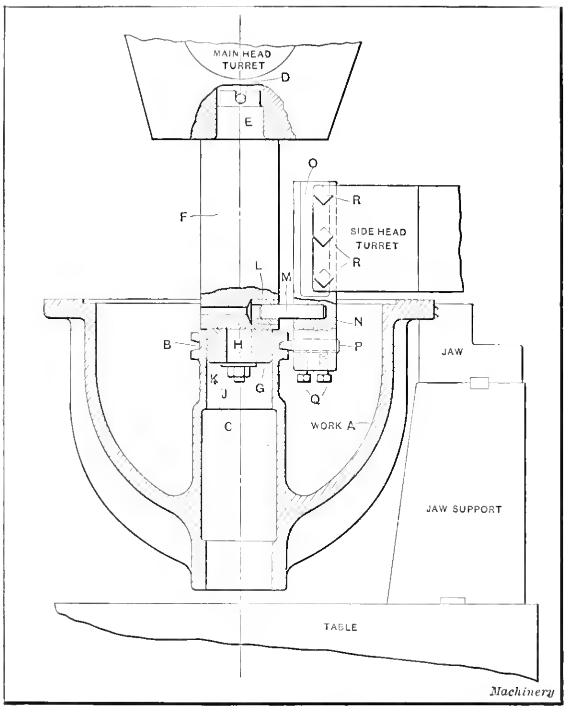


Fig. 11. An Arrangement for cutting a Groove on the Outside of a Sleeve

the piece complete in one setting. The work was, therefore, held by the inside by special jaws B and supported at three points by the steel buttons C. A good driving action was provided by the side of the jaws bearing against the ribs shown. In order to properly make the dovetail cut D, it was necessary to move the tool radially to secure the proper depth and then move it upward and downward in order to machine the corners of the dovetail. The shoulder in the casting made it impossible to see the work which was being done. The steel bushing U was centered in the table and acted as a guide for the pilot-end of bar L. The entire bar is a steel forging and contains a plug V at its lower end against which the coil spring W thrusts. The operating rod N bears against this spring which is sufficiently strong to keep it up to the limit of its upper movement. The lower portion of the rod is slabbed off at X to a 20-degree angle, this angular portion acting as a wedge to force the tool-block S outward. A flat spring T keeps the tool-block back against the angle on the operating rod and assists in releasing the tool after the groove has been cut. The dovetail tool R is held in position in the block by means of the two screws shown. The operating lever O is pivoted at Y and passes through a slot in the operating rod N. A pin Q bears against the elongated slot P and thereby

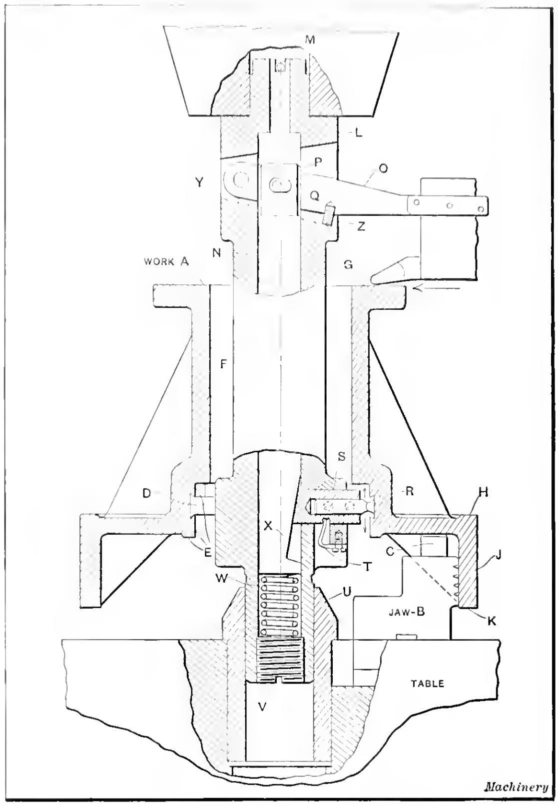


Fig. 12. A Recessing Tool cutting a Dovetail-Shaped Recess

moves the rod in a vertical direction. The adjustable stop-screws Z limit the movement. The lever O is shown in a position 45 degrees toward the rear of the machine from that in which it is really located. It will be noted that the side-head tool may be facing the work at G during the progress of the recessing operation. In machining this piece the surfaces D, E, F, G, H, J, and K were all finished at this setting.

* * *

In an interesting article in the *Manchester Guardian* (England) the author asks what will be the next step in our civilization that will follow the iron age, or as some people prefer to call it, the steel age. Some day it is conceivable that the mineral and coal supplies of the world will give out, and then the world will have to fall back upon the vegetarian substances for all materials of construction, these being the only ones that can be reproduced with such rapidity that there would be a constant supply. When this time arrives, the author says, the great bulk of the world's requirements will be met by the products of the field and the hillside. Fuel will either be grown directly, as timber, or more likely be distilled from suitable plants in the form of alcohol and oils. Structural materials would then, again, be mainly stone and wood, and only tools, ornaments, and products to meet special requirements would be made of metal. When such a time comes, the world will literally go "back to the land" and evolve a new civilization, multiplying the productivity of the land to a degree at present beyond imagination. In the history of the world, the present mineral age is but one brief day.

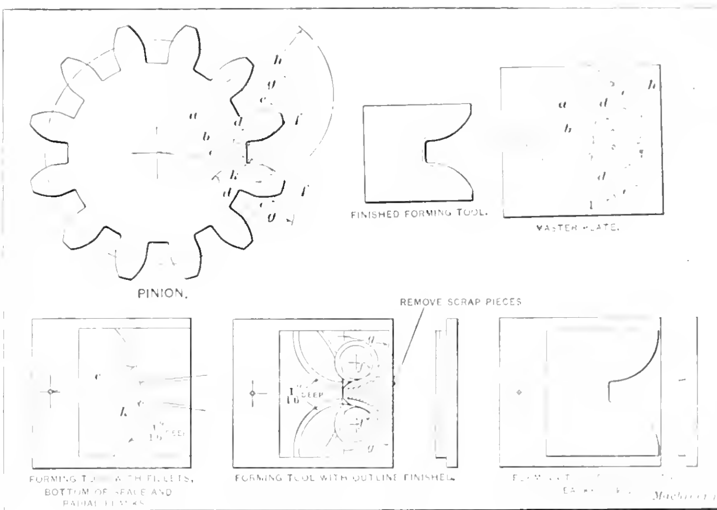
MAKING A FORMING TOOL FOR A GEAR-CUTTER

BY EARLE BUCKINGHAM*

If the shape of the teeth in a rack or gear is known, the shape of the teeth for another gear to mesh with it may be determined by laying out a tooth of the known gear to an enlarged scale and revolving it about the pitch circle of the other gear, thus generating the shape of the required tooth. Arcs may then be found to match this generated shape. Grant's "Treatise On Gear Wheels," pages 29 and 42, gives tables for the shapes of both involute and cycloidal teeth that are close enough for the majority of gears. These tables may also be found in MACHINERY's Handbook on page 583.

There are several ways of making templets and forming tools for the gear-cutter; I wish to describe one method that is simple and accurate, and may be carried out with the tools found in every tool-room. With this method a templet is not necessary, as the forming tool is made directly; but if desired, the templet may be made in a similar manner. After the proper shape of the tooth is determined, the distances between the centers of all of the radii are computed and a master plate is made with holes accurately drilled at all the centers so determined. These holes should all be reamed to the same size—0.250 inch diameter, for example. A plug to fit these holes is turned up in the lathe, and should not be removed before the work is completed. The stock for the forming tool is soldered firmly to this master plate, this stock being left about 1/16 inch thicker than is required for the finished forming tool.

The work is clamped to the face-plate of the lathe so that the hole in the master plate locating the center of one of the fillets at the bottom of the tooth space fits over the plug in the lathe. The holes in the illustration of the master plate are numbered to show the order in which they should be placed over the plug. The hole for the fillet is drilled to the exact size called for. The hole forming the other fillet is then made in a similar manner. After the two fillet holes are finished, the work is set up in a shaper to machine the radial grooves, as shown in the illustration, that form the flanks of the teeth. Using the hole in the master plate representing the center of the gear, and with the two fillet holes to work from, the work is very readily and accurately set up.



Method employed in making Master Plate and Forming Tool

When both grooves are finished, the work is replaced in the lathe with the hole in the master plate locating the center of the gear over the plug. A groove is turned about 1/16 inch deep with its inside edge exactly tangent to the edge of the fillet holes, as shown in the illustration. When the correct diameter is found, the lathe is turned back and forth by hand, stopping at the points of tangency, until the forming tool is cut through. Stops should be attached to the spindle of the lathe to prevent over-travel. The hole locating the center of the radius forming the outer part of the face of the tooth is next placed over the plug. Another circular groove about 1/16 inch deep is turned when the proper diameter is found. The stock for the forming tool should be left large enough so that a full half circle may be turned and measured. After this diameter is found, the lathe is turned by hand, as before, until the forming tool is cut through as shown. The arc forming the other face is then made in the same manner.

The work is next moved again so that the center of the circle forming the tooth at the pitch line is over the plug, and this diameter is found in the same way. After the form is finished, the scrap pieces shown in cross-section are removed from the master plate; the forming tool is next faced off smooth and is then ready to be backed off. To back off the tool, the work is set up in the same manner as for first forming it, while the upper slide of the lathe or the tool slide of the shaper is set at the proper angle. A slight flat or land is left at the cutting edge of the tool. This tool will not allow of much grinding, but after the master plate is made, new forming tools may be quickly made when needed. When the forming cutter is finished, the gear-cutter is made in the usual manner.

A similar method is found to be very accurate when making blanking and piercing punches and dies, the same master plate being used for both punch and die. Drill jigs may also be bored by this method, when extreme accuracy is desired. If, in any case, the centers of the different radii should be so close together that the holes for the plug could not be bored in the same master plate, another plate is doweled to it containing the other holes. I have known of cases where three or four plates were used.

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* * *

STANDARD SIZES OF CATALOGUES

A committee of the American Society of Mechanical Engineers has made extensive investigation of the various sizes of catalogues in common use, and in a report presented to the society the committee recommends that the standard size of catalogues be made 6 by 9 inches, but that an additional size for bulletins and large catalogues may also be considered as standard, this size being 8½ by 11 inches. For folders, two sizes are also recommended, *viz.*, small folders to be 3⅝ by 6 inches, and large folders, 3¾ by 8½ inches.

For paper covered catalogues intended to be permanently filed, the edges, including the cover, should be trimmed to exact size. No fancy deckled edge should be used. Overlapping edges of the cover should be used only when the catalogue is bound in covers stiff enough to support its weight when resting on the cover edges. Whenever possible, the title should be printed on the exposed back of the catalogue and should read from the top downward. Every catalogue should have the date of its publication on its title page and it is recommended that a standard size index card, 3 by 5 inches, be enclosed in every catalogue, with the title of the book and a brief statement of the character of its contents printed on it.

* * *

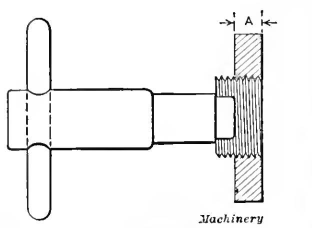
If a good color is to be obtained on brass castings, it is necessary that new metals be used, as a large percentage of scrap in the castings is indicated by a dull color. To produce a good luster on castings which are not machined to any great extent after casting, use at least two-thirds of new metal. An alloy extensively used in the brass trade consists of 88 pounds of copper, 3½ pounds of tin, 6 pounds of zinc, and 2½ pounds of lead.

STANDARDIZATION OF PIPE THREAD GAGES

The following information relating to standards for Briggs pipe thread gages has been abstracted from the report of a Committee on the Standardization of Pipe Threads appointed by the American Society of Mechanical Engineers. The purpose of the Committee on Standardization of Pipe Threads has been to fix manufacturing limits for the use of the Briggs standard pipe thread gages when tapping fittings or flanges, so that pipe cut to the Briggs standard might always enter a definite number of turns. Although the Briggs standard is used almost universally for pipe threads in the United States, the method of its use for female threads has not been established, in that no determinations have ever been made of the standard depths to which hand plug gages should enter. This has resulted in much confusion in the past, inasmuch as pipe threaded to the Briggs standard is liable to vary in the number of threads it would screw into fittings tapped at different shops. This tendency is so marked that pipe fitting is handled in practically all cases by sending the flanges to the shop where the pipe is cut, to be sure of satisfactory results.

This matter is conceded to be a simple one in that all it requires is an agreement among the manufacturers of fittings

STANDARD THICKNESS OF PIPE RING GAGES



Pipe Size	Thickness A, Inches	Pipe Size	Thickness A, Inches
1/8	0.1801	1	0.400
1/4	0.200	1 1/4	0.420
3/8	0.240	1 1/2	0.420
1/2	0 320	2	0.436
3/4	0.339	2 1/2	0.682

Pipe Size	Thickness A, Inches
3	0.766
3 1/2	0.821
4	0.844
4 1/2	0.875
5	0.937
6	0.958
7	1.000
8	1.063
9	1.130
10	1.210
12	1.360
14	1.562
15	1.687
16	1.812
18	2.000
20	2.125
22	2.250
24	2.375
..	.....

as to the point at which a ring should be attached to the gage, to establish, when the gage is inserted by hand, the proper depth of the thread. To this end the committee has met in conference with representatives of the manufacturers and also of the committee of the Society on International Standards for Pipe Threads. Mr. C. A. Olson, chairman of the Manufacturers' Sub-committee on Pipe Thread Gages, stated at this meeting that his committee had made a study of present practice among the various manufacturers and had adopted tentative definitions of the gages to be used, of the proposed thickness of ring gages acceptable to the manufacturers, and of the tolerances to be allowed. These he submitted as follows:

The gages shall consist of one plug and one ring gage of each size.

The plug gage shall be the Briggs standard pipe thread as adopted by the manufacturers of pipe fittings and valves, and recommended by the American Society of Mechanical Engineers in 1886. The plug is to have a flat or notch indicating the distance that it shall enter the ring by hand.

The ring gage is to be known as the American Briggs standard adopted by the Manufacturers' Standardization Committee in 1913, and recommended by the American Society of Mechanical Engineers, the committee on International Standard for Pipe Threads, and the Pratt & Whitney Co., manufacturer of gages. The thickness of the ring is given in the accompanying table. It shall be flush with the small end of the plug. This will locate the end of the flat on the plug flush with the large side of the ring.

When using the plug gage, as shown in the illustration accompanying the table, the flat indicates the exact size, and the allowable limits should be one thread large or small. When using the ring gage, the male threads are to gage when the plug gage is flush with the small end of the ring. The allowable limits are one thread large or small. A set of these gages to be known as the "American Briggs Standard for Pipe Threads" is to be deposited with the Bureau of Standards at Washington, D. C.

* * *

HEAT AND LIGHT OF THE SUN NOT REAL

Edwin F. Naulty, in an article published in the *New York Herald* March 15, states that the sun is not hot, despite all that has been taught to the contrary for thousands of years and the apparent evidence of our senses. He sets up the theory that the sun does not radiate light and heat and that the actual body of the sun is probably cool. The tremendous energy poured forth by the sun is not light and heat initially. Solar energy is invisible and is without temperature. Not until the rays of solar energy enter the atmosphere of the earth do they become light and heat. He likens the atmosphere of the earth to a huge spherical transformer which, by resistance, changes cold and invisible solar energy into light and heat, precisely as the filament in an electric lamp transforms the cold and invisible electric fluid that feeds it into light and heat. Only the solar rays entering the atmosphere of the earth or that of any other planet are so transformed. All other rays pass outward from it into space as cold and invisible as when they leave the sun. Outside the atmosphere of any planet is utter darkness as complete and absolute as if there were no sun.

Mr. Naulty affirms that the fact that the gases composing the outer shell of the sun are in a state of violent motion does not necessarily mean that they are on fire. An observer on the moon looking at the earth while a tornado was raging would see the atmosphere of the earth apparently on fire. Violent motion does not mean flames. In the upper levels of the earth's atmosphere the winds sometimes blow at the high rate of five hundred miles an hour and yet they remain cold.

If the sun were made of the best steam coal and were burning up it would be wholly consumed in five thousand years. If the sun were constantly pouring out heat, the solar system, in all these myriads of millenniums it has been in existence, would, by the cumulative effect, have become so superheated that the earth, the moon, Venus and Mercury would long ago have been expanded to gases. A burning sun is poor mechanics and a burning sun is a wasteful way of running the solar system. Because it is a wasteful way and because it is not mechanically perfect we may be sure that it is not the way heat and light are produced.

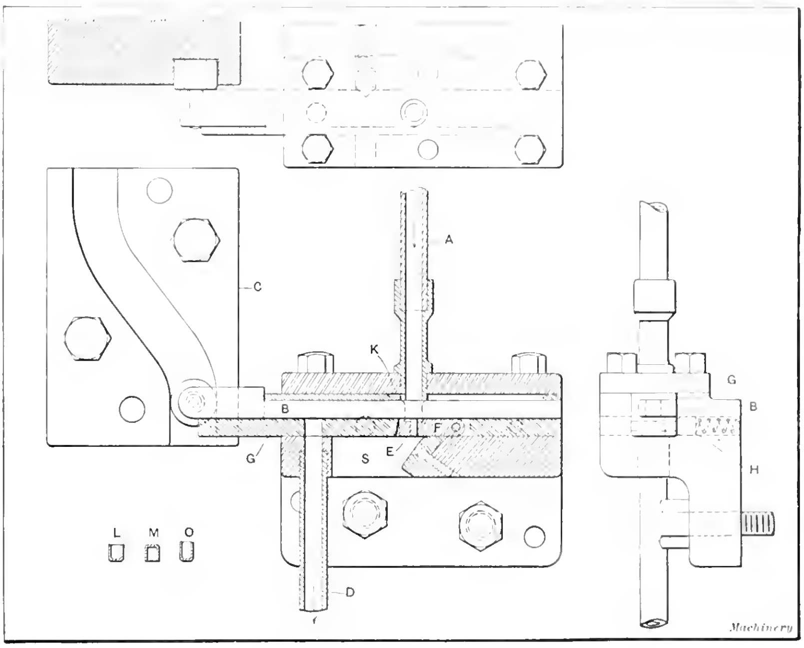
Mr. Naulty advances the theory that the energy of the sun which we perceive as light and heat is due to an electrical flux in the equatorial plane. The greatest strength of this electrical flux is exerted within a zone of about twenty degrees in width. The sun is considered to be a great combined generator and dynamo, deriving its initial energy from the entire solar system and, in turn, changing this into a radiant energy that spins the planets in their orbits and furnishes the invisible force which the atmospheres of the planets, in their turn, transform into light and heat. He claims that the theory of contraction of the sun as a means of generating light and heat is absurd and that of meteorites producing it by falling into the sun is equally absurd. In fact he denies the possibility of meteorites falling into the sun because it is the center of the solar system. As proof that the atmosphere of the earth is the transformer which changes the radiating energy to light and heat, he calls attention to the fact that at the equator the perpendicular rays of the sun at noon may be so energetic that the thermometer will stand at 120 degrees F. while at a distance of a mile above the temperature will be only 70 degrees and at a height of three miles on the mountains in Equador, we find the mercury below the freezing point, and still at each of the three points the thermometer is under the perpendicular rays of the sun.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

AUTOMATIC FEED MECHANISM FOR SMALL BRASS CUPS

The accompanying illustration shows an attachment for a press for heading the small brass cups shown in the lower left-hand corner. These are called "battery cups" and are used in shot-gun shell cartridges. The attachment was designed with the object of preventing broken tools and rejecting all cups that had not previously been trimmed to length. The cups feed down through the supply pipe *A* from the usual feed hopper, in the position shown at *L*. Slide *B* is reciprocated by the plate cam *C* carried on the cross-head. The cup is picked up by the cavity in slide *B* and is carried over and dropped into the supply pipe *D*, from which it passes to the feed dial. It sometimes happens that the cup will find its way into the feed pipe *A* in an inverted position, as indicated at *M*. When it enters slide *B* in this position it falls into the cavity around pin *E* and slide *G* is carried over along with slide *B*. The function of pin *E* is not primarily to catch the cups that fall with the mouth downward, but to hold up the cups that fall with the head downward, so that the bottom of the cups is level with the bottom of the slide *B* under normal conditions. When, however, the cup falls with the mouth downward over pin *E*, which is riveted in hinge *F*, the latter drops down over a hardened block, as slide *G* is carried forward, and the inverted cup drops out through cavity *S*. Slide *B* then returns slide *G* to its former position during the return stroke. Normally, the slide is held in position by plunger *H*.



Automatic Feed Mechanism for Small Brass Cups

A cup that is too long or that has not been previously trimmed, as at *O*, is caught by the edge *K* of slide *G*; the slide is then carried forward and the cup dropped out through cavity *S*, as before.

LAWRENCE FAY

SHOP EMPLOYES' SAVINGS AND LOAN DEPARTMENT

The particular advantages and benefits of encouraging a savings and loan department among shop employes are effectively shown by the results obtained at the plant of the Celluloid Co., of Newark, N. J. The Savings & Loan Department of the Celluloid Club, composed of about four hundred male and female operatives of the company, has recently issued a statement of its work for the past six months, showing total deposits of $11,500, or an average individual saving of approximately $29. This sum represents the savings of the rank and file of the shop workers, exclusively. The department is operated by employes for employes, without any assistance from officials of the company, or deposits from salaried or higher paid associates; and it is entirely separate from any other branch of welfare work carried on by the company.

This department of the club has now been in operation slightly over seven years, during which period its deposits have aggregated about $130,000. The organization of such a branch was the idea of President Lefferts of the company, offering a practical plan for the encouragement of the saving habit among its members; and it has proved a popular success from the start. The savings end of the department is operated in periods of six months duration. These are known as "series," and the regular withdrawal dates are in December, just before the mid-winter holidays, and about the middle of June, prior to the summer vacation season. The loan branch of the department renders temporary financial assistance to the depositors, and in this particular has shown that the lending of money to employes who are known to be steady and conscientious workers is a logical and safe departure. Beyond this, it eliminates the necessity for such employes to seek outside aid when in need of funds, and the attendant disheartening features of customary loan brokerage methods.

Members are privileged to borrow sums ranging from $1 to $200, at a charge varying from two per cent a month to six per cent per annum. The particular amount which the borrower has on deposit does not affect the extent of the loan allowed; an employe may deposit twenty-five cents at any time, and immediately obtain the maximum of $200. In the case of minors, however, the department requires the approval in writing of the parent or guardian for all loans desired in excess of $10.

Under regular conditions, no indorsement is needed for loans under $25, but above this sum an additional responsibility is requested in the form of a second guarantor, this usually being the written indorsement of a trusted employe. Notes given for loans are limited to a period of three months, and are renewable upon maturity. Borrowers must make weekly deposits to the fund, the object being to assist them out of their financial difficulty, as the borrowing of money is not encouraged for financial benefit of the department.

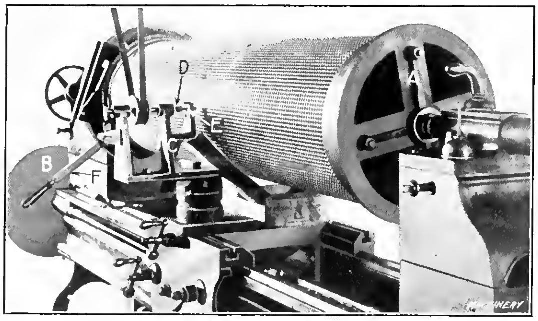
Should a borrower fail to keep an agreement to enter regular deposits, or fail to pay a note when due, the further advantage of accommodation for future loans is lost, as the department will not permit loans to such a member. Following the payment of a loan, the transaction becomes known by number, and the borrower's name is taken from the regular record of business. By loaning money on character in this

manner, the department encourages honesty and thrift among employes, and indirectly impresses them with the value of good habits and integrity in business. A. R.

DRILLING A BRONZE DRUM

A problem of drilling was placed before us a few days ago that had to be handled with the equipment ordinarily found in machine manufacturing plants. As it was out of the ordinary line of work, a few special fixtures were necessary. The piece in question was a bronze drum with an outside diameter of 23⅜ inches, bored inside so as to leave a wall practically ½ inch thick. It was necessary to drill this piece so that the spacing of the holes was exactly ½ inch from center to center, the size of the drilled holes being 3/16 inch. After the drilling operation was completed, the top or outside diameter of the drum had to have these holes countersunk with a countersink of 45 degrees angle and to a sufficient depth so that it would allow a little flat surface of the actual diameter between the countersunk portion and the surface of the drum practically 1/32 inch wide.

The drilling had to be done accurately, and in order to handle this work the following means were resorted to. Having a lathe large enough to swing the diameter of the drum and also take it in between centers, it was decided to do the work on this lathe. Two cast-iron plates *A* were made and shoulders turned on them so as to set in each end of the bronze shell, serving as heads. Hardened plug centers were inserted in the center of these heads, and four ⅝-inch bolts were placed in the four arms so as to bolt the two heads together and make them fast with the shell. The head nearest to the faceplate of the lathe was used as an index and 128 V-notches were cut in it. An index finger was provided on the faceplate of the machine. The spindle was locked and the front bearing of the lathe bound to hold it from any lost motion. As the feed-screw on the machine was 4-pitch, it was used for indexing the holes longitudinally, and by two turns of the feed-screw the spacing of ½ inch was obtained.



Simple Method of drilling a Bronze Drum

As a means of locking the feed-screw and bringing it to an exact point at every indexing, a hole was drilled in the large pulley *B* and a pin placed in this hole was received in the end of the bed of the lathe. A small cast-iron drilling head *C* was made up as shown in the illustration. This was bolted to the rest of the lathe and fitted with babbitt bearings. The drill chuck is shown at *D* and at the point indicated by *E*, a hardened bushing was inserted for guiding the drill. A lever *F* was provided to apply pressure on the spindle for feeding the drill. Between the end of the spindle and the lever a hardened steel plug was placed, the point of this plug that comes in contact with the lever being made ball shaped. Between the pulley and front bearing of the drilling head there was a small spiral spring which returned the drill automatically ready for drilling another hole.

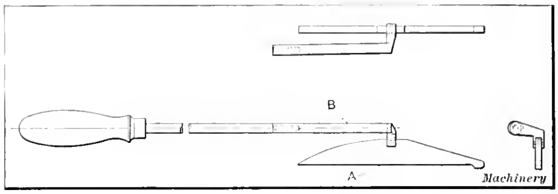
The drilling of this drum required two operators, one for indexing and the other for feeding the drill. The number of holes drilled in the shell was 16,512. It is usually thought that work of this class requires a special machine and the illustration of a method of handling this type of work in a simple way will, no doubt, be of interest to readers of MACHINERY. The drilling and indexing of the 3/16-inch holes was at the rate of about six holes per minute. It will be seen from this that it required but a few seconds per hole to index the work. This work was performed at the plant of the J. N. Lapointe Co., New London, Conn.

New London, Conn. FRANK J. LAPOINTE

MAGNET FOR DETERMINING HARDENING TEMPERATURE OF STEEL

A piece of tool steel loses its power to attract a magnet when its temperature has been raised up to or beyond the point of decalescence at which it should be quenched for hardening. This fact has been taken advantage of in determining hardening temperatures, for which purpose various forms of magnets have been designed to test the temperature of the steel while in the furnace. The accompanying illustration shows a convenient form of magnet, and by following the instructions outlined for using it, very satisfactory results can be obtained.

This tool consists of a piece of magnetized steel *A* which is pivoted to the arm *B* so that it is free to swing. The arm



Useful Form of Magnet for determining Hardening Temperature of Steel

B is made of brass or some other non-magnetic metal, and the magnet is pivoted so that in the event of differences in temperature between parts of the work, either end of the magnet can swing down to indicate such an inequality in the intensity of the heat at different sections of the furnace. It will be seen that a hook is formed at the end of the magnet opposite the handle, for the purpose of drawing light pieces of work out of the furnace when the desired temperature has been reached.

In testing the temperature of steel in this way, the magnet is brought into contact with the work at frequent intervals as it is heated in the furnace, and the steel will continue to attract the magnet until the desired hardening temperature has been reached. When the magnet ceases to be attracted by any part of the steel, it shows that the proper hardening temperature has been attained; and the work should then be withdrawn from the furnace and quenched. Frequent tests should be conducted during the heating of the steel, and care should be taken not to allow the magnet to become too hot. This makes it necessary to withdraw the magnet from the furnace immediately after making each test.

Hartford, Conn. HENRY E. GERRISH

TO OXIDIZE BRASS BLACK

A method of oxidizing brass which I have used and found satisfactory is as follows: Prepare a solution of copper nitrate by dissolving pure copper in commercially pure nitric acid until all action ceases. This should be done in a large jar out of doors, as the chemical action throws off a dense brown vapor which will rust steel or iron, and the volume of the acid increases as it heats. After all action ceases and the mixture becomes cold, the clear liquid is decanted into another jar. Sand-blast the work or clean it thoroughly by some other method, so that it is free from grease of any kind. Work washed in a solution of hot lye and soda, dried in sawdust, and then kept from contact with the fingers or grease until the blackening solution is applied will give the best finish.

Heat the work to a temperature of about 212 degrees F., or the boiling point of water, immerse it in the copper nitrate solution, then remove and heat again until it is just hot enough to dry off the solution and to burn off the green color which appears. This process may be repeated, if it is thought necessary. The work is then cooled and all free

oxide removed by brushing, after which it is dipped in ammonia and rubbed dry with a soft cloth or in sawdust. This will leave the work with a brownish color. To get the dead black color, heat the piece to a temperature that is not high enough to burn the hands but very warm, and rub it with a piece of soft leather having a few drops of pure olive oil on it, after which it should be heated enough to dry the oil.

Highly polished work, if well cleaned and dipped in commercial ammonia before applying the copper nitrate, will take a permanent black. Work that is sand-blasted takes a black that cannot be removed by ordinary wear. Plates used to label steam valves are usually located in semi-dark localities. Good plates may be made for this purpose by stamping the letters into a piece of brass, sand-blasting and oxidizing them and then filling the letters with a mixture of chalk and ammonia. Different colors of chalk may be used and the letters show very plainly in a place where the light is dim. The chalk put in in this way will stand considerable handling before it is dislodged. This is the most permanent black finish that I have ever found and may be applied very economically in quantities.

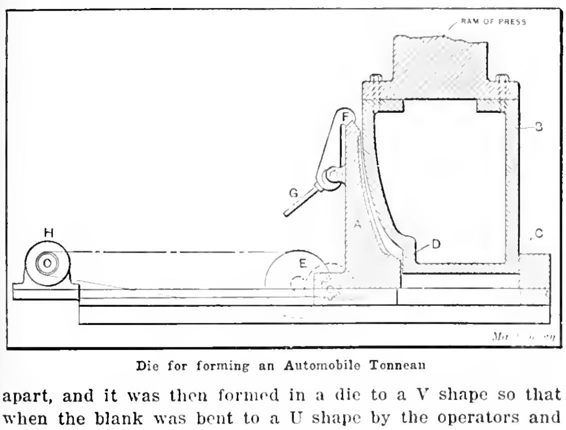
Southbridge, Mass. WARREN E. THOMPSON

DRAWING AN AUTOMOBILE TONNEAU

Some time ago we had an order for steel automobile bodies, and among other shapes we had the tonneau or back of the rear seat to form. The total height of this piece was 23½ inches, while the stroke of the only power press available for the work was 11½ inches. The method of doing the work that was finally adopted was as follows:

The punch *B* was cast and machined to size. The die *A* was fitted to *B* all around at *C* and *D*; the two were then put together and the recess in the die was poured full of type metal. Along the back, on the two sides and the front edges, clamps *F* were fitted; these were operated by eccentric cams. The whole die was fitted to a slide and suitable gearing was provided at *E* to move the die in or out. This gearing was driven by a motor *H* wired to run in either direction.

In operation, the blank was first cut to shape; then the top edge was slit in about 2½ inches at spaces a few inches



Die for forming an Automobile Tonneau

apart, and it was then formed in a die to a V shape so that when the blank was bent to a U shape by the operators and dropped into the die, the top edge fitted on the top of the die, ready for the clamps *F* to engage. The piece was put in place and the side and back clamps locked with the die out at the end of its track. Then the die was run in to a position under the punch and the front edges clamped.

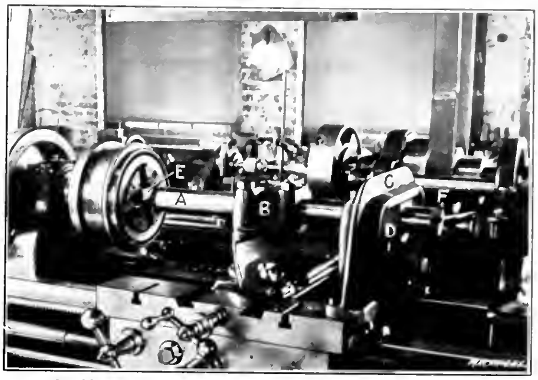
When the punch came down it engaged the backing at *C* and the metal at *D*. As the blank was firmly held at the top, the only place it could draw was from the bottom, and most of the shape was stretched from the metal itself. The die worked fairly satisfactorily and several thousand pieces were formed with it. The blank used was considerably wider than the finished piece, allowing it to project down into the straight part of the die and provide metal to draw from.

This is not offered as the best possible way of doing a job of this kind, but it was the only way possible with the equipment at hand. It is probable that most of the tonneaus in use today could not be made by this method, because the difference in size at the top and bottom would be so great that the metal could not be stretched sufficiently to form them without breaking.

Philadelphia, Pa. W. A. VALLENTINE

RIGID BORING AND THREADING TOOL

An unusually stiff bar for boring and threading high-speed steel dies was needed, and to meet the requirements of this work, the bar shown in the accompanying illustration was designed. It is shown in use on a 16-inch Le Blond engine lathe and it was unnecessary to change the construction of the lathe in any way except to drill and tap three 3/8-inch holes for the cap-screws which hold the yoke *C* to the carriage.



Combination Boring and Threading Bar with Rigid Support

The design of this equipment differs from that of most rigs in that the strain resulting from the overhang of the bar *A* is carried by the yoke *C*. This yoke is provided with a finished pad on its under side, on which the shoe *D* slides to provide for transverse adjustment. Longitudinal adjustment is also provided to allow different lengths of the bar to project. The holder *B* has a tongue on its under side which enters the toolpost slot, and the holder is set at an angle of 29½ degrees, which has been found most desirable. A Novo steel thread chaser *E* is shown working at the end of the bar, and at the opposite end of the bar there is a Novo steel bit *F*. The same bar is available for both boring and threading operations, it being merely necessary to change it end for end. This bar was made of two-inch extra-heavy pipe plugged at each end. The depth of cut and the coarseness of the feed which can be handled are dependent upon the rigidity and pulling power of the lathe.

Pottstown, Pa. CLAYTON DANE

LAYING OUT GEAR-CUTTER FORMS

In the January number of MACHINERY, How and Why section, A. J. T. asks for information relating to gear-cutters. The writer does not pretend to know the method used by gear-cutter makers—they seem to try to keep this matter very secret—but offers the following which has been used in actual practice several times and given satisfactory results.

Some time ago, the writer was employed in a factory where a machine was built in which the teeth in a gear transmission were required to be as nearly correct as possible. The shape of the teeth had to be correct for the exact number of teeth in the gear and pinion, in as far as theoretical accuracy was commercially possible. This requirement eliminated the circular cutter method of milling with standard cutters, as these are correct only for a certain number of teeth, and only approximately correct for the great majority of numbers of teeth in the range covered by one cutter. The gears could have been cut on a Fellows gear shaper and the desired results obtained, but there were other conditions which prevented this, so it was necessary to use a circular cutter. A special cutter, however, had to be made. The writer was given the job and

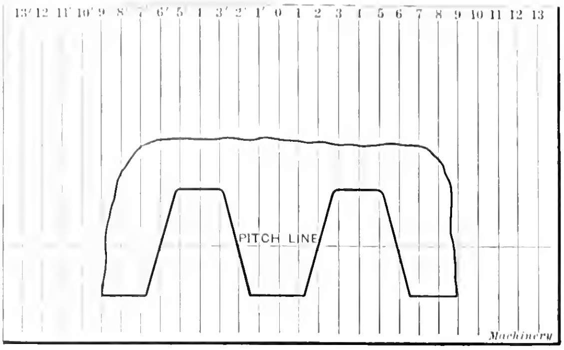


Fig. 1. Short Section of Rack laid out on Enlarged Scale

looked for information on the subject everywhere, but without success.

Starting, however, from the fact that if two gears work perfectly with a rack they will also mesh perfectly with each other, the following method was devised: On a piece of paper lay out a short section of a rack as carefully as possible to correct proportions, and on an enlarged scale, say ten times full size. Make arbitrary divisions and draw lines parallel to the center line, numbering them as shown in Fig. 1. Now on a piece of tracing paper or cloth, draw a center line and scribe the pitch circle, top circle and clearance circle of the gear required, to the same enlarged scale as the rack tooth. Lay off divisions on the pitch circle, draw lines toward the center, and number them as shown in Fig. 3. The divisions on the pitch circle, Fig. 3, are, of course, equal in length to the divisions in Fig. 1. The zero line on the rack is in the center of a tooth and the zero line on the gear will be the center line of a space. The tracing should be tacked firmly to the drawing board. Now slip the rack drawing under the tracing so that the pitch and zero lines coincide, and trace the rack tooth on the tracing cloth. Move the rack drawing so that lines No. 1 coincide and then trace the tooth as before. Do this with every position on both sides of the zero line, and the result is a drawing showing the positions which the rack tooth would occupy if a rack and gear were rolled together. Through the points and lines thus determined draw curves, and we have the exact shape of a formed cutter which will cut an accurate gear. The shape, of course, is on an enlarged scale. Determine the outline by filling in on the tracing with solid black ink. Then draw around the shape thus determined a rectangle *ABCD* of such dimensions that the sides are conveniently divisible by 10, if ten times the natural size has been chosen as the scale.

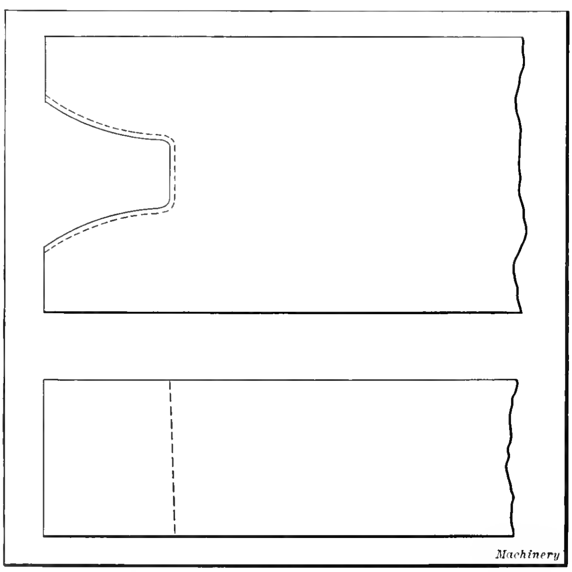


Fig. 2. Formed Tool made from Layout in Fig. 3

The next step is to reduce the tooth outline by photographic means to the natural size. On the ground glass of the camera draw a rectangle one-tenth of the rectangle *ABCD* in Fig. 3. Pin the drawing squarely in front of the camera and focus so that the rectangles match up correctly. Expose the plate, and develop and print by the usual methods. We have now prints showing the exact shape and size of the cutter tooth as nearly correct as it is possible to get them. The next step is for the toolmaker to make a flat cutter from these, as shown in Fig. 2. This is the most difficult part of the work, but it is not as difficult as one might think, when carefully carried out.

The circular cutter is now made, and, after having been rough-turned as nearly to shape as possible, the formed tool, Fig. 2, is used to finish off with a light cut. After the cutter has been gashed to form the teeth, the formed tool is used to

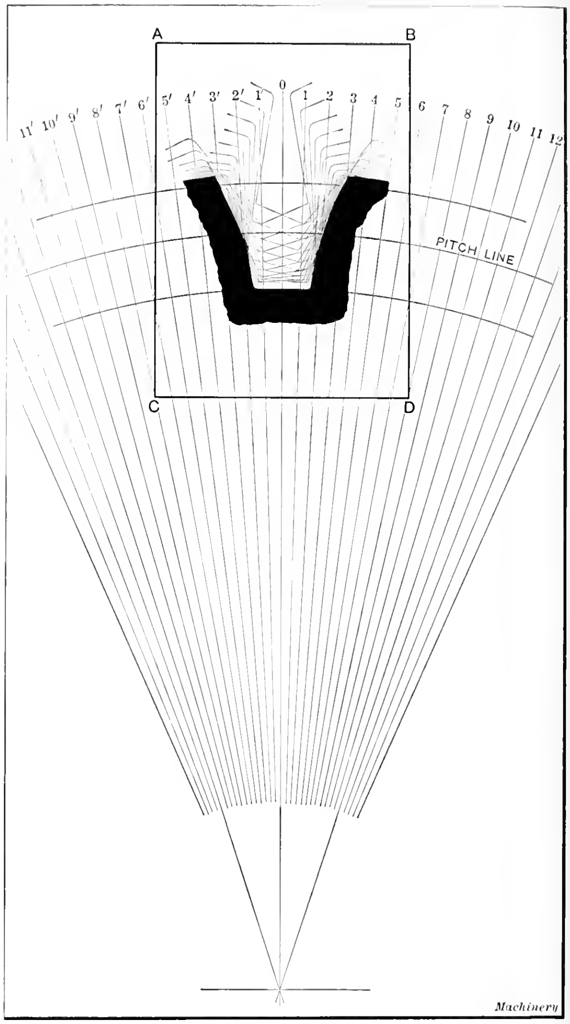


Fig. 3. Tracing of Rack Tooth in Various Positions, giving Form of Gear-cutter

back off or relieve the teeth, preferably in a backing-off machine or in a lathe with a backing-off attachment. If neither of these means is available, the next best way is to pull the belt of the lathe by hand, with the back-gears in, and feed by the cross-slide for each tooth. All that now remains is to harden the cutter carefully and grind the faces of the teeth.

Pawtucket, R. I. RICHARD W. DICKINSON

MEAN CIRCUMFERENCE OF A RING

The usual formula for obtaining the mean circumference of a ring of the form shown at the right-hand side of the accompanying illustration is:

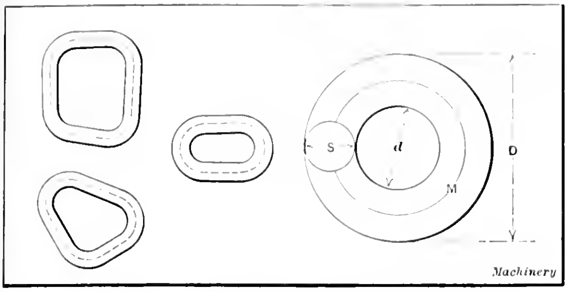


Diagram used in deriving Formula and Examples of Odd shaped Rings

$$\text{Mean circumference} = \pi \times \frac{D + d}{2}$$

where D and d are the inside and outside diameters.

The length L of the wire in a spiral is given by the following:

$$L = N\pi \times \frac{D + d}{2}$$

where N is the number of coils in the spiral.

In working on a certain device where there were a number of rings of different shapes, and in such positions that it was only possible to measure the periphery and the diameter S of the wire, the following formulas were found more convenient to use:

Mean circumference $= \pi\ (D - S) = \pi\ (d + S)$.

Similarly, for spirals, the length L of the wire is given by the following formula:

$$L = N\pi\ (D - S) = N\pi\ (d + S).$$

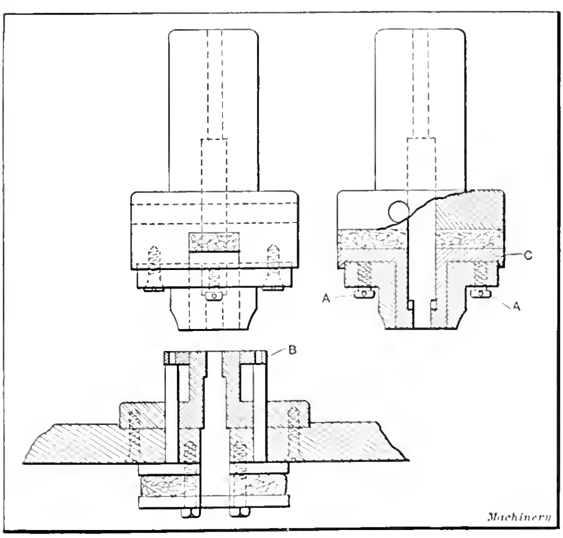
The three small rings shown at the left-hand side of the illustration are examples on which these formulas can be used to advantage.

Syracuse, N. Y. E. J. Engman

DIE FOR MICA WASHERS

The die shown in the accompanying illustration was designed for cutting small mica washers. The familiar form of punch and die made with a leader to push the blank down through the die does not work well on mica, as the material has a tendency to flake off and stick to the bottom of the punch. Mica is also found to wear a die of this form very rapidly. In handling mica in a punch and die, the material should be put in a bath of turpentine and kept in the liquor until it is to be worked up under the press.

The die illustrated in this connection gives good results in making mica washers and affords the operator plenty of room



Compound Die for cutting Mica Washers

to handle the strips of mica. He is able to see through the material to locate it in position over the die so that unnecessary waste will be avoided. The screws A are used in setting the die. By turning them up, the ejector C is forced into the rubber pad. The stripper B is next raised and lifted out It is made free enough to be drawn up by hand. Then the punch and die may be put together ready for setting up on the press; after setting, the stripper B is put back into place Guide pins could be used but they would be in the way in operating the die on scrap stock.

Stamford, Ontario, Can. R. Wilcox

JIG AND FIXTURE DESIGN

In the December number of Machinery, I noticed an interesting article by "Server" describing a variety of clamping devices applicable for use in jig and fixture design. I would like to suggest a few methods that practice has proved to be superior to some shown in the article referred to.

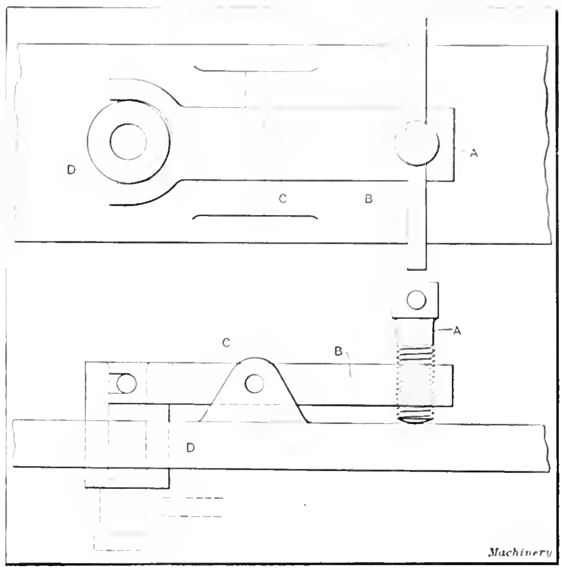


Fig. 1. Good Substitute for Bellmouthed Bushing

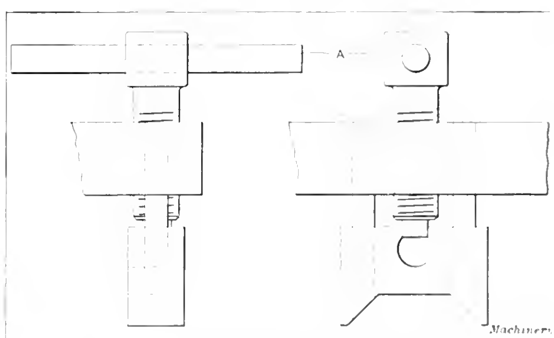


Fig. 2. Superior Method of turning Screw Clamps which avoids Sore Hands

Fig. 5 of "Server's" article showed a bell-mouthed screw bushing which locates and clamps the work for drilling and reaming. This style of bushing requires an extra long drill, and if made with two sizes of holes, as shown, particular care will have to be taken in using small drills to prevent breaking a number of them. Another objectionable feature of this clamping device is that chips work into the threads and prevent turning the bushing easily; this also shortens the life of the thread

Fig. 1 of the present article shows a clamping device which, although a little more expensive, the writer believes to be far superior to "Server's" method. This device would prob-

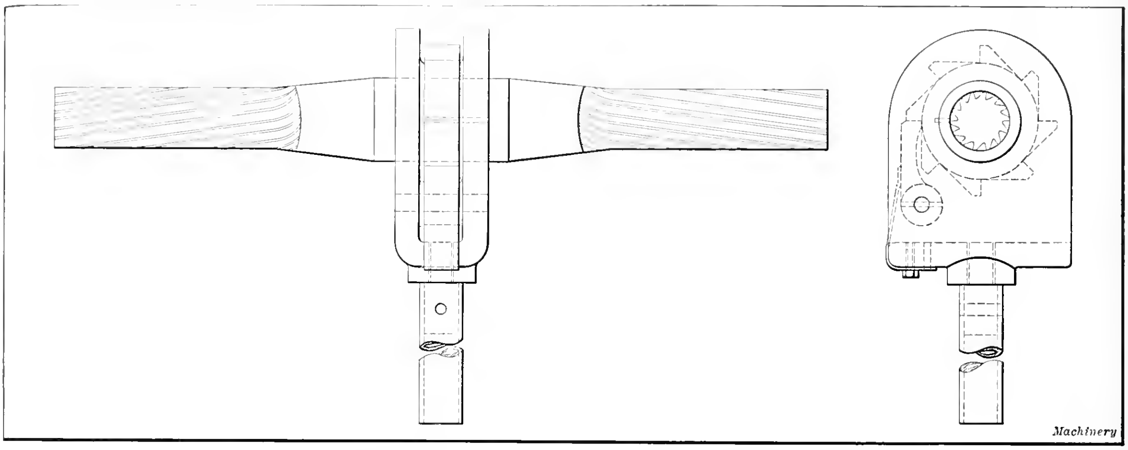
ably pay for itself in saving the breaking of drills, as the bushing on this jig can be made shorter and with one sized hole. Little explanation is necessary to make the operation of this device clear to any mechanic. The screw *A* swings the lever *B* about pin *C* and pushes down the bushing *D* which is a slip fit in the body of the jig.

Figs. 9, 10, 11 and 15 in the article previously referred to showed jigs in which a cast-iron knob was employed for turning the clamping screws. I have seen operators with sores on their hands which were caused by manipulating these cast-iron screw knobs. If it is necessary to use a hand-screw for clamping work in a jig, the design shown in Fig. 2 of the present article will be found far superior. A screw of this kind is cheaper to make and does not injure the workman's hands, as the pin *A*, which is pressed into the head of the screw, may be 3 or 4 inches in length, thus affording ample leverage for tightening the screw. The only reason that I can see for using a cast-iron screw knob is that it looks well in the drawing.

Detroit, Mich. CHARLES STAPLES

REAMING FIXTURE FOR CAM-SHAFT BEARINGS

A great deal of time and labor is required to properly scrape a bearing by hand, and any tool or fixture that will do better work or assist the operator to do the work in a short space of time is a money saver. The reaming fixture shown in the accompanying illustration was designed to overcome the difficulty we had experienced in scraping the bearings for oil engine cam-shafts by hand. These bearings were always babbitted in place in the crank-case by means of a special babbitting mandrel which was designed to bring the cam-shaft bearings in proper alignment with each other, and in the proper relation to the crankshaft bearings. The hand scraping was slow and unsatisfactory and ordinary reaming was of little assistance because of the impossibility of obtaining the required degree of accuracy.



Duplex Reaming Fixture with Ratchet Drive for finishing Cam-shaft Bearings

The spiral reaming fixture which forms the subject of this article is equipped with a ratchet handle for turning it. It will be seen that one right-hand and one left-hand spiral reamer are used, the two reamers being a single unit to prevent any tendency for them to draw away from or push against each other. By placing the reamers in the cam-shaft bearings and tightening the nuts down on the bearing caps, while turning the reamers by means of the ratchet handle, a smooth accurate bearing surface is produced. The bearings are brought to the proper size and in accurate alignment with each other in a very short space of time. M. W. W.

THE "FOLLOW-UP" ENGINEER

To sell a machine and then promptly forget about it until it is thought the same purchaser might be in the market for additional equipment, is fast becoming a selling plan that represents a relic of bygone days. It has long been conceded that a "satisfied customer is the best advertisement," but although this business axiom has been universally revered it has seldom been acted upon so as to really accomplish results. There is, however, a decided tendency toward the increased use of expert demonstrators; in fact, the expert demonstrator might be more properly called a "follow-up" engineer. The activity of the so-called expert demonstrator is no longer confined, by progressive manufacturers, to the aid his services may bring in effecting an immediate sale, but rather as a substantial means of building up a future business. It is in this respect that the activity of the expert demonstrator as a "follow-up" engineer can be made an influence for far-reaching good.

Let us assume that a number of competitive machines are at work in a certain machine shop. Each machine is capable of performing work up to a certain capacity, and if that capacity is not reached, the loss will be felt eventually by the builder of the machine and possibly to a greater extent than by the user. So long as a machine is permitted to be used under conditions that impair its efficiency, it remains a chronic injury to the reputation and business of the builder. Ordinarily, the services of an expert demonstrator circulating among the shops of the users of a certain machine are looked upon as entirely gratis on the part of the builder, but progressive firms have learned that such a practice is mutually beneficial. Aside from the enormous advertising value accruing from the fact that manufacturers' products are working up to a capacity that stamp them as efficient tools, there is an additional benefit to the manufacturers that is often entirely overlooked.

Let us assume, for example, that a grinding machine manufacturer employs as a regular part of the selling organization, the services of an expert demonstrator whose duty it is to visit periodically the shops of users of the product of his company with a view to assisting in bringing the machines up to an increased standard of production. Undoubtedly such an expert is in a position to lend material assistance to the manufacturer which, in itself, should be sufficient recompense. It will be just as readily appreciated, however, that such a circulating expert can also become of great value to the designing organization of the manufacturer whom he represents, in that he is constantly coming in contact with mechanics whose ingenuity is often a potent factor in increasing the utility of the machines they are using. In this way the manufacturer's representative has an opportunity of observing improvised improvements designed for special purposes, that can well be made a part of the design of improved machines as they are brought out from time to time. It is safe to say that many an improvement in the design of machine tools originated in the shops of users. In the same way that a shop that permits no visitors, probably

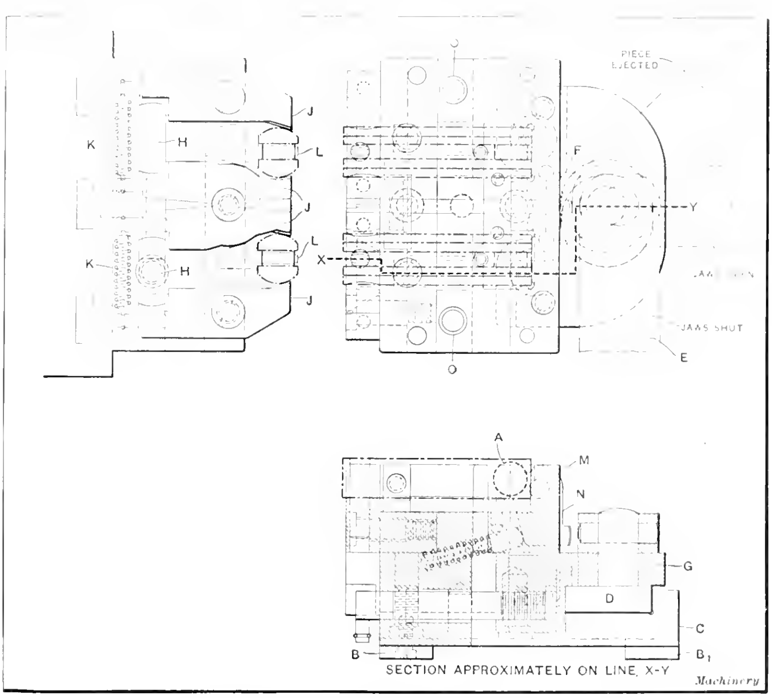
loses as much as it keeps away from competitors, the expert demonstrator learns as much as he dispenses.

A. V. Francis

FIXTURE WITH CLAMPING AND EJECTING DEVICES

The fixture shown in the end, plan, and sectional views of the accompanying illustration was designed for holding the two parts shown by the dot-and-dash lines, while the ends were being ground in an ordinary disk grinder. Each piece consists of two hardened steel strips, shaped as shown by the end view. These two strips are joined by a circular spacer *A*, to which they are electrically welded. The fixture is mounted on the sliding table of the grinder. When grinding, the ends are brought up against the abrasive disk, after which the work is moved back and forth across the face of the disk in the usual manner. The length of the parts is regulated by a stop on the grinder table.

This fixture was made of steel throughout and some of the details were hardened. The fixture is located on the grinder table by the tongue pieces *B* and B_1 attached to part *C*, which, in turn, is fastened in a slot formed in the main body. This member *C* takes the thrust of cam *D* which is operated by lever *E* and serves to clamp the work in position by means of the wedge and lever clamping arrangement seen in the end view. This cam, instead of having a fixed center, floats between parts *C* and *F* and is held sideways by yoke *G*. This yoke has enough swiveling motion to compensate for any inequality in the clamping, due to variations in the size of the work. The clamping bolts *H* are threaded into yoke *G* and have wedge shaped ends which engage the clamping levers *J*. The threaded connection allows for adjustment when the cam or other members become worn. The jaws *J* swivel about the screws shown and are normally held open by springs *K*.



Grinding Fixture so designed that Work is clamped and ejected from Locating Pins by a Single Handle

The work is located by pins *L* and the end-stop *M*. Owing to variations in the size of the work, some of the pieces stuck to the front pins *L* and could not readily be removed. To overcome this difficulty, the ejector *N* was provided to "strip" the parts from the pins. This ejector is operated by the same handle *E* which controls the movement of the clamping jaws. After the jaws are open sufficiently to release the clamps, a further motion of the handle brings it into contact with the end of ejector *N*, thus raising the front end and forcing the work off the pins. The holes marked *O* are used for clamping the fixture to the grinder table by means of screws and T-nuts.

One of the points that facilitated the operation of this fixture was that the handle moved to the left to tighten the jaws and this motion was continued after the work was clamped, thus pushing the grinder table, which moved freely, over toward the abrasive disk and in position for grinding. On the other hand, when the work was to be removed, the pressure on the handle necessary to release the clamps moved the table back away from the wheel.

Elizabeth, N. J. George R. Richards

ADVERTISING IN THE PROFESSIONS

There are many kinds of advertising but the object of all advertising is to increase business. The merchant who has goods that he wishes to sell at a profit buys newspaper space and uses it to tell buyers that his goods are the best obtainable for the money; but that is only one of the ways in which he advertises. His window display is an advertisement, he donates goods to fairs, gives prizes for contests, and, in fact, misses no opportunity to get his name and his goods before the buying public. He is not accused of lack of modesty when he praises his goods and claims that he has made the best selection possible when he bought his stock.

The professional man also has goods to sell. His stock in trade is his services, and the value of his services depends on his ability to get results. It is not good form for a professional man to buy newspaper space and use it to exploit the desirable qualities of his own services, but there are other ways of advertising his ability that are legitimate and are constantly used by professional men. You can hardly pick up a newspaper without seeing an item stating that Dr. So-and-So, the local expert on tuberculosis, delivered a lecture on the benefits of the Red Cross stamp fund, to the Woman's Club, or that Mr. Somebody, the noted lawyer, addressed the Chamber of Commerce on the working of the new income tax law, or that the Honorable Somebody-or-Other—congressman from the first district—addressed a mass meeting on the duty of congress to the people, and, once in awhile, we read of John Jones, the well known engineer, delivering a lecture on efficiency in every-day life.

In this day and age it is not only perfectly legitimate to advertise what you have to sell, but necessary for any large success, and if engineers advertised more extensively than they do their professional standing would be better recognized. It is true that the engineer is not interested in advertising his ability to the general crowd, in the same degree as is the doctor and lawyer; nevertheless, if Joe Brown, the factory superintendent, delivered a lecture to the business men on how to handle men, the "Boss" would be impressed with the fact that Joe did have less trouble with the men than his former superintendent. Furthermore, other bosses that heard the lecture or read of it would note that Joe had some good ideas and was the kind of man they would like to have in their organizations. The opportunities for delivering lectures to general audiences are limited, but one has a good audience at any meeting of the engineering societies to which he belongs. There is another medium, however,

that reaches a large and select audience and that is the technical magazines.

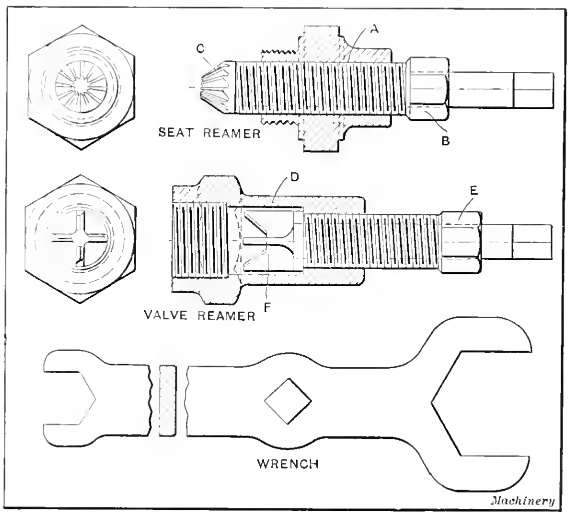
Advertising of this sort, whether it consists of lectures delivered personally or articles published, has a two-fold value: First, it secures a desirable publicity and, second, it provides an incentive for improvement. The man who delivers a good lecture or has a valuable article published begins to think he really does amount to something and he gets the ambition to do something better. He becomes so interested in his subject that it is a pleasure to burn the "midnight oil," digging up everything he can find on that subject, and he goes to the office or shop with a new interest, his field is broadened because his ideas are presented to people all over the world, and if his ideas are faulty, people from all over the world will tell him so, too. This puts him on his mettle to perfect his ideas and defend them, until he is soon looked upon both by others and himself as an authority in his line. When he has secured this result he has reached the same stage as the manufacturer who puts out a staple line of goods with a countrywide reputation. He can sell his services anywhere and the position he reaches is limited only by his ability and energy. This does not mean that advertising need be the only reason for presenting papers personally or through the press, but the advertising and the incentive to better and broader work, are enough to well repay any man for his trouble, and many a man made his start out of the rut in this manner.

NAVILLUS

TOOLS FOR TRUING VALVES AND VALVE SEATS

Keeping gage cocks in good condition is often a serious problem in districts where the water is bad. In such cases the sediment in the water has a tendency to cut the valve and seat. The usual method of grinding takes a considerable amount of time and on account of the difficulty that is experienced in holding the valve exactly in line with the seat during the grinding operation, it is not always possible to get a good tight joint.

The accompanying illustration shows tools which make it possible to grind valves and valve seats with a high degree



Tools used for truing the Valves and Seats of Boiler Gage Cocks

of accuracy. The parts of this outfit consist of a seat reamer, a valve reamer and a wrench for adjusting the parts. The body of the seat reaming tool *A* is screwed into the body of the gage cock, and the adjusting screw *B* is turned until the reamer *C* rests lightly on the seat. Then using the square hole in the handle of the wrench, it is only necessary to give the reamer a few turns in order to true up the seat. Similarly, the valve reamer body *D* is screwed onto the gage cock bonnet with the valve in position, after which the adjusting screw *E* is turned to bring the reamer *F* into contact with the valve. The valve is then trued up in the same way that the seat of the valve was refinished.

The importance of having the cutting face of both reamers of exactly the same angle is evident, for if they do not correspond it is obvious that the valve will not fit properly in its seat. These tools cut rapidly and the operator who uses them should be instructed to apply a very light pressure and to be careful not to ream away more material than is necessary to insure a good fit. Although these tools were designed for use on gage cocks, the design could be easily modified to produce a tool suitable for use on any common type of valve having the same style of seat.

Lincoln, Neb. H. E. GILLETTE

GAGE FOR SCREW MACHINE WORK

A type arm pivot made on the automatic screw machine is illustrated in Fig. 1, and an interesting form of gage for testing the accuracy of these parts is shown in Fig. 2. The thin ends of this part constitute the main bearings of the pivot and it will be seen that the limit of tolerance allowed is very small. Referring to the illustration of the gage shown in Fig. 2, it will be seen that the block *A* is secured to the base by means of two screws and two pins and that it is drilled to receive the gage *B*. This gage is a press fit in the block *A*. A similar block *C* is secured to the base and drilled to receive the gage *D*. This block is of greater length in order to accommodate the spring which returns the gage to its original position after it has been moved back by the handle *E* to allow the work to be put in place.

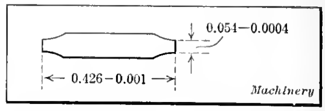


Fig. 1. Screw Machine Work to be gaged

To check the dimensions of a piece of work with this gage, the inspector pulls back the lever which moves the gage *D*

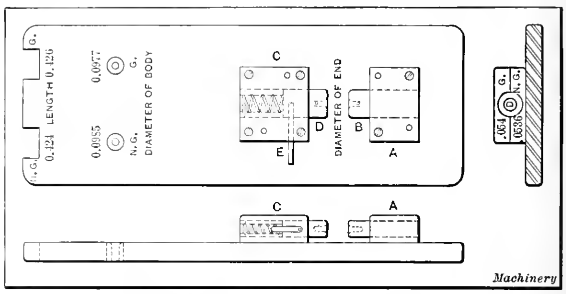


Fig. 2. Gage for Piece shown in Fig. 1

with it. This enables one end of the type arm pivot to be slipped into the gage *B*, which has a hole in it of exactly the same shape as the end of the work to be gaged. The handle *E* is then released and the spring returns the gage *D* over the opposite end of the work. It will be seen from the illustrations that the limit of tolerance on these pins is between 0.0536 and 0.0540 inch, and the gage indicates whether the dimensions are within these limits by the position of the movable gage *D*. All screw machine operators do not have a micrometer graduated to 0.0001 inch and this gage takes the place of such a micrometer with perfect satisfaction. It will also be seen that holes and slots are provided at the left-hand end of the gage for checking the dimensions of the large diameter and the length of the work.

LEO MORTON

* * *

Automobile engineering as a career will be made the subject of a series of talks before the engineering societies of various colleges, according to a plan that has been formulated by the metropolitan section of the Society of Automobile Engineers. The need of trained men is constantly felt in the automobile industry, and it is believed that it properly devolves upon this society to assist in attracting the attention of undergraduates to this field. Incidentally, the advantages of junior membership will be advocated as a means of getting into touch with current practice before engaging in practical work.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO REMOVE OIL VAPOR FROM COMPRESSED AIR

O. B. M. Co.—We are interested in a device for extracting oil vapor from compressed air. We use compressed air to blow bottles with our bottle machine, and the oil vapor, we believe, causes the inside surface of the bottle to become smoky. We will be glad to receive details of any successful device for removing the oil vapor resulting from the lubrication of the air compressor cylinder.

A.—The apparatus used by the large watch companies for purifying the air supplied to rooms in which certain operations are conducted would, perhaps, answer your requirements. The Waltham Watch Co. has been fairly successful in removing lubricating oil from compressed air by passing the air through an after-cooler and settling chamber before it enters the discharge pipes. The after-cooler breaks the air up into small columns and the air is cooled to a temperature that causes a large percentage of the oil to be deposited in the bottom of the settling chamber. Further refinement is accomplished by the use of oil separators in the air mains provided with suitable drip connections. It is necessary to cool the air, and to reduce its travel to a low velocity in the settling chamber in order to remove the oil efficiently.

STRESSES IN SHEAR FRAME

W. W. McK.—I wish to build a small hydraulic shear and would like to have some information regarding the forces acting on and in the frame. Referring to Fig. 8, there is a driving force of 40,000 pounds acting at A. When the plate or bar to be sheared is held perpendicular to the line of action of the driving force A, what will be the force tending to separate the shear blades; *i. e.*, what will be the amount in pounds or in terms of the driving force A of the forces at B and C? I would also like to know what the angle θ in degrees should be between the top and bottom shear blades in order to offer the least possible resistance to shearing.

Answered by William L. Cathcart

The angle between the blades, that is, the inclination of the upper blade to the horizontal, varies between 5 and 15 degrees — 5 degrees for thin, and 15 degrees for thick material.

General Methods of Determining Stresses

In finding the principal stresses in this shear, the methods of graphic statics will be used, since, in this case, they will be simpler and more compact than analytical treatment. The leading principles on which these methods are based are as follows: To every action there is an equal and opposite reaction. Thus, if an anvil be struck by a hammer, it will strike back with a reacting force equal to the force of the hammer blow. When two bodies strike each other or are pressed together, the reaction of the body struck or pressed upon is, disregarding friction, always normal to the surfaces in contact. A body in motion may be considered as in momentary equilibrium at any instant under the action of the forces and reactions acting upon it at that instant. In order that a body shall be in equilibrium, the lines of action of its forces and reactions must meet in some common point; if they do not thus meet, there is a resultant couple tending to make the body rotate. The particulars required to be known as to each force or reaction of any given system are its magnitude and direction. When all but two of these particulars are known for the system, a "force triangle" or—for more than three forces or reactions—a "force polygon" can be drawn, with each of its sides parallel to the line of action of a corresponding force or reaction. From such a triangle or polygon the unknown magnitudes or directions can be determined. In order that a body shall be in equilibrium, there are two conditions: the force triangle or polygon must close, that is, its sides must meet; and, second, the forces and reactions must all have the same direction in passing around the periphery of the triangle or polygon. When, on the other hand, the direction of any one force in such a triangle or polygon is opposed to that of all of the others, the corresponding side represents, in magnitude and direction, the resultant of a system acting on a body which is not in equilibrium.

Negligible Factors

There are some factors in this problem which, for all practical purposes, may be disregarded, since they have no very material effect on the results, and their omission will greatly simplify the analysis. For example, friction will not be considered although, acting near the upper left-hand corner of the tilted moving blade, it has a relatively slight effect in opposing and reducing the driving force. Again, the cutting edges of the blades are usually ground to an angle of about

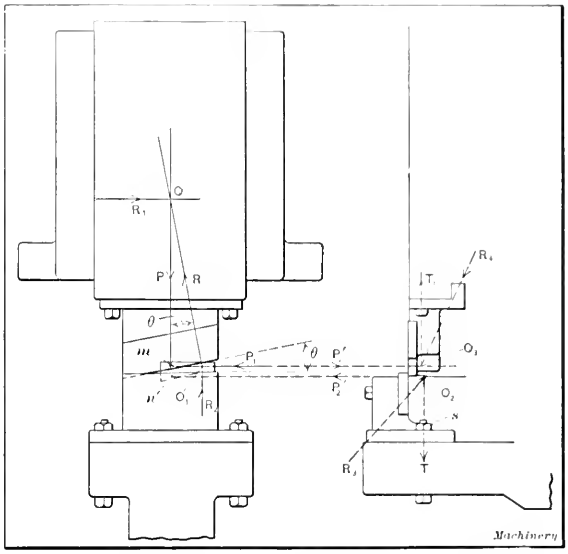


Fig. 1. Diagram showing Forces and Reactions to be considered

87 degrees, that is, 3 degrees with the horizontal, which diverts the effective shearing force and blade reactions into a plane 3 degrees from the vertical. This inclination is too small for consideration in this machine and the shearing faces of the blades will, therefore, be taken as horizontal. Again, the upper blade, after shearing the plate, bends it as the blade moves downward, which reduces the gross driving force by the amount required for bending—a factor which may be neglected. Finally, in finding the reactions of the guide and the lower blade, these reactions and the driving force will be temporarily taken in Fig. 1 as in the same vertical plane, an assumption which will not modify the results appreciably.

Effective Shearing Force and Thrust on Guide

The effective shearing force is the component of the driving force which is normal to the cutting face of the upper blade. The thrust on the guide is the horizontal component of the driving force. Referring to Fig. 1, the driving force is uniformly distributed over the cutting face of the upper blade and the resultant of these distributed forces is a single, concentrated force P, having a vertical line of action at the middle of the blade. The upper reactions of the plate or bar which is being sheared have a resultant R which is normal to the cutting face of the blade. Similarly, the reactions of the guide against the thrust of the blade have a resultant R_1 which, disregarding friction, is normal to the surfaces in contact and is therefore horizontal. At any point in its stroke the upper blade may be taken as in momentary equilibrium under the action of P, R, and R_1. While the position of the line of action of P is fixed, the positions—although not the inclinations—of the lines of action of R and R_1 vary with the position of the blade and that of the bar under shear. As the blade is in equilibrium, the

three lines of action must meet in a common point. Assume that point to be O for this position of the blade and bar.

The driving force is given as 40,000 pounds. In Fig. 2 lay off ab parallel to the line of action of P and equal, to any convenient scale, to 40,000 pounds. From b, draw bc and from a lay off ac, parallel, respectively, to the lines of action of R and R_1. Then, measured on the same scale, $bc = R$ and $ca = R_1$. The directions of P, R, and R_1, as transferred from Fig. 1, are the same in passing around the triangle abc, and hence the blade is in equilibrium. The effective shearing force is equal to R but opposite in direction. Similarly, the thrust on the guide is equal and opposed to R_1. If friction had been considered, R_1 would have been inclined upward from the horizontal by the amount of the angle of friction and the thrust on the guide would have a downward component. In Fig. 1, let θ be the angle between the blades. Then, in Fig. 2, the angle abc is also, by geometry, equal to θ. Hence, analytically, we have:

$$\text{Cos } \theta = \frac{ab}{cb} = \frac{P}{cb}.$$

$$\text{Effective shearing force} = cb = \frac{P}{\cos \theta}.$$

This force is greater than P, as it is distributed over the inclined shearing face of the blade. Similarly:

$$\text{Reaction of lower blade} = R_2 = \frac{P \cos \theta}{\cos \theta} = P.$$

Tilting Couple acting to Force Blades Apart

Fig. 4 shows a vertical section of the blades and bar being sheared, the section being taken just to the right of the middle of the blades in Fig. 1. Shearing is not a cutting or sawing action, but a detrusion—a bodily thrusting down by the upper blade of the metal along the plane of shear. The effective shearing force, $\frac{P}{\cos \theta}$, is normal to the cutting edge of the inclined upper blade; it has a vertical component equal to the driving force P, which component is opposed by the reaction from the lower blade, and, as has been shown, this reaction is also equal to P. As the cutting edges are ground to an angle of but 3 degrees with the horizontal, there is no tendency to tip the bar when the upper blade first strikes it, since the pressure of the latter and the reaction of the lower blade have practically the same line of action; but, as soon as the cutting faces of the blades engage the bar fully, the lines of action of the force and reaction move to the centers of their respective blades, and, as shown in Fig. 4, are then distant by an amount x which depends on the thickness of the blades. The two equal and opposite forces P, whose lines of action are separated by the distance x, constitute a couple

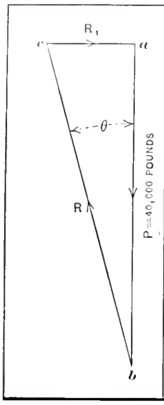


Fig. 2. Force Triangle for Reaction of Upper Blade

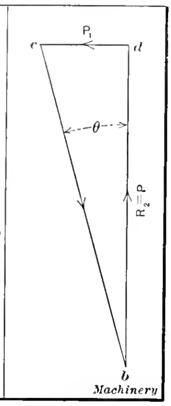


Fig. 3. Force Triangle for Reaction of Lower Blade

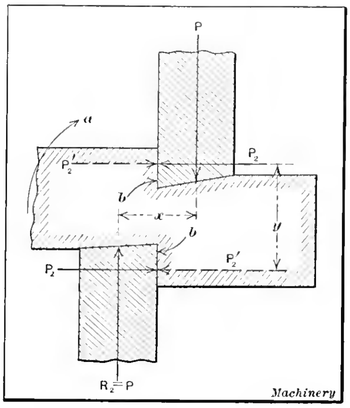


Fig. 4. Diagram showing Tilting Couple and Couple resisting Tilting

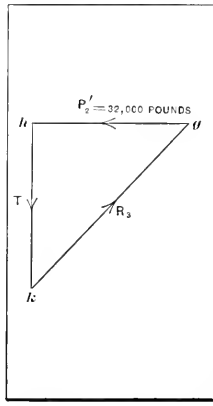


Fig. 5. Force Triangle for Forces and Reaction of Lower Bracket

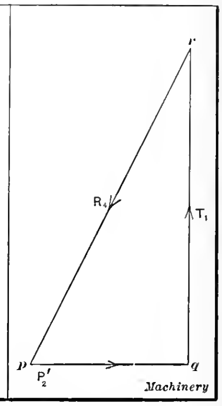


Fig. 6. Force Triangle for Forces and Reaction of Upper Bracket

$$\text{Sin } \theta = \frac{ac}{cb} = \frac{ac \cos \theta}{P}.$$

$$\text{Thrust on guide} = ac = \frac{P \sin \theta}{\cos \theta} = P \tan \theta.$$

Reaction of Lower Blade

Referring again to Fig. 1 and assuming, as previously stated, that the lines of action of the forces and reactions of the blades all lie in the same vertical plane, the bar which is being sheared is in equilibrium under the action of the effective shearing force, which is the reaction R reversed; the reaction R_2 from the lower blade, which is normal to the surfaces in contact and therefore vertical; and a force P_1 which is equivalent to the effect of friction and acts horizontally toward the left. If there were no friction and if this force were absent, the bar would slide out of the shear toward the right as soon as the upper blade put pressure on it. Since the bar is in equilibrium, these three lines of action meet at the common point O_1.

In Fig. 3, lay off to any convenient scale, cb equal to the effective shearing force and parallel to its line of action. From b, draw bd and from c lay off cd, parallel, respectively, to the lines of action of R_2 and P_1. Then, measured on the same scale, $bd = R_2$ and $dc = P_1$. The angle $cbd = \theta$ and as:

$$cb = \frac{P}{\cos \theta}$$

$$\text{Cos } cbd = \cos \theta = \frac{bd}{cb} = \frac{R_2 \cos \theta}{P}.$$

whose moment or power is equal to the product of one of the forces and the arm of the couple, that is:

Moment of tilting couple $= Px$ inch-pounds.

The tendency of a couple is always to produce rotation of the body on which it acts. As shown by the arrowhead a, this couple, if unopposed, would revolve the bar in a clockwise direction and press it against the blades, tending to force them apart as indicated by the arrows b.

It should be observed that this tilting moment Px is a theoretical maximum which will not be fully attained in practice. It disregards the friction of the upper blade in its guide and assumes that the bar being sheared is thick enough and wide enough to require the full driving force to shear it and to bend the sheared part under the upper blade, as shown in Fig. 1. Further, while the common theory of flexure assumes the shearing stress to be uniformly distributed over the cross-section of a bar under shear, the actual power required to shear such a bar varies at different points in the depth. Thus, Prof. Goodman, in "Mechanics Applied to Engineering," page 315, states that, from autographic shearing diagrams it is found that the maximum force required occurs when the shearing "tackle" is about one-fifth of the way through the bar. At this point then the tilting couple would be a maximum. As, at all other points in the depth of the bar, it would be less, and as the inclination of the upper blade makes every point of its cutting edge shear simultaneously at a different depth, it is wholly probable that the average tilting moment at any point in its stroke is considerably less than the theoretical maximum calculated above—how much less is, however, indeterminate theoretically.

The Couple Resisting Tilting

As has been stated, the couple Px tends to rotate the bar. Since the bar does not thus rotate, this couple must be opposed and balanced. A couple can only be balanced by an opposite couple of equal moment. This resisting couple must be constituted by the reactions of the blades to the pressure upon them by the bar, owing to its attempted rotation by the tilting couple. In other words, the blades make fulcrums of their supports to withstand the strain produced by their own action in different vertical planes, as is essential in shearing. The resisting couple is represented in Fig. 4 by the forces P_2 with the arm y, which arm decreases as the blade moves downward. In accepting the theoretical maximum of the tilting couple as above, we shall err on the side of safety. To balance each other, the moments of the two couples must be equal. Therefore:

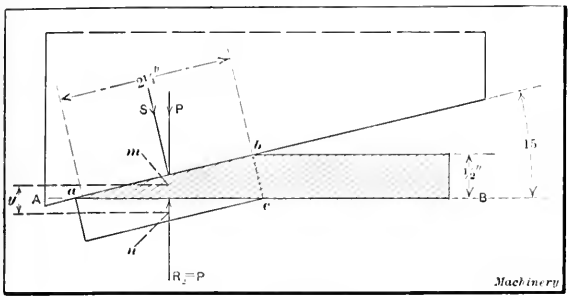


Fig. 7. Section through Plate under Shear showing Average Value of Arm y of Resisting Couple

Moment of resisting couple $= P_2y = Px$ inch-pounds.

It is evident that, so far as tilting is concerned, the couple Px may be replaced by the equivalent couple P'_2y, having the same line of action as the resisting couple P_2y. Then:

Moment of equivalent tilting couple $= P'_2y = Px$ inch-pounds, in which $P'_2 = P_2$.

From this equation, the normal pressure acting near the extremity of each blade to force the blades apart is:

$$\text{Normal tilting force} = P'_2 = \frac{Px}{y} \text{ pounds.}$$

Numerical Results

Substituting in the several equations deduced above, we have the numerical results given in the table. These results apply strictly only when the bar to be sheared is so thick and wide that the total driving force of 40,000 pounds is required to split it. The data for a blade angle of 5 degrees can be found similarly from these equations, if the driving force P be given a suitable value for this metal. In any case, average values of the tilting couple and normal pressure should be estimated from the maximum values tabulated.

TABLE OF SUMMARY OF RESULTS

Blade Angle $\theta = 15°$: Driving Force $P = 40{,}000$ pounds.

Natural functions of 15°: sin $= 0.259$; cos $= 0.966$; tan $= 0.268$.

$$\text{Effective shearing force} = \frac{40{,}000}{0.966} = 41{,}408 \text{ pounds.}$$

Horizontal thrust on guide $= 40{,}000 \times 0.268 = 10{,}720$ pounds.

Reaction of lower blade $= 40{,}000$ pounds.

Maximum moment of tilting couple $= 40{,}000 \times x$ inch-pounds.

Maximum normal tilting pressure on each blade $= 40{,}000 \times \frac{x}{y}$ pounds.

Stresses in Holding Bolts of Jaw

The stresses in the bolts holding the jaw, due to the tilting forces on the blades, can be ascertained with accuracy by the methods of graphical statics, when a drawing made to a fairly large scale is available. The results given below — found from a cut no larger than Fig. 1 — are necessarily somewhat approximate. The methods of obtaining them, however, can be made entirely clear, and will serve for later application to a suitable drawing. Each of the two brackets of the jaw should be considered separately and regarded as in equilibrium under the action of the forces and reactions acting upon it. The lower bracket is of the same height throughout; the upper bracket, however, slants downward and is deepest at the left, giving the normal pressure a greater leverage there. The force P'_2 represents the total tilting force on each blade, and, while it is distributed along the part of the edge which is cutting it may be considered as concentrated at any selected point where the resultant of its distributed forces may be assumed to act. This force should be given a definite value, in order to find the stresses in the bolts. Assume that a narrow bar of 1/2-inch steel is to be sheared, and that it will be inserted at about the center line of the blades, as shown in Fig. 1. Take $x = 3/8$ inch and $y = 3/8$ inch as an average value when the maximum resistance to shearing occurs; and estimate four-fifths of the maximum tilting pressure as the average normal pressure along the cut at this time. Then, from the table:

Normal tilting pressure $P'_2 = 4/5 \times 40{,}000 \times 3/8 \times 8/3 = 32{,}000$ pounds.

Now, assume the forces P'_2 as acting at the points m and n near the center lines of the blades. Consider the lower bracket of the jaw; as the force P'_2 is regarded as concentrated at the point n, we may take the total tensile stresses in the two bolts as temporarily concentrated in a single bolt s, which alone secures the flange and is in the vertical plane passing through the points m and n. The bracket is, therefore, in equilibrium under the action of the force P'_2, acting toward the left; the tensile stress T in the bolt, acting downward; and a reaction R_3 from the frame. From n project the line of action P'_2 on the side elevation of the bracket and draw through the center of the bolt the vertical line representing the line of action of T. These two lines of action meet at the point O_2. Under the thrust of the force P'_2, the bracket will tend to tip, pivoting on the lower, left-hand corner. This corner gives one point in the line of action of R_3; the other point is determined by the fact that, for equilibrium, the lines of action of all forces and reactions must meet at a common point, which is the point O_2. The line of action of R_3 therefore passes through O_2 and the lower, left-hand corner of the bracket and is so drawn in Fig. 1.

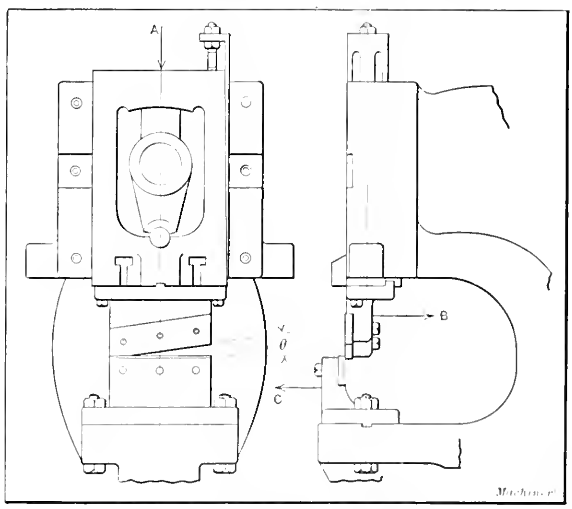


Fig. 8. Type of Shear to be Designed

In Fig. 5 — which should be drawn to as large a scale as possible — lay off gh parallel to the line of action of P'_2 in Fig. 1 and equal to 32,000 pounds. From g and h, draw gk and hk parallel, respectively, to the lines of action of R_3 and T, as given in Fig. 1. Then, measured on the same scale, the total tensile stress T will be found to be 34,130 pounds. As there are two bolts, the stress in each will be 17,065 pounds, since the points m and n are on the center lines of the blades. If the bolts are made small enough to stretch to an appreciable extent when under strain, tensile bending stress will also occur in them. With moderately large, body-bound bolts, the effect of bending may be disregarded.

Fig. 6 shows the force triangle for the upper bracket. It is drawn similarly. The line of action of P'_2 in Fig. 1, projected from the point m, meets the line of action of the upward tensile stress T_1 in the bolt at the point O_3. The bracket pivots on its upper right-hand corner. The line of action of the reaction R_4 passes through this corner and the point O_3. The bracket is in equilibrium under the action of P'_2, T_1, and R_4. In Fig. 6, the line pq is drawn parallel to the line of action of P'_2 and equal, as before, to 32,000 pounds. From q and p, the lines qr and pr are laid off parallel, respectively, to the lines of action of T_1 and R_4, as given in Fig. 1. Then, measuring on the same scale, we have $qr = T_1 = 64{,}000$ pounds or 32,000 pounds in each of the two bolts. As in Fig. 5, the direction of the reaction R_4 is determined by the condition that, in passing around the triangle, all forces and reactions must have the same direction.

The greater tensile stress in the upper bolts, as compared with that in the lower, is due to two conditions: first, the distance from the point m to the flange above it is slightly greater than the corresponding distance from the point n to the lower flange, giving the pressure on the upper blade a greater leverage; and, second, according to the cut, the base of the upper bracket is narrower than that of the lower, which makes the inclination of the line of action of its reaction more nearly vertical than that of the lower bracket. It should be remembered, as to these results, that they are neither exact nor closely approximate, owing, first, to the necessary assumptions as to the average magnitude and location of the resultants of the normal tilting forces on the blades, and, second, to the small scale of the drawing from which the directions of the reactions were found. The method of obtaining them has, however, been made sufficiently clear to enable more accurate results to be obtained under suitable conditions.

In any event, the values of the resisting couple and the normal pressures on the blades will vary with any differences in the thickness and shearing strength of the plate to be sheared. The maximum possible values should, of course, be used in designing. Thus, if the driving force P be taken as 40,000 pounds and the ultimate shearing strength of steel as 70,000 pounds per square inch, then $\frac{40{,}000}{70{,}000} = 0.57$ square inches, the greatest possible area of the triangular section abc under shear in Fig. 7. This gives a thickness of plate of ½ inch, a length ab of 2¼ inches, and an average value of y of about 0.35 inch, or slightly less than ⅜ inch. It will be seen that the points m and n and the locations of the forces P and R_2 move to the right as the blade descends. Hence, if plates of nearly the full width of the blades are to be sheared, the total normal pressure on either blade cannot be considered as equally divided between the two holding bolts, but must be taken as applied at some points as near relatively to each bolt as is shown for the left-hand bolt in Fig. 7, which is drawn approximately to scale. In this figure, AB represents the top of the lower blade and S the effective shearing force which has been made equal to P to allow roughly for friction and bending. The force P'_2 should be taken as near as practicable to either bolt and then divided between the two bolts, inversely as their distances from it. Thus, if P'_2 acts three times as far from one bolt as from the other, the latter will have a maximum strain of ¾ P'_2.

* * *

GENERAL TREND OF AMERICAN MOTOR DESIGN

In a paper presented by W. M. Power before the Metropolitan Section of the Society of Automobile Engineers in New York City March 26, 1914, a comparison was made between the general developments of American and British motors. American motors, with few exceptions, are characterized by large cylinders, the ratio of bore to stroke, compression, piston speed, maximum output per pound, and economy being low. The British automobile makers have gone to the other extreme and are building motors having almost exactly opposite characteristics, from which they are getting power outputs which, a few years ago, would have been considered impossible. The fuel economy of these engines is far beyond anything obtained by American makers. These results are due to very large valves and ports, the latter being designed to give smooth flow lines. High compression and very high piston speeds, well above 3000 feet per minute, are characteristic of these motors; but these engines must be driven carefully if they are to give maximum service. The motor must never be allowed to run on wide open throttle at low speeds. This means, of course, that gear changing is frequently necessary. These engines require great care in driving and adjustment, and the overhauling must be carefully done.

The British and American types of motors have advantages peculiar to themselves both from the manufacturing and operating standpoint. Given proper equipment in the shop, the workmanship required in the two types is about the same, except that the light connecting-rods and pistons required for the small motor are somewhat more costly and more difficult to manufacture.

The probability is that the most suitable motor for service in America is a compromise between the extreme British type and the present American type, being designed to give a well sustained torque up to about 2000 feet piston speeds per minute. The capacity of an engine for a five-passenger car should probably be about 4000 to 4500 cubic centimeters for a four-cylinder motor and about 5500 to 6000 cubic centimeters for a six-cylinder car.

* * *

WORLD'S OUTPUT OF IRON AND STEEL

The probable world's output of iron ore in 1912 was about 152,000,000 tons, or more than 5 per cent above that of 1910. The principal producers were the United States, Germany, France, the United Kingdom and Spain, in the order given, these five countries producing about six-sevenths of the total output of the world. The following table gives the output of iron ore in 1911 and 1912:

	1911, Tons	1912, Tons
United States	43,877,000	55,150,000
Germany (including Luxemburg)	29,399,000	32,190,000
France	16,372,000	18,744,000
United Kingdom	15,519,000	13,790,000
Spain	8,633,000	———
Russia (excluding Finland)	6,882,000	8,054,000
Sweden	6,055,000	6,593,000
Austria-Hungary	4,640,000	2,880,000
Canada	188,000	156,000
Belgium	148,000	165,000

The ore resources of the world are given in an estimate made at the International Geographical Congress at Stockholm in 1910. It was then estimated that the total actual resources of iron ore existing in deposits that can at present be worked at an economic profit amount to 22,408,000,000 tons, representing 10,192,000,000 tons of iron. This total would supply the requirements of the world for considerably less than two centuries, even were the present rate of output not exceeded. The actual resources of the principal ore-producing countries are estimated to be, in the United States 4,258,000,000 tons, the equivalent in metallic iron being 2,305,000,000 tons; in Germany and Luxemburg, 3,878,000,000 tons, estimated to yield 1,360,000,000 tons of metallic iron; in the United Kingdom 1,300,000,000 tons, equal to 455,000,000 tons of metal; in France 3,300,000,000 tons, equal to 1,140,000,000 tons of metal; and in Spain 711,000,000 tons, equal to 349,000,000 tons of metal. In addition, the potential resources of the world not yet developed are estimated, so far as they can be calculated in figures, to amount to 123,377,000,000 tons of ore, representing 53,136,000,000 tons of iron. Further, very large supplies of iron ore are understood to exist in China, Canada, and other countries.

The world's production of pig iron in 1912 was about 72,000,000 tons, the United States, Germany, and the United Kingdom accounting for about seven-ninths of the total. The United States' output was 29,727,000 tons; Germany's, 17,582,000 tons; and the United Kingdom's, 8,751,000 tons. For the first half year of 1913 the figures for the three principal countries were: United States, 16,489,000 tons; Germany, 9,414,000 tons; United Kingdom, 5,411,000 tons.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

UNION FORMED CUTTER GRINDER

The grinding machine which forms the subject of this article has been developed by the Union Twist Drill Co., Athol, Mass., for use in sharpening gear-cutters and similar types of formed cutters. Its use enables the cutting face of the teeth to be ground radial, with the periphery of each tooth at the same distance from the center of the cutter. The grinding wheel is mounted on the lower end of the vertical spindle, the spindle being carried by a slide which has a vertical movement to provide for advancing the wheel to the cut. The spindle may also be moved in a plane at right angles to its axis to suit the diameter of the cutter to be ground. The cutter is mounted on a horizontal arbor supported by the table. The capacity of the machine is for cutters up to 8 inches in diameter by 3 inches face width, and the size of the grinding wheel used is 6 inches in diameter, with an adjustment of 4 inches to or from the work in a horizontal plane.

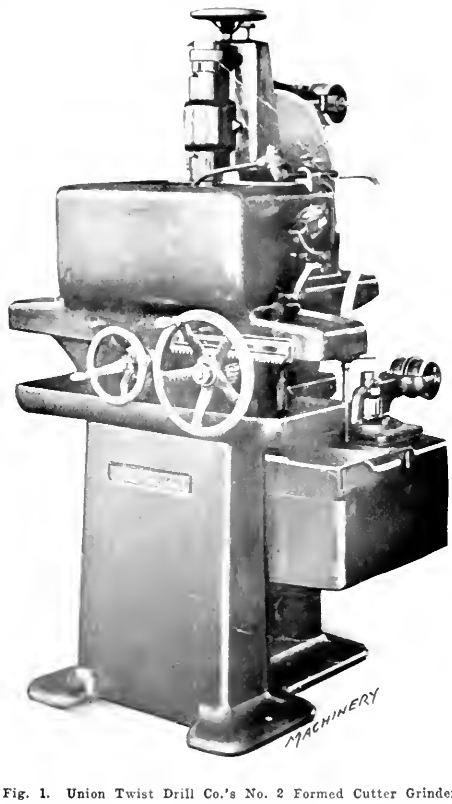


Fig. 1. Union Twist Drill Co.'s No. 2 Formed Cutter Grinder

A pump and tank provide an ample flow of water to the grinding wheel and the spray thrown off by the wheel is caught by the walls of the tank in which the cutter and wheel are located. In the operation of sharpening the cutter, the table carrying the cutter is moved back and forth past the grinding wheel. An extra movement of the table toward the right carries a diamond across the face of the grinding wheel. This diamond serves two purposes. First, it may be used to remove glaze and true the face of the wheel; second, it acts as a stop for the vertical adjustment of the wheel when sharpening each tooth of the cutter. The diamond is located in the horizontal plane passing through the center of the cutter arbor by means of a gage provided for the purpose. When the wheel slide has been adjusted downward until the wheel makes contact with the diamond, the cutting face of the wheel must be in the same plane as the center of the cutter, and the face of the teeth of the cutter ground with the wheel in this position must be truly radial.

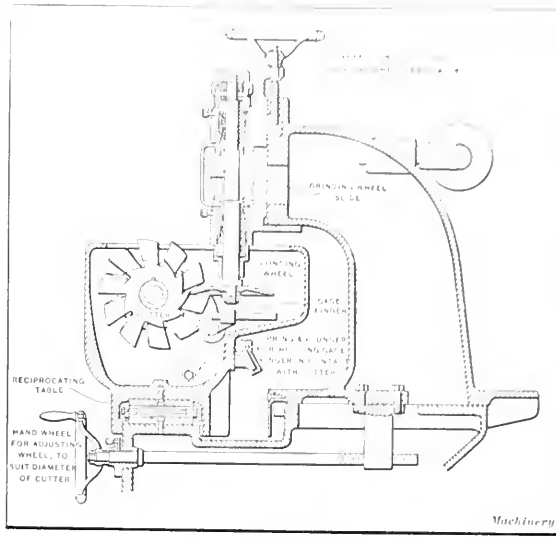


Fig. 2. Cross-section through Grinder showing the Gage Finger for measuring the Peripheral Eccentricity

For indexing the teeth of the cutter when grinding, a patented principle is employed. In explanation it may be remarked that if an evenly spaced index plate is used for locating each tooth of a cutter relative to the grinding wheel, the cutter may not run true, *i. e.*, the periphery of each tooth need not be at the same exact distance from the center of the cutter. This is due to the change of form which frequently takes place when the cutter is hardened. When hardened, the cutter will have a tendency to assume an elliptical shape, in which event it will not run true when the teeth have been evenly spaced. The eccentricity of the different teeth of the cutter suggests a way of correcting this error resulting from the hardening operation. By gaging each tooth, it is possible to determine which teeth are farthest from the center, and by grinding these teeth on their radial face, the distance of the periphery of each tooth from the center can be made the same. The design of the Union Twist Drill Co.'s No. 2 cutter grinder is such that the amount ground off the radial face of each tooth is proportional to the distance of the periphery of that tooth from the center of the cutter.

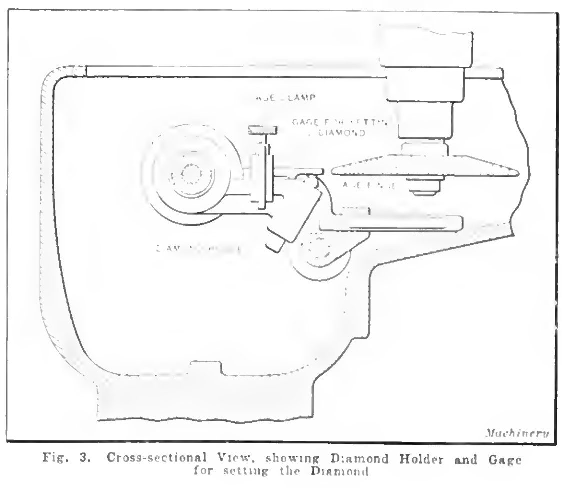


Fig. 3. Cross-sectional View, showing Diamond Holder and Gage for setting the Diamond

After the cutter is correctly ground, it may be that the teeth will not be accurately spaced but the cutter will run very true. This result is obtained by means of a gage finger shown in Fig. 2, which is adjusted to engage with the relieved periphery of a tooth of the cutter at a point near the radial face of the tooth. The gage is held in contact with the cutter by a spring and the exact location of the point of the gage relative to the center of the cutter is indicated on a dial. A movable pointer on this dial is actuated through a system of multiplying levers so that a variation in position of the gage finger of 0.001 inch may be easily read. This gage is virtually a radius caliper. By applying the finger of the gage to each successive tooth of the cutter, and rotating the cutter on its axis until the reading of the pointer on the dial is the same for each tooth, the particular point in the periphery which is at the same distance from the center may be de-

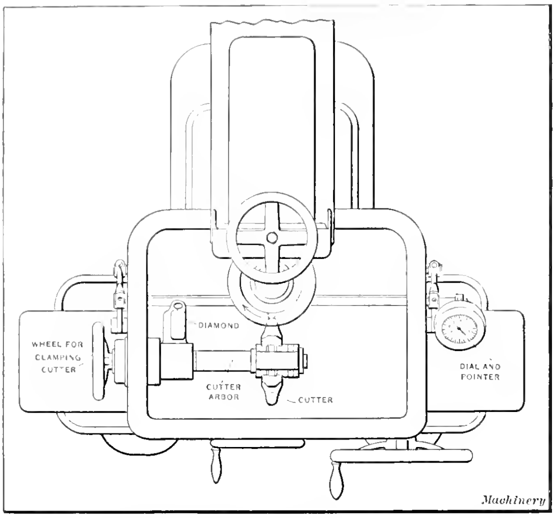


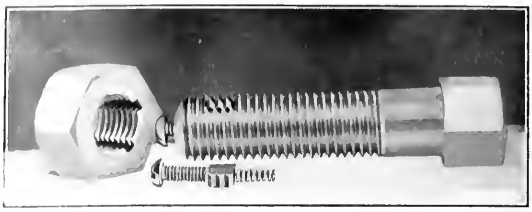
Fig. 4. Arrangement of the Cutter Arbor and Dial of the Gage for testing the Work

termined. It now only remains to grind the radial face of each tooth with exact reference to the gage finger to insure the truth of the cutter.

SCHUM LOCK-NUT

A lock-nut of somewhat unusual design, which is illustrated herewith, is a recent product of Schum Bros., Metropolitan Tower, New York City. Referring to the illustration it will be seen that a bolt and nut arranged for this system of locking are shown, and also a binding screw and locking key which have been removed from the bolt in order to illustrate the principle of operation. The nut to be locked has four slots broached in it, two of these slots being clearly shown. A hole is drilled into the end of the bolt and a small compression spring fits into the bottom of this hole, while the upper part of the hole is tapped to receive the binding screw. It will also be seen that a transverse slot is cut through the bolt and the ends of a key which fits loosely in this slot are threaded to correspond with the threads on the bolt. When the screw is turned down, this key is pushed to the right so that the threads are brought into alignment with the threads on the bolt. Under these conditions the nut can be screwed onto the bolt in the usual way.

When the nut has been screwed down into place and it is desired to lock it in position, it is merely necessary to loosen the small screw in the end of the bolt. When this is done the compression spring pushes the key



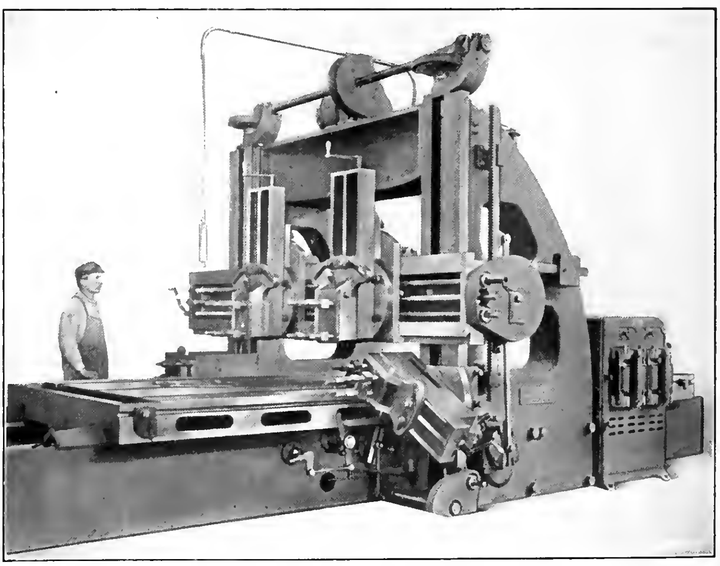
Schum Lock-nut

toward the left (as the bolt appears in the illustration). Should the nut start to loosen, it can only turn far enough to bring the key into the first slot in the nut. When this point is reached, the spring will push the key up so that the threads are out of alignment with the threads on the bolt. In this way the key is held in one of the slots in the nut and cannot enter the threads on the opposite side of the slot to enable the nut to turn any farther. As there are four slots in the nut it is obvious that the maximum distance through which the nut can turn before being positively locked is one-fourth revolution. When it is desired to remove the nut it is merely necessary to tighten the adjusting screw, thus forcing the key down into alignment with the threads on the bolt to enable the nut to be turned off in the usual way.

NILES-BEMENT-POND PLANERS

Heavy-duty planers with capacities of 120 by 72 inches, 96 by 72 inches and 86 by 48 inches have recently been built by the Niles-Bement-Pond Co., 111 Broadway, New York City, for use in the plant of the Commonwealth Steel Co., of St. Louis, Mo. All of these machines have capacities for planing work up to 18 feet long and they are all equipped with two heads on the cross-rail and a side head on each of the housings. These planers were constructed for very severe work on steel castings, and to meet the requirements of this service it was necessary for the construction to be worked out along exceptionally heavy lines. All of the gears are made of steel castings or steel forgings, and all of the bearings are bronze bushed and supplied with provision for ample lubrication. All of the shafts are unusually heavy and all wearing surfaces are proportioned for long and accurate service.

The accompanying illustration shows one of the 86 by 48 inch by 18 foot machines. This planer is 88 inches wide between the uprights and takes 50 inches between the table and cross-rail; the table is 80 inches wide by 20 feet long. The drive is from a 50-horsepower reversing motor of the Niles-Bement-Pond Co.'s system, which is direct connected to the



Niles-Bement-Pond 86-inch by 48-inch by 18-foot Planer built for the Commonwealth Steel Co.

gearing. The speed of the table may be instantly adjusted by handwheels which are conveniently located on the controller, without requiring the planer to be stopped. The speed range is from 25 to 50 feet per minute for the cutting stroke and from 50 to 90 feet per minute for the return stroke. The driving motor is direct-connected to the first driving shaft at the back of the planer, and the controller, resistance, pilot switch and circuit breaker are mounted in a ventilated cabinet which also contains all of the wiring except the wires from the controller to the motor, which are carried across the planer bed in a metal conduit.

Operating levers on the front and back of the bed are connected to the reversing switch and may be operated by hand or automatically by means of adjustable dogs on the table. At the instant of reversal, the motor—through proper connections in the controller—is disconnected from the line and becomes a powerful dynamic brake, stopping the table at once without taking current from the line. A patented pendant switch, carried by a swiveling bracket mounted on the arch, may be moved by the operator to any convenient position and gives him control of the driving motor for starting, stopping or reversing the table. This switch is particularly convenient in handling work which requires the operator to be in such a position that he cannot reach either of the levers on the front or back of the bed. In order to prevent the table running off the gearing, or damage to the tools or machine caused by failure of the line current or overload, a circuit breaker is provided which will stop the motor at once by dynamic braking. The cross-rail is raised and lowered by an independent reversible motor.

SHUSTER STRAIGHTENING AND CUTTING-OFF MACHINE

The machine for straightening and cutting off round, square or hexagonal bar stock, which is illustrated in Figs. 1 and 2, is a recent product of the F. B. Shuster Co., New Haven, Conn. The design follows the general lines of the No. 6 machine of this company's manufacture which was illustrated and described in the April, 1912, number of MACHINERY. The special feature of the No. 17 machine, which is the subject of the present article, is the provision of independent adjustment for each of the vertical and horizontal straightening rolls. This is obtained by means of universal joints which connect all of the straightening roll shafts and roll gears, giving a wide adjustment of the rolls without changing the gears. This makes it possible to handle round, square or hexagonal stock from 3/8 to 3/4 inch in size with one set of rolls, thus saving the expense of extra rolls and the time consumed in changing. It will, of course, be understood that one set of rolls is only applicable for handling one shape of stock. The rolls are grooved to correspond with the shape of the material which they are intended to handle and the range of the machine is for work from 3/8 to 3/4 inch in size.

The machine consists of a substantial bed, on which a housing is mounted which supports five vertical and five horizontal straightening rolls that are adjusted by means of square-head screws. There is a set of feed rolls at the rear and another set at the front of the machine. A balance wheel, which connects with a train of gears that operates all of the rolls, drives the machine. The method of operation is as follows: the coil of material to be straightened and cut up is placed on a reel at the rear of the machine and the end is carried through guides and passed between the feed rolls. These rolls grip the stock and carry it along through the horizontal and vertical straightening rolls, from which it passes to the front feed rolls and then through the stationary die. After

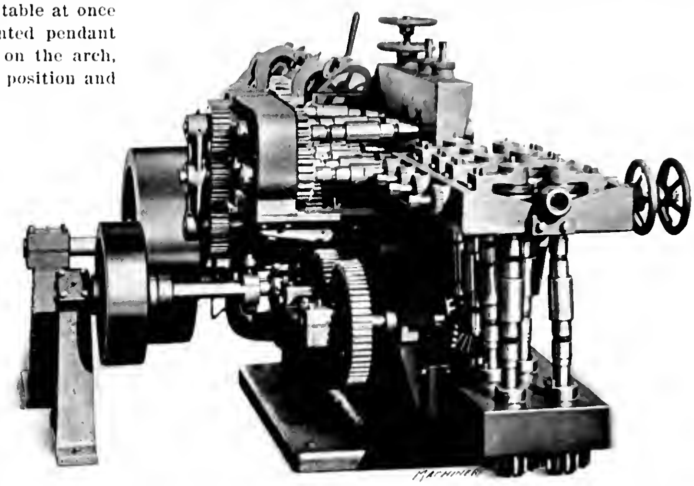


Fig. 2. Rear View of Shuster Straightening and Cutting-off Machine

leaving the die, the stock enters the covered guide bar and moves forward until it strikes a gage which is set for the desired length of pieces that are to be cut off.

When the stock strikes the gage it operates a clutch mechanism which instantly stops the feeding of the stock and operates the cut-off. The cutter severs the piece, after which the cover of the guide bar is raised and the straightened bar drops into the forked holders placed to receive it. The return of the cutter to its starting point sets the feed rolls in motion and another piece is fed through the machine and cut off, the cycle of operations being repeated over and over until all the material on the reel is cut up. The stopping of the feed rolls during the cutting operation prevents any crowding of material against the cutters. The machine shown in the illustrations is arranged to cut off lengths up to 20 feet but

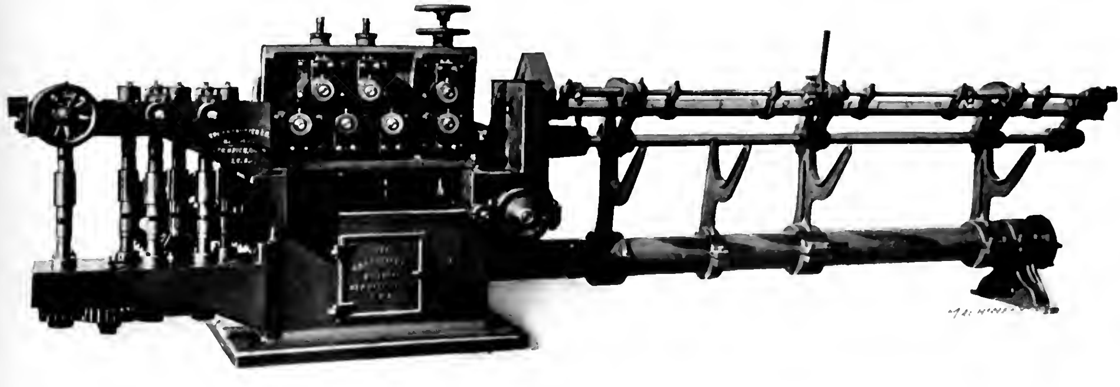


Fig. 1. Shuster No. 17 Straightening and Cutting-off Machine for Square, Hexagonal or Round Stock

only a portion of the extension of the machine is shown. Machines of the same type could be made to cut off longer bars if desired.

SLEEPER & HARTLEY SPRING COILING MACHINE

Sleeper & Hartley, Worcester, Mass., have recently brought out a special spring coiling machine which is made in five sizes. The No. 1 machine which is shown in the accompanying illustration has a capacity for coiling springs of wire ranging from 0.023 to 0.080 inch in diameter. These machines are particularly intended for the rapid production of straight springs in long or short lengths, and of either the extension or compression type. A cutting-off attachment, a diameter varying attachment and adjustable pitch tools can be provided. Either open or close coil springs of straight, conical or barrel shape may be wound. The No. 1 machine will coil springs at an average rate of 200 feet of wire per minute on any size within the capacity of the machine. It will not, however, produce open coil springs having the end coils laid close.

A front view of the machine is shown in Fig. 1, and Fig. 2 illustrates the side of the machine where the cam-shafts are

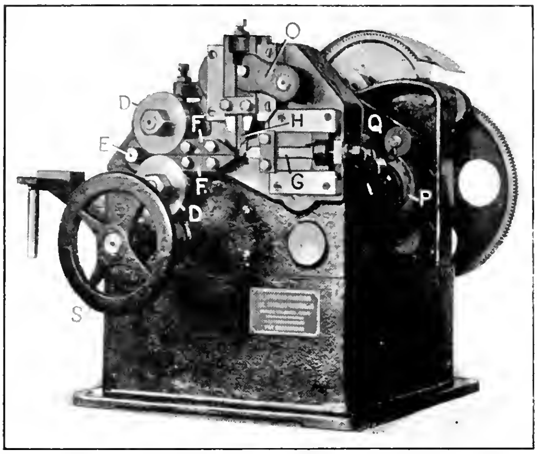


Fig. 1. Front View of Sleeper & Hartley Spring Coiling Machine

located which operate the feed and cut-off mechanisms. Referring to Fig. 2, power is transmitted from the driving pulley *A* to the camshaft, upon which the large gear *B* is mounted. The feed roll shafts are also driven through gearing from pulley *A*; these shafts are almost hidden as they are very nearly in line with two other shafts nearer the front of the machine.

The wire is fed between the feed rolls *D*, Fig. 1. Before being gripped by the feed rolls, it passes through the guide bushing *E* and after passing through the rolls it is fed between the guides *F* and strikes the coiling point or deflector *G*. The point of this deflector may be adjusted so that springs of any required diameter may be coiled. As soon as the required length of coil has been run off, the cutter *H* descends and severs the wire. This cutter is actuated from the shaft *K*, Fig. 2, on which there is a cam *M* that acts on the lever *N*. The lever *N* is located on a short shaft and transmits motion to the lever *O* at the front of the machine. The end of the lever *O* is slotted and fits over a pin in the cut-off slide, the slide being reciprocated through the action of this system of levers and the cam.

While the cutter is operating the wire is at a standstill. This interruption of the wire feed is secured by raising the upper feed roll *D* so that it is out of contact with its mate, thus releasing the wire. This movement of the feed roll is governed by the leaf cam *P* on the shaft *K*. The cam *P* actuates a lever *Q* carried by the shaft *R*. Levers from the shaft *R* extend over the upper feed roll shaft and by means of the cam action, these levers raise or lower the upper feed roll. By means of the three leaf cams, any desired length of feed may be secured. A handwheel *S* provides for trying the machine on any set-up before commencing to operate it under power. This machine is entirely automatic in action, coiling

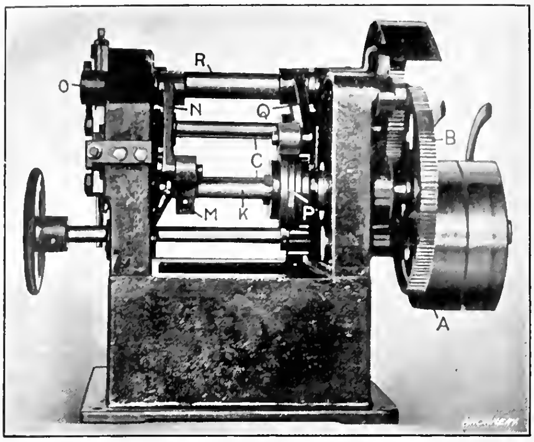


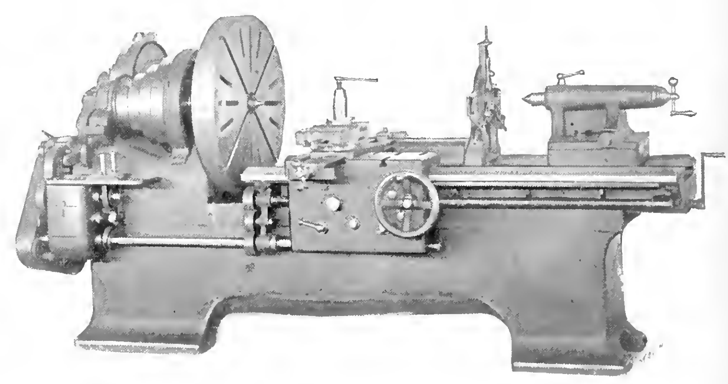
Fig. 2. Side View of Machine showing the Cam-shafts for controlling the Feed and Cut-off

any shape of springs within its range and automatically cutting them off without requiring attention from the operator.

BARNES EXTENSION GAP LATHE

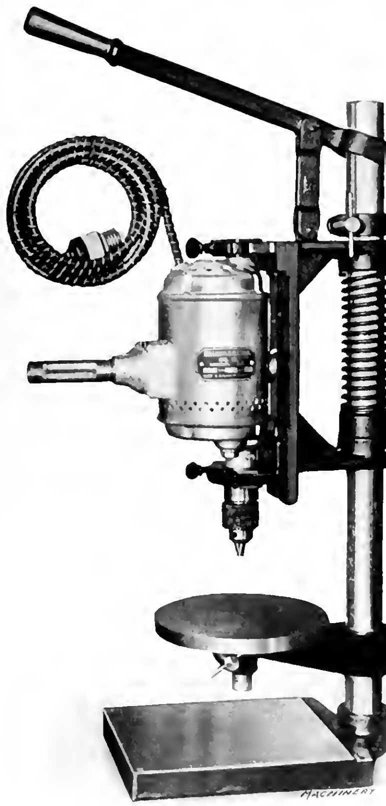
The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now building the heavy-duty extension gap lathe which is illustrated herewith. This machine swings 22 inches over the bed, 36 inches through the gap and 14 inches over the carriage. It takes 50 inches between centers when closed and 86 inches between centers when extended; the gap opens 36 inches. The ratio of the back gearing is 8 to 1 and of the double back gearing 44 to 1. There are twelve changes of spindle speed ranging from 2.3 to 400 revolutions per minute and six changes of geared feed as follows: 0.008, 0.15, 0.27, 0.39, 0.71 and 0.123 inch per revolution.

The lathe is intended for heavy duty and is of exceptionally rigid construction. The bed is adequately braced and of ample proportions, with the top of the sliding bed 24 7/8 inches wide in order to afford strong support for the carriage when the machine is operating on large work through the gap. The spindle is 3 15/16 inches in diameter in the front bearing and has a 2 1/8-inch hole through it. The steps of the cone pulley are made of exceptionally large diameter to afford ample power from a 3-inch belt, this plan having been adopted in place of increasing the width of the steps. This enables the headstock to be shorter than would otherwise be the case.



Barnes Double Back Geared Extension Gap Lathe

The diameter of the four steps of the cone pulley are 18, 15, 12 and 9 inches, respectively, by $3\frac{1}{8}$ inches wide. The machine will cut from 2 to 20 threads per inch. The regular



Cincinnati Combination Hand Drill and Sensitive Drilling Stand

length of bed furnished with the lathe is 8 feet $6\frac{1}{2}$ inches, and with a bed of this length the approximate weight is 5300 pounds.

CINCINNATI SENSITIVE DRILLING STAND

The accompanying illustration shows the combination of a portable electric hand drill and a stand upon which this tool can be mounted. With the hand drill set up in position on the stand, the combination constitutes the equivalent of a sensitive bench drill, while the drill may be removed from the stand and used as a portable tool. The hand drill may be mounted in the stand in a few seconds by means of thumb nuts which secure hinged caps that lock the drill in the bracket. The bracket has a feed of 3 inches on the column and is provided with quick return; the feed is operated by means of a hand lever. The bracket also has a vertical adjustment through the clamping screws on the column and can be set at any desired point. A stop regulates the depth to which the holes are to be drilled.

This sensitive drilling stand is made to receive hand drills of $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ inch capacities. It weighs 60 pounds. The table is 8 inches in diameter and is adjustable for height; it can be swung to one side to enable the machine to handle work for which the table is not required. The distance from the column to the center of the table is 5 inches and the column is 30 inches high by $1\frac{3}{4}$ inch diameter. The base of the machine is 9 by 11 inches in size. This combination hand drill and sensitive drilling stand, which is a recent product of the Cincinnati Electrical Tool Co., Cincinnati, Ohio, will be found particularly handy for use in shops where the work includes bench drilling and drilling operations for which a portable tool is required. The stand can be set up anywhere and occupies very little space.

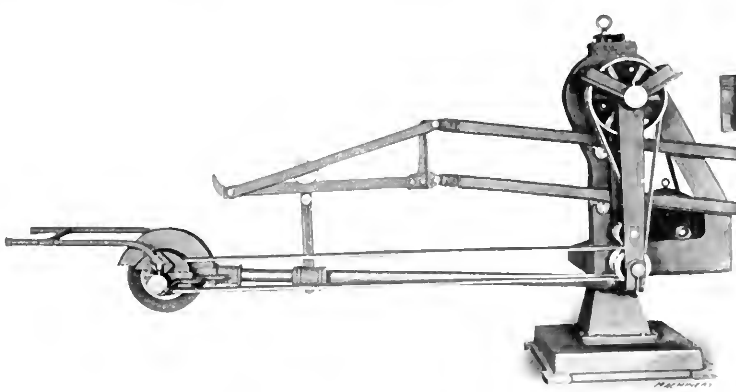
MUMMERT-DIXON RADIAL GRINDER

The Mummert-Dixon Co., Hanover, Pa., has recently added to its line of grinding machines the radial swing grinder which is illustrated herewith. This machine is intended for grinding large and medium size castings and for handling general classes of buffing work. It will be evident from the illustration that the machine is fully self-contained, being driven by a motor mounted on a platform which is part of the main housing of the machine.

The machine is adapted for portable service and requires no preliminary work in setting it up before it is ready for work. This feature enables the grinder to be carried about by a crane, the eye at the top of the pedestal being convenient for receiving the crane hook. This is a complete radial grinder, it being possible to swing the arm carrying the grinding head through a complete revolution. The grinding head and swinging arm are carried back and forth by a roller bearing trolley which runs on a track held in a horizontal position by two parallel arms. The counterweight is placed at the opposite end of these arms. This arrangement of parallel arms or "paradox lever combination," as it is sometimes called, keeps the head perfectly balanced for any position of the trolley on the track and gives a free movement to the swinging arm. The grinding head can be twisted in either direction up to 90 degrees, which is a great convenience in grinding the sides of castings.

The emery wheel is driven by a single belt which is carried around the jointed connection of the swinging arm and hanging swing frame by two self-oiling idler pulleys from which the belt runs to the large pulley at the top of the machine. The upper pulley is driven by a shaft from the driving pulley, which is located on the inside of the housing, the motor being belted to the driving pulley. The machine is mounted on a substantial base which supports a vertical pedestal, and the main frame or housing is mounted on this pedestal, being free to turn on it.

On the side of the housing, there is a bracket which carries the swing frame in which the pulleys are supported. The swinging arm to which the grinding head is attached is joined to the lower end of this frame. The swing frame hangs on two phosphor-bronze bushings which extend through the bracket, these bushings forming the bearing for the main driving pulley. The emery wheel in the grinding head is protected by a hood and the handles attached to the head enable the operator to obtain a good hold and to have full control of the head at all times. The wheel arbor runs



Mummert-Dixon Portable Radial Swing Grinder

in phosphor-bronze bearings with provision for taking up wear. The arbor has safety flanges to protect the wheel and carries a wheel 18 inches in diameter by 3 inches face width.

ROBERTSON NO. 7 POWER SAW

The latest addition to the line of "Economy" power saws built by the W. Robertson Machine & Foundry Co., Buffalo, N. Y., is the No. 7 machine illustrated herewith. This tool has a capacity for work up to 10 by 24 inches in size, and work can be cut at angles up to 45 degrees. In mentioning the capacity of this machine it should be stated that stock as small as ½ inch can be cut very accurately, the range extending from this size up to 10 by 24 inches.

The machine is of heavy construction to adapt it for the large work for which it is intended, and the bearings are of ample proportions and provided with efficient means of lubrication so that the saw operates smoothly and quietly. The cut is taken on the draw stroke and the blade is lifted clear of the work on the return stroke by means of the Robertson dash-pot mechanism. This consists of a plunger which is so timed in relation to the crankshaft of the machine, that it starts to compress oil contained in a cylinder below the bed at the same time that the saw starts on the return or idle stroke. The result is that the blade is lifted clear of the work so that it is not exposed to the wear which would result by dragging it. At the end of the stroke, the pressure in the oil cylinder is released and the saw is let carefully down into contact with the work ready for another cut. This feature has been used for several years on Robertson hacksaws with

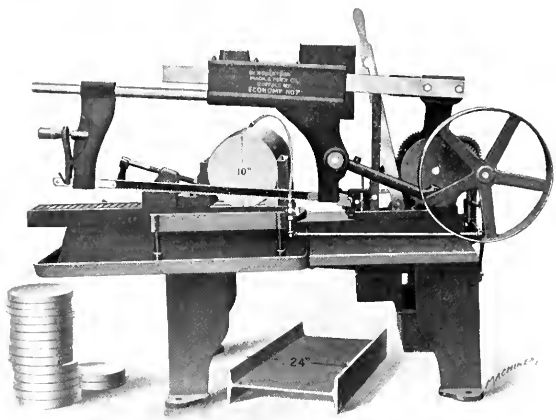


Fig. 1. Robertson No. 7 "Economy" Power Saw

very satisfactory results. Another feature of this machine is the two-speed drive, which was briefly described in the March number of MACHINERY. The arrangement consists of a set of sliding gears by means of which the high speed may be employed for cutting soft steel and the slow speed for cutting tool steel, either speed being obtained by simply pulling out or pushing in a knob.

The vise used on this machine is of the quick-acting type and can be opened or closed through its full range of 24 inches in less than one second. The vise swivels up to 45 degrees and is substantially supported on an extension to the bed which is provided with a T-slot by which the outer end of the vise is guided. This T-slot also provides for clamping the vise rigidly in any required position. When the vise has been swiveled to the full angular adjustment of 45 degrees, work up to 15 inches can be handled. The lubricant for cooling the blade is contained in a tank located under the bed of the machine. In order to protect the teeth of the saw in cutting through thin flanges on structural steel, and also for adapting the machine for operation on the wide range of sizes which can be cut, the counterweight on the frame is made adjustable. For small work or while cutting through flanges on structural steel, the weight is moved back to its extreme position; but when the saw is working on large sections this weight is moved out to apply a pressure of 195 pounds on the cutting stroke. When the weight is moved back the saw frame is evenly balanced. The blades used may be from 12 to 32 inches in length and the stroke

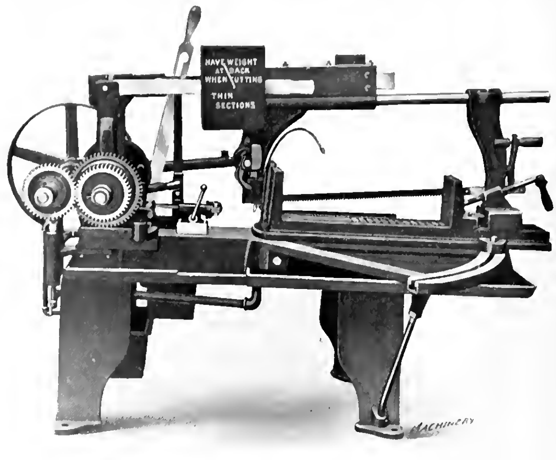
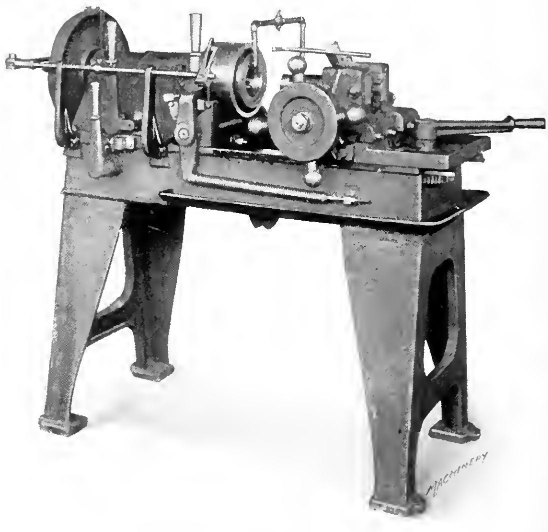


Fig. 2. Opposite Side of Machine showing Vise Support and Two-speed Drive

of the saw is 6 inches. The net weight of the machine is 900 pounds.

WILLIAMS PIPE THREADING MACHINE

The accompanying illustration shows a semi-automatic machine for cutting nipples, short lengths of pipe and bolts, which is a recent product of the Williams Tool Co., Erie, Pa. This machine is made in two sizes, one of which has a capacity for work ranging from ¼ to 1 inch in diameter and the other for work from 1 to 2 inches in diameter. The machine is designed along lines which adapt it for a high rate of production. The pipe to be threaded is gripped in a sliding chuck, the jaws of which are operated by a screw and handwheel. The pipe is reamed while the thread is being cut and the dies open automatically.



Williams Semi-automatic Pipe Threading Machine

LEES-BRADNER GEAR HOBBER

The Lees-Bradner Co., Cleveland, Ohio, has recently applied single pulley drive to its No. 5 gear generator in place of the cone pulley drive which was formerly used. The single pulley is situated below the shaft on which the cone was mounted. From this lower shaft gears transmit the power up to the original driving shaft. The gearing provides nine changes of speed for the cutter, with a range of from 44 to 147

revolutions per minute. The machine is double back geared with ratios of 3 1/3 to 1, and 10.8 to 1. The extreme ratio of 10.8 to 1 makes it possible to take advantage of the exceptionally rigid construction of the machine when operating on heavy work, while the ratio of 3 1/3 to 1 provides satisfactory results when using small hobs on light work.

The machine stops automatically when the work is finished, and the lever for starting is located at the front just to the left of the micrometer handwheel. This arrangement is the means of increasing the efficiency when the time required to

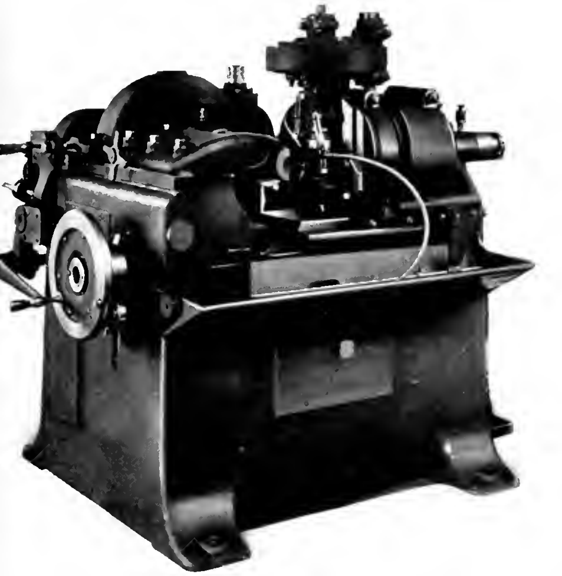


Fig. 1. Front View of Improved Lees-Bradner Gear Hobber

complete one set of blanks is not very long. With the present arrangement, the operator controls all of the movements from the front of the machine. The longitudinal feed of the work-slide is controlled by a hand lever which replaces the friction clutch formerly employed. A shield has been placed over the feed gearing and the shield may be readily swung back to cover the gears from the rotation shaft to the feed-screw, when used on the universal machine.

The new design makes the machine particularly well adapted for the application of individual electric motor drive. A constant-speed motor can be located at the rear of the machine either above or below the main driving pulley. The loose pulley is mounted on a roller bearing, with the

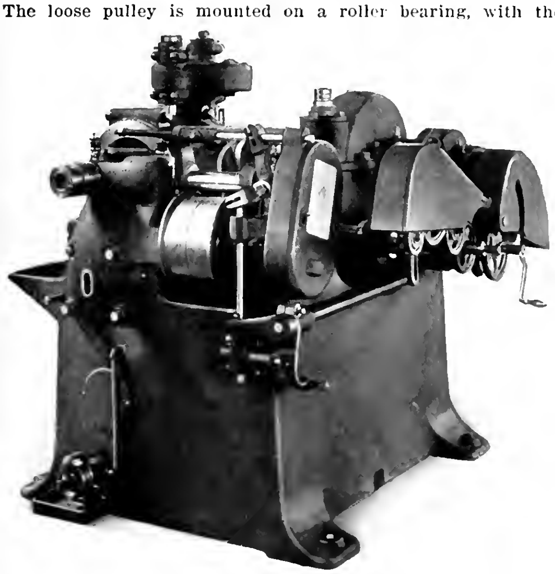
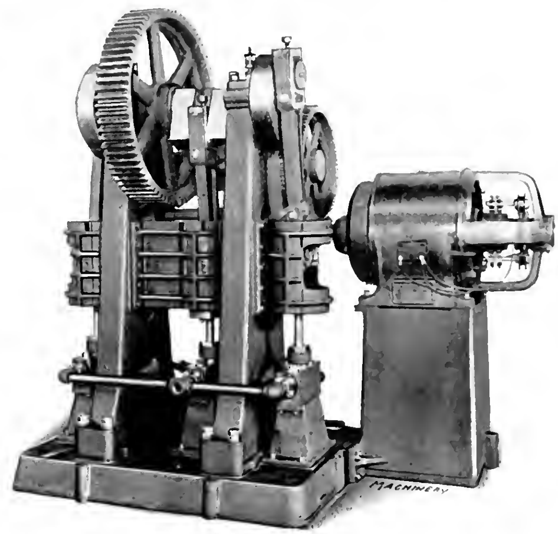


Fig. 2. Opposite Side of Machine showing Single Pulley Drive

rollers running on a hardened and ground bushing. In this way the trouble often experienced from loose pulleys wearing out their bearings and becoming noisy is done away with. This generator will cut spur gears, helical gears, worm-wheels and worms. The standard size in which the machine is built is for work up to 11 inches in diameter, but a special machine is also made which takes work up to 17½ inches in diameter. Worms 8 inches in diameter by 8 inches long and up to 1 inch pitch can be threaded on the universal machine.

HYDRAULIC TRIPLEX PUMPS

The accompanying illustration shows a vertical type of single acting triplex hydraulic pump which has recently been added to the line of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Pumps of this type are made in three series of sizes which are known as the Series J, Series JJ and Series JJJ. The Series J pumps have a stroke of 8 inches and are equipped with plungers ranging in size from ¾ inch to 3¼ inches in diameter. The Series JJ pumps have a stroke of 12 inches and plungers ranging in size from 1 inch to 4½ inches in diameter. The Series JJJ pumps have a stroke of 12 inches and plungers ranging in size from 1¼ to



Hydraulic Style JJ Triplex Pump

5 inches in diameter. The pressure capacity is from 600 pounds to 16,000 pounds per square inch, depending upon the size of the piston. The pumps are either belt driven or equipped with individual electric motor drive. The J pumps require 25 horsepower to operate them; the JJ pumps require 50 horsepower, and the JJJ pumps, 100 horsepower. The effective speed of each of the three pistons is 33 1/3 feet per minute for the J pumps and 45 feet per minute for the JJ and JJJ pumps.

These pumps are fitted with screw glands working against followers when they are equipped for high-pressure work, or with stud glands when they are equipped with large pistons for low-pressure work. The pistons are packed with compression packing. Forged steel is used in the construction of the high-pressure pump cylinders and crankshafts. The cross-heads are guided and fitted with cast-iron adjusting shoes which are bored to provide a perfect guide. The connecting-rods are made of open-hearth cast steel and have bronze bearings with wedge and screw adjustments.

When these pumps are operated by belt, there is a single reduction of gears for the J pumps and double reduction for the JJ and JJJ pumps. The pulleys can be arranged to drive from either end. When motor drive is employed, there is a double reduction of gears for all sizes of pumps. The first reduction has a ratio of 5 to 1 and the second reduction depends upon the speed of the motor that is used. The height of the J pump is 5 feet 9 inches; of the JJ pump, 8 feet 1½ inch, and of the JJJ pump 8 feet 10 inches.

NEWMAN-COFFINGER DRILLING AND TAPPING MACHINE

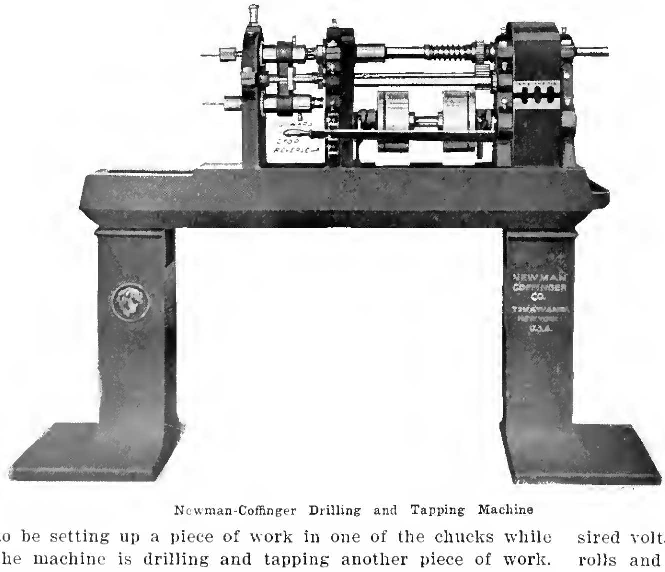
The combination drilling and tapping machine shown in the accompanying illustration is a recent product of the Newman-Coffinger Co., Tonawanda, N. Y. This machine is adapted for drilling, tapping, counterboring, hollow milling and similar operations. As two operations may be performed and the operator may be preparing another piece of work while the machine is so engaged, it will be evident that a high rate of production is attainable.

The method of operating the machine may be briefly described as follows: Assuming that one of the collets has been connected with the feed shaft, the operator shifts the drilling lever to the "forward" position. This connects the friction clutch with the forward driving pulley and starts the machine. The shaft upon which the driving pulleys and friction clutch are mounted transmits power to the spindle through a train of spur gears. Passing through the spindle there is a feed-shaft casing fastened to the spindle by a set-screw which slides in a groove to allow forward and reverse motion. The feed-shaft is fastened to the casing. This shaft is threaded at one end to provide for feeding the tool and there is a coupling at the other end which connects with the collets of the machine. The drilling and tapping spindles are bored No. 2 Morse taper.

The proper rate of feed is obtained by the train of gears previously referred to. The shaft upon which the clutch revolves has a driving gear keyed to it. This gear transmits power through an intermediate gear to the driven gear on the feed-shaft. The driven gear has a nut in it through which the threaded feed-shaft passes. When the hole has been drilled to the required depth the operator shifts the lever to the "reverse" position, which results in driving the machine in the opposite direction to back out the tool.

The turntable is actuated in the following manner: The feed-shaft passes through a neutral gear which becomes active when the direction of rotation of the machine is reversed. In this way the turntable is caused to revolve through one-half revolution, which is completed before the lever is shifted back to the forward position.

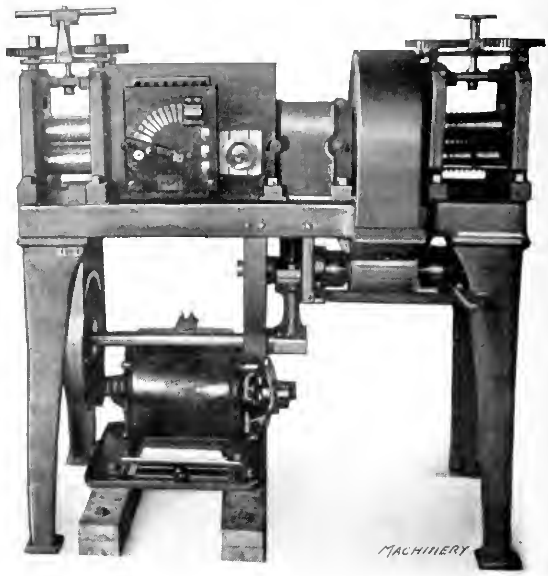
It will readily be seen that with the entire machine under instant control by means of a single lever, the operator would be idle during the time that the machine was working. To make use of this time, the turret tailstock is equipped with two work chucks. This makes it possible for the operator to be setting up a piece of work in one of the chucks while the machine is drilling and tapping another piece of work. When the drilling and tapping operation is completed, and while the machine is automatically reversing, the operator simply turns the turret around to bring the next piece into position to be machined. The machine can be built in various sizes and with either two or four collets. The work holding fixture is made to suit the requirements of the parts to be machined.



Newman-Coffinger Drilling and Tapping Machine

LEIMAN COMBINATION ROLLING MILLS

For use in rolling gold, silver, brass, copper and similar metals, Leiman Bros., 62 John St., New York City, have developed a combination rolling mill in which two sets of rolls are mounted in a single machine. The machine shown in the illustration is equipped with one set of rolls for flat work and one set for rolling wire, but machines may be equipped with two sets of rolls for flat work or two sets of wire rolls.



Leiman Combination Rolling Mill for producing Flat Work and Wire

Although these machines can be arranged for any form of drive, the most satisfactory method is that in which an individual motor is employed. Where this system is used the motor is mounted under the machine and provided with a rawhide pinion which meshes with the first spur gear. The power is transmitted to a second pair of spur gears and then through a pair of spiral gears to the driving shaft. The application of spiral gears in this machine is particularly important because the vibration would tend to take up the lost motion in spur gears and destroy the uniformity of the rotation of the rolls. This, in turn, would show itself on the work in the form of ripples. The frame and housings of the machine are of particularly rigid construction, reducing possibility of vibration to a minimum; and this precaution, in connection with the application of spiral gears, results in work of exceptionally good finish.

The ends of the driving shaft are squared and a sliding coupling fits over each of these squared ends of the shaft. These couplings are controlled by individual levers and may be slid over so that they connect with corresponding squared ends on the shafts which drive the rolls at either end of the machine. This arrangement makes it possible to operate both pairs of rolls at the same time, or to use either pair as required. The motor employed for driving the machine is of standard design and may be supplied in any desired voltage. For a machine equipped with one pair of flat rolls and one pair of rolls for rolling wire, the motor required to drive the machine should develop about 1½ horsepower.

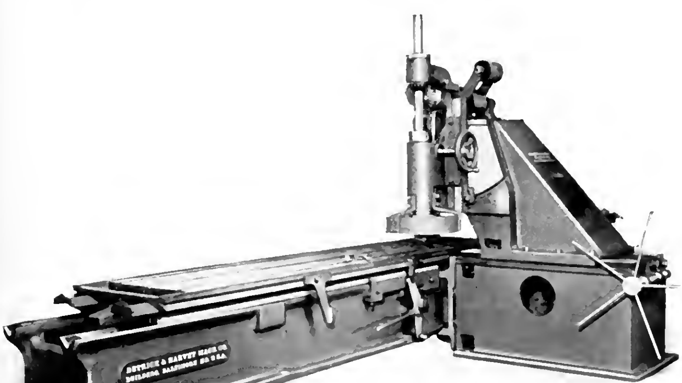
The rolls are made of a special steel which experience has shown to be suitable for this class of work, and the housings are equipped with bronze bushed bearings in which the rolls

run. A handwheel at the top of the housing at each end of the machine provides for adjusting the center distance between the rolls. The adjustment of either pair of rolls is secured by means of two screws which fit in tapped holes in the housings. When these screws are turned by means of the handwheel and gearing, yokes which fit over each end of the movable roll cause this roll to be raised or lowered as required. While both the flat rolls and wire rolls are provided with means of adjustment, it is not necessary to adjust the rolls used for producing wire. The spiral driving gear is located in the casing shown close to the wire rolls and the driving shaft which transmits power to the flat rolls is arranged with universal joints. The object of having the spiral gear close to the wire rolls is that the maximum adjustment for the flat rolls is made possible by this arrangement.

DETRICK & HARVEY GRINDING MACHINE

The grinding machine shown in the accompanying illustration is built by the Detrick & Harvey Machine Co., Baltimore, Md. This machine is particularly intended for edge grinding operations on safe and vault work but could be successfully employed in a variety of other lines. The table is 32 inches wide and gibbed down on one side to prevent it from tilting; the table speed is 24 feet per minute in both directions. The machine is belted to the countershaft and driven through a pair of bevel gears and a spiral worm engaging a rack on the under side of the table. The bed has two V-slides for the table, these slides being 21 inches between centers. It is planed on one side to provide a surface to which a sub-base is tongued and bolted. This sub-base is for the purpose of supporting the driving and belt shifting mechanisms.

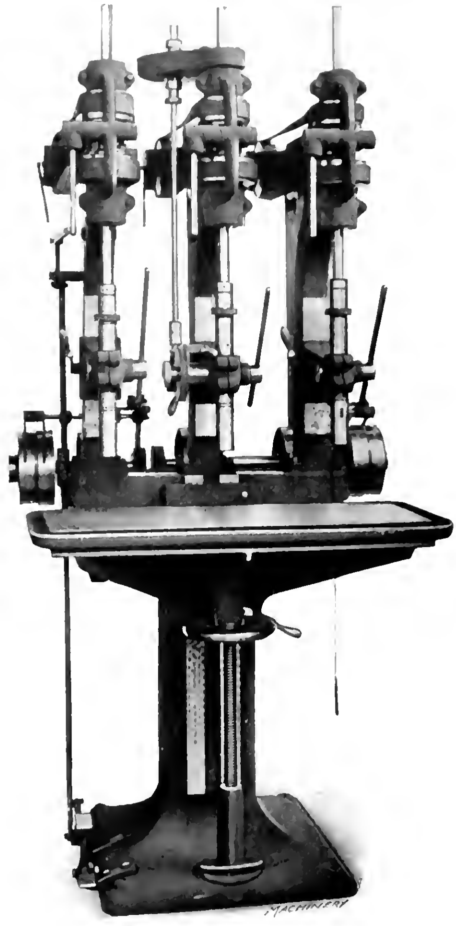
The spindle is 3½ inches in diameter and runs in a bronze bushed bearing, the bushing being tapered on the outside and provided with means of adjustment for wear. The spindle carries a grinding wheel 20 inches in diameter by 4 inches face width and runs at 600 revolutions per minute. Power is transmitted to the spindle through bronze and steel bevel gears, the power for driving the spindle being taken from the countershaft by an 8-inch belt. The spindle bearing has a vertical adjustment of 12 inches to provide for the proper alignment of the grinding wheel when the bearing is swiveled for angular grinding. This spindle bearing is clamped to a swiveling bracket which swings from a trunnion bearing through which the driving shaft revolves. A T-slotted plate is attached to the upright and the swiveling bracket is bolted to this plate. The upright is mounted on the top surface of the sub-base and can be adjusted either toward or away from the table. The adjustment is made by means of a handwheel and screw. The countershaft is of the hanger type and designed to run at 300 revolutions per minute when it is desired to operate the table at a speed of 24 feet per minute.



Detrick & Harvey Edge Grinding Machine for Safe and Vault Work

KERN BALL BEARING DRILL

The Kern Machine Tool Co., Hamilton, Ohio, is now building the three-spindle high-speed ball bearing drill press shown.



Kern High-speed Ball Bearing Drill Press

Several new ideas have been incorporated in the present machine. It will be noted that the left-hand head is equipped with a friction tapping attachment and that it may be operated by either a foot treadle or a hand lever. This arrangement enables the operator to use one hand to control the jig and the other hand to start and withdraw the tap. It will also be seen that the tapping column of the machine is provided with an independent backshaft which may be operated at 450 revolutions per minute. On the slow speed, this gives a tapping speed of about 300 revolutions per minute in addition to three higher speeds. At a tapping speed of 300 R. P. M. it has been found possible to tap cast-iron plates for ¼-inch gas pipe and produce a nice "full thread." The machine was also tested by tapping through a ¾-inch cast-iron plate with a ½-inch standard U. S. tap; and another test to which the machine was subjected consisted of tapping ½-inch flat steel bars with a ⅜-inch machine tap. Satisfactory results were obtained on all of these classes of work.

The middle spindle of the machine is provided with power feed. This feed mechanism is driven from the spindle by gearing which is fully enclosed, two changes of feed being provided—0.006 and 0.008 inch per revolution, respectively. The feed shaft comes down and is connected to the worm-wheel by hardened steel clutches; and a suitable trip lever is provided to either knock off automatically at any point to

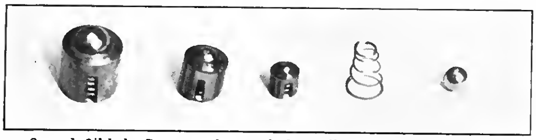
which the depth collar is set, or to be tripped by hand. In addition, the machine is provided with friction feed, the knurled nut at the left being used to engage or disengage the friction.

The right hand head is equipped with the standard hand feed mechanism used by the Kern Machine Tool Co., which is too well known to require detailed description. As each of the drilling heads are individual units, more than one head can be equipped with power feed if so desired. Experience has shown that it is advisable to locate the tapping attachment at the outside of the machine on account of the necessity of reaching it with the foot treadle. With this combination of heads on a single machine, it is possible to drill several small holes by hand while the power feed is employed for drilling a deeper hole. Then if there is any tapping to be done, the tapping operations may be performed before the work is taken from the machine.

OSGOOD OIL-HOLE COVERS

The J. L. Osgood Co., 43 Pearl St., Buffalo, N. Y., is now making a line of oil-hole covers, which comprises seven different sizes ranging from ¼ to ½ inch. Three of these sizes are shown in the accompanying illustration, together with one of the balls used to close the cover and the conical shaped spring which holds the ball in contact with the hole in the top of the shell.

A fairly good idea of these oil-hole covers will be obtained from the illustration. The cover consists of three parts—



Osgood Oil-hole Covers and one of the Balls and Retaining Springs

the brass shell which fits into the oil-hole, the ball which closes the hole at the top of the shell, and a conical spring which retains the ball in position. The hole in the shell is machined to form a close fitting bearing for the ball, and in this way it is insured that the ball will always return to its proper position after having been pushed down by the nose of the oil-can. The brass shell is split at the bottom so that there is a certain amount of latitude to permit the shell to adapt itself to the size of the oil-hole. The bottom of the shell is spun over to retain the spring in place.

WRIGHT PIPE WRENCH

The A. Harvey's Sons Mfg. Co., Ltd., Detroit, Mich., is now making an adjustable pipe wrench which is illustrated herewith. The important feature of this tool is its simplicity, and the fact that it can be instantly adjusted for any size of pipe which comes within its range without requiring the use of both hands. This wrench consists of three essential parts, which are the rocking jaw, the yoke or frame and the handle bar on which the fixed jaw is formed. These parts pivot on each other instead of on a rivet and it is

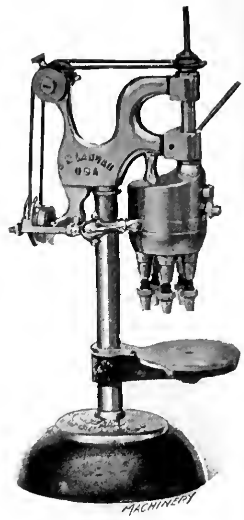
Wright Pipe Wrench made by A. Harvey's Sons Mfg. Co.

claimed that this construction adds very materially to the strength and durability of the tool. If any one part of the wrench is held stationary, the other two parts pivot about it and this action has led to the use of the name "planetary wrench" as applied to this tool.

To operate the wrench, the man takes it in his hand and places his thumb on top of the back strap of the yoke. While pressing his thumb down on the back strap, he pushes the yoke forward or back to adjust the wrench to the required size. In setting for a given size the jaws are opened wider than the point at which they are required to be. The tip of the stationary jaw is then put against the pipe and the rocking jaw is pulled back against the pipe on the opposite side. The thumb pressure is then released and the wrench drops into the proper adjustment. It is used in the same way as any other pipe wrench. At present, the wrench is being made with a 9-inch handle and a pipe opening up to 1 inch; and with 14- and 18-inch handles, with a maximum pipe opening of 2 inches.

LANDAU MULTIPLE CHUCK DRILL

J. N. Landau, 101 W. 117th St., New York City, has recently brought out an automatic multiple chuck drill shown in the accompanying illustration. This little machine has a capacity for handling drills ranging in size from a No. 70 up to ¼ inch in diameter, and reamers, counterbores, etc., of similar sizes. It will be seen from the illustration that there are five chucks in the turret. Tools required for performing successive operations on a piece of work are mounted in these chucks and can be rotated to bring them into the operating position. The multiple head of this machine may be attached to any drill press or the head may be set up in the tailstock of a lathe to serve as a turret attachment.



Five Spindle Landau Multiple Chuck Drill

The multiple head consists essentially of three parts—a stationary bonnet which is secured to the frame of the machine, a rotating turret in which are mounted any number of chucks up to ten, and the operating ring and handle which are used to rotate the turret. After any tool has finished its work the operator grasps the handle shown at the left-hand side of the head and pulls it around. The first movement of 15 degrees of the operating ring causes a cam to disengage the locking pin which holds the turret in any given position. As the ring continues to revolve, it pulls the turret around with it and the locking pin slips along until it registers with the next hole in the turret. The pin is pushed into this hole by a spring and locates the next spindle in the operating position. The operator then releases the handle, and the handle and ring are returned to the starting point by a spring.

Each of the spindles in the turret has a positive pin clutch at its upper end, and this clutch engages with a corresponding clutch member at the bottom of the machine spindle. The chuck in the operating position is the only one that rotates, so there is no waste of power in driving idle chucks. The arrangement of the drive will be evident from the illustration and the feed is obtained by the hand lever seen at the right-hand side of the machine. An eccentric adjustment is provided on the idler pulleys at the back of the machine so that the belt is lined up properly when changing from the fast to the slow speed or *vice versa*. This eccentric also provides a certain amount of adjustment for the belt tension. The mechanism is completely enclosed by the stationary bonnet and combines the features of strength and simplicity.

GARDNER NO. 1 DISK GRINDER

The Gardner Machine Co., Beloit, Wis., has recently added to its line of grinding and polishing machines the No. 1 disk grinder which is shown in the accompanying illustrations. Fig. 1 shows the floor type of machine which is equipped with disk wheels 12 inches in diameter, and with plain work tables. The spindle runs in ball bearings and is driven by a pulley 3 inches in diameter by 3¼ inches face width. The rocker shaft which supports the work tables is

1½ inch in diameter and 30 inches long. The floor space occupied by the machine is approximately 3 by 4 feet. The full equipment includes a countershaft, bench wheel-press, two extra disk wheels, an assortment of abrasive disks and the necessary glue and brushes for use in securing them to the wheels. The complete weight of the machine is 550 pounds.

Fig. 1. Floor Type of Gardner No. 1 Disk Grinder

Fig. 2 shows the same type of machine built for bench work. With the exception of the pedestal, this machine is of the same design as the floor type. The same equipment is furnished with both the floor and bench type machines.

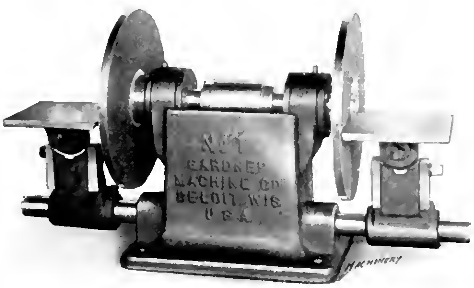


Fig. 2. Bench Type of Gardner No. 1 Disk Grinder

These No. 1 disk grinders are built with ball bearings and are particularly adapted for use in tool-rooms, assembling departments, model works, garages and other places where small work is handled which is required to fit closely.

BRISTOL ELECTRIC TACHOMETER

The field of usefulness of recording tachometers covers the application of these instruments in connection with engines, machinery and shafting, where information is desired in regard to the speed of rotation. Some of the most important applications of instruments of this type are on engines, turbines, generators, blast furnace blowing engines, motors and pumps. As recording tachometers are usually required for continuous service under ordinary shop or mill conditions, they must be made especially durable.

The Bristol Co., Waterbury, Conn., has recently brought out an A. C. electric tachometer which has been particularly designed to adapt it for use in industrial plants. Two of the most important features of this tachometer which make it suitable for the rough usage which such instruments receive in industrial work are, first: the application of the induction magneto; and, second: the voltmeter movement. The application of the induction type of magneto eliminates the use of sliding contacts or brushes and the indicating and recording instruments are voltmeters.

The indicating instrument is equipped with a Weston jeweled pivot bearing voltmeter movement, and the recording instrument is equipped with an improved Bristol voltmeter movement which is so designed that ample power is provided for actuating the recording arm, even though the pen is in continuous contact with the chart. The movement is mounted on frictionless knife edge bearings and equipped with a new supporting device for the moving elements, which eliminates the effect of changes of temperature. This recorder can be furnished for use with 6, 8 or 12 inch charts.

The accompanying illustration shows a combination indicating and recording instrument. The indicating instrument is for the use of the operator and the recording instrument is set up in the office of the superintendent or foreman. Suitable lengths of leads can be furnished for locating either instrument in any desired position. If so desired, connections can be furnished for more than two instruments. A simple form of this tachometer can also be furnished with either the indicating or the recording instrument as desired.

Bristol A. C. Electric Recording and Indicating Tachometer

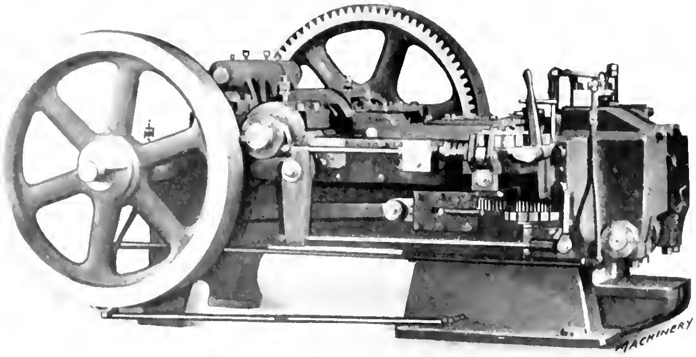
WATERBURY FARREL NUT MAKING MACHINE

To meet the demand for a large machine for use in the manufacture of nuts by the cold process, the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., is now building an automatic cold pressed nut machine which has a capacity for hexagon or square nut blanks ⅝ inch in size. The machine produces the blanks from bar stock and either hexagon or square blanks are finished complete, being chamfered and re-sheared and provided with a pierced hole ready for tapping, which is done on another machine.

In operating this cold pressed nut machine, one bar of stock follows immediately after another, with the result that it is unnecessary to stop the machine between bars and no short ends are wasted. In order to facilitate starting the stock into the ratchet driven feed rolls and between the straightening rolls, the latter are made with a quick adjustment for opening and closing them. In starting the stock it is necessary to have the end practically square before it enters the machine. This precaution guards against the possibility of breaking the punches. After the end of the

stock is between the open straightening rolls and gripped by the feed rolls, the straightening rolls are brought together by a lever. When the machine is working on bars of stock that are straight, the straightening rolls may be left open, as they are not required.

While the different operations performed in the machine are taking place, the tools are thoroughly flooded with lubricant which is pumped from the tank and delivered through a suitable system of piping and valves. The tank and pump constitute part of the regular equipment. As the lubricant



Waterbury Farrel Machine for making Nut Blanks by the Cold Process

flows away from the tools it is caught in a retainer and carried back to the tank. The scrap produced in making square nuts consists of the piercings and trimmings from the reshearing operation; and in making hexagonal nuts the scrap consists of the piercings, trimmings and the scalloping of the stock which is taken from the sides of the bars. The scrap is automatically separated from the finished blanks, the scrap falling into an iron pan and the blanks being delivered through a tube at the end of the machine. The machine illustrated in connection with this article is for making nuts ⅝ inch in size, but the Waterbury Farrel Foundry & Machine Co. also makes these machines for nuts ½, ⅜ and ¼ inch in size.

NATCO NO. 26 MULTIPLE SPINDLE DRILL

The National Automatic Tool Co., Richmond, Ind., has just added to its line of multiple spindle drills the No. 26 machine illustrated herewith. This is a much larger and heavier machine than the other sizes built by this company and was designed to meet the demand for a multiple spindle drill having a capacity up to 1 inch. It is built along simple and sturdy lines and ample power is provided to drive high-speed drills at their maximum efficiency, regardless of the speed.

It will be seen that single pulley drive is employed so that the machine may be belted direct to the line-shaft if so desired. However, it is a very simple matter to apply individual motor drive. The driving pulleys are of large diameter and wide face and are mounted on Hyatt roller bearings. The speed box is located at the top of the column of the machine and three changes of speed are provided by the sliding gear transmission. The gears, which are of coarse pitch and wide face, are hardened. Any one of the three available speeds is obtained by shifting the hand lever to one of the positions marked *A*, *B* and *C*. For each speed obtained from the speed box, two changes of speed may be made by means of gearing in the head. These changes are made while the machine is running.

The bearings in the speed box are also provided with high-duty Hyatt roller bearings which insure a high transmission efficiency. The speed box and feed box gears are provided with the cascade system of lubrication and a sight-feed oil glass shows the operator at a glance whether the pump is working properly. There are three independent drill feeds which permit the use of any feed with either of the three double drill speeds that are available in the head. All of the feed changes can be made while the machine is running. The feed box is located at the base of the column of the machine and the feed gears are of hardened steel. They are of large diameter and run at moderate speeds. It will be noticed that the cover of the feed box is provided with a small tray that is particularly convenient for holding tools.

The machine is mounted on a heavy base which is provided with an oil channel for catching the overflow. This channel has a screened pocket through which the cutting lubricant must flow to enter the tank from which it is pumped back to the tools. The pumps employed for oiling the machine and delivering cutting lubricant to the drills are independent of each other. When so desired, the base of the machine may be provided with T-slots.

Several sizes of heads can be used on this machine and these heads may be equipped with various combinations of adjustable spindles and cluster boxes for carrying drills ranging from ⅛ to 1 inch in diameter. The head used on the machine is provided with power feed and a pilot wheel to facilitate advancing or returning it easily and rapidly. The power feed may be tripped either automatically or by hand. Referring to Fig. 1, it will be seen that the head is counterbalanced by two chains that support a counterweight contained in the column of the machine, which is of box section. The spindles are made of special steel, hardened and ground and provided with ball thrust bearings at the lower end, and lock-nuts at the upper end to take up any end wear that may develop. The spindles are made to carry either straight shank or Morse taper shank drills, as required. Individual flexible oil tubes deliver the cutting lubri-

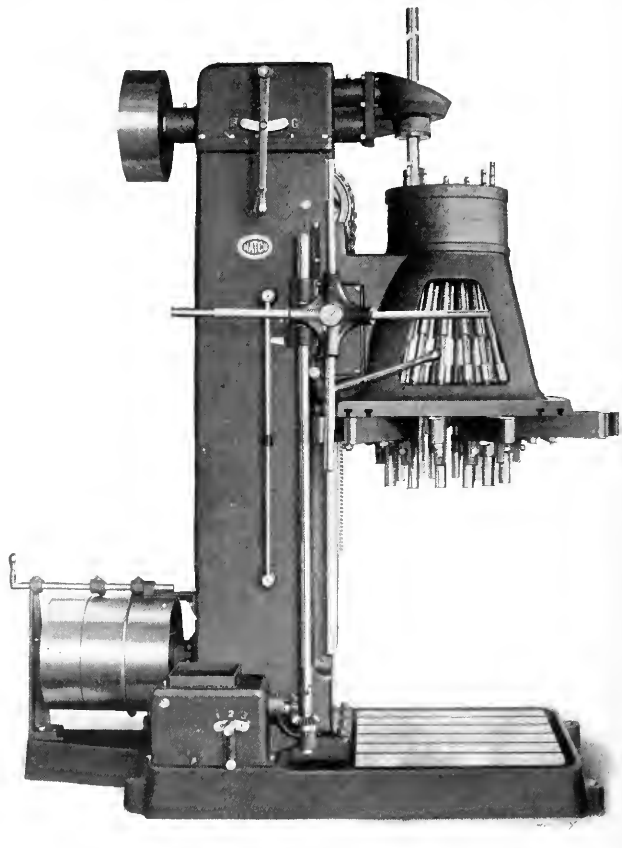


Fig. 1. The Natco No. 26 Multiple Spindle Drilling Machine

cant to each drill when the machine is working on steel or aluminum.

The bronze bearings which carry the drill spindles are provided with vertical adjustment to compensate for variation in the drill lengths. This adjustment is quickly and easily secured by simply loosening one nut which is always accessible, regardless of how close the spindles may be clustered together. This spindle adjustment—which is a patented construction—holds the bearing rigidly to the end of the arm, and the arm may be moved to cover any layout within the range of the head. The construction is illustrated in Fig. 2. In making the adjustment, it is only necessary to loosen the nut *A* as mentioned. This allows the steel beam *B* to rock on its fulcrum and loosen the bearing to provide for making the adjustment. The ball thrust bearing on this spindle is shown at *C* and the lock-nuts and washer for taking up end wear are illustrated at *D*. It will be seen that an oil chamber is provided in the bronze bearings in order to insure adequate lubrication of the spindles.

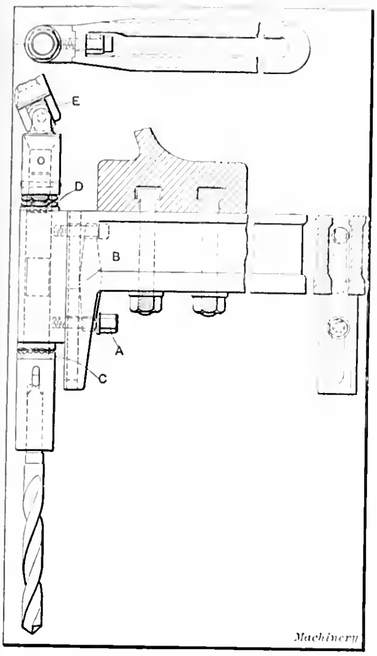


Fig. 2. Quick-acting Device for making Vertical Adjustment of Spindle Bearings

The universal joints used on the Natco multiple spindle drills are milled from the solid and carefully hardened. One of these joints is shown at *E* in Fig. 2. This is composed of only five pieces and does not depend upon a cross-pin that may be broken, or upon screws that may work loose. These universal joints are guaranteed to stand up for two years.

One of the most important features of this machine is the independent drill speeds in the head, which give two independent changes of speed to each spindle for each of the three changes of speed obtained in the gear box. It is well known that it is impractical to drive drills of different sizes at the same speed and feed per revolution, and the Natco independent drill speed feature gives approximately the correct speed and feed for each size of drill that comes within the range of the machine. For example, using ½-inch and 1-inch drills in cast iron, it is possible to secure a feed of 4.72 inches per minute. For this purpose the speed box lever is shifted to station *B* which gives 547 revolutions per minute or 71.5 feet per minute as the peripheral speed of the ½-inch drills which are fed at 0.0086 inch per revolution. By shifting the driving pinion in the head which drives the 1-inch drills these drills can be driven at 271 R. P. M. or 71 feet per minute, with a feed per revolution of 0.0174 inch per revolution. It will be noted from the preceding that the peripheral velocity of the drills in feet per minute is practically the same, while the feed of the ½-inch drills is only one-half as great as that of the 1-inch drill. Experience has led the National Automatic Tool Co. to believe that cone pulleys for driving and feeding machines of this type are unsatisfactory, while very gratifying results have been obtained with the powerful single pulley drive with geared feeds now employed.

* * *

More than 32,000 tons of aluminum was consumed in the various industries in the United States during 1913.

NEW MACHINERY AND TOOLS NOTES

Pinion Rod: Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J. The pinion rod recently placed upon the market by this company is made in any length and with the teeth either straight or helical, and of either regular or odd shape.

Baling Machine: Famous Mfg. Co., East Chicago, Ind. A machine for baling sheet metal scrap which is arranged for either belt or motor drive. The sides and ends of the box in which the material is pressed are built of rolled steel sections bolted together.

Sensitive Drilling Machine: Berghauser Machine Co., Cincinnati, Ohio. A sensitive single-spindle drilling machine equipped with a feed box which has a series of steel sliding gears running in oil. Nine changes of speed are provided, ranging from 225 to 1850 R. P. M.

Link Grinder: Newton Machine Tool Works, Inc., Philadelphia, Pa. A radius link grinder for finishing the slots in hardened locomotive links. For narrow slots and those with little end clearance, small wheels are used, while on larger sized links the entire face is ground at one time.

Milling Attachment: Cincinnati Pulley Machinery Co., Cincinnati, Ohio. A milling attachment for use on the lathe which is particularly adapted for the use of jobbing and repair shops. It will do various classes of work which are ordinarily handled on standard milling machines.

Drilling and Tapping Chuck: Victor Tool Co., Waynesboro, Pa. The collets of this chuck are driven by a key which is released when the sleeve of the chuck is raised. The tapping chuck is provided with an adjustable friction which may be set to the desired tension so that the drive will be released before the tap can be broken.

Baling Press: Logemann Bros. Co., Milwaukee, Wis. A hydraulic press for baling scrap brass, copper, aluminum, sheet steels, etc., into compact bundles ready to be remelted. These machines are built in three sizes. The pressure is obtained from a double system of hydraulic rams which compress the scrap in a covered box.

Radial Drill: Cincinnati Bickford Tool Co., Cincinnati, Ohio. A radial drill which is driven by a Westinghouse adjustable speed motor with the controller mounted on the head of the drill. Compressed air is used to bind the column and lock the arm in position, the air control lever being conveniently located for the operator.

Tapping Attachment: Hoefer Mfg. Co., Freeport, Ill. The reverse motion of this tapping attachment is either controlled by the hand lever or by an automatic trip secured to the front of the machine. The automatic trip is operated by the collar on the quill, which is set to reverse the tap when it has reached a predetermined depth.

Drill Chuck: Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y. In the October, 1912, number of MACHINERY the automatic Wahlstrom drill chuck for straight shank drills was illustrated and described. The company has now brought out a similar chuck, the design of which has been modified to adapt it for handling taper shank drills.

Sand-blasting Outfit: Carter Metals Cleaning Co., Philadelphia, Pa. A sand-blasting outfit which uses air at a pressure of from 80 to 100 pounds per square inch. The compressed air passes through the upper hose connection of the nozzle and the sand from the lower hose meets the air inside the head and is projected from a ¼ inch orifice in the nozzle.

Automatic Drilling Machine: Standard Mfg. Co., Bridgeport, Conn. This machine is equipped with automatic cam feed so that the operator has to simply load and unload the jigs. The cams are so timed that the drilling operations performed by the four spindles proceed progressively. Adjustment is provided for the depth of hole and the range of drilling.

Drilling Machine: Taylor & Fenn Co., Hartford, Conn. The important feature of this machine is the provision of safeguards which protect every part of the mechanism. The only possible way in which the operator could be injured is by putting his hand under the drill. This machine is known as the type C. Each spindle has independent automatic feed and quick return.

Combination Shear and Punch: Schatz Mfg. Co., Poughkeepsie, N. Y. A combination shear and punch which combines three separate units. The first of these is a plate shear for cutting plates of any desired length or width. The second unit is a punch for punching sheets, plates and structural shapes and the third unit is a shear for cutting structural material at right angles or on a miter.

Power Press: Max Ams Machine Co., Mount Vernon, N. Y. A line of double crank cutting and stamping presses which are adapted for handling a great variety of work for which machines of this type are used. The machines are made in four sizes with capacities of 15, 25, 50 and 100 tons, re-

spectively. Each size is made in a number of different widths between the housings, ranging from 24 to 120 inches.

Multiple Spindle Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A high-speed multiple spindle drilling machine in which each spindle has independent vertical adjustment controlled by an outside clamping screw. The drive is through helical gears which are enclosed in a case and immersed in oil. The main driving shaft slides up through the yoke or down through the head, thus economizing in overhead space.

Abrasive Wheel Cutting-off Machine: Nutter & Barnes Co., Hinsdale, N. H. In the December, 1910, number of MACHINERY, the abrasive wheel cutting-off machine of this company's manufacture was illustrated and described. This machine was equipped with a handwheel and screw for clamping the work in a V-block. This was a slow method and has recently been improved by the substitution of a lever-operated device which can be manipulated much more quickly.

Tapping Chuck: Cincinnati Bickford Tool Co., Cincinnati, Ohio. A tapping chuck designed for use in upright, horizontal or radial drilling machines, which are not provided with a tap leading mechanism. With this device, the danger of stripping the threads or reaming out the hole while drawing to start the tap is eliminated. The chuck consists of a driving spindle and a floating outer sleeve which have two rectangular ball bearings in place between them that drive the outer sleeve. The tap holder and tap are attached to this sleeve.

Screw Plates: Russell Mfg. Co., Greenfield, Mass. Two screw plates known as styles A and B, respectively. Style A plate is very simple to adjust, adjustment being accomplished by a single screw, while the die is in the stock ready for use. In the style B plate, the screw guide forces the beveled edges of the die against the beveled surfaces of the collet. As these beveled surfaces are identical in form, a combined screw and taper fit is effected which compensates for wear. The adjustment of the cutting size is accomplished by turning screws located back of the die.

Drilling Machine: Kern Machine Tool Co., Hamilton, Ohio. Two types of drilling machines. One of these is a tilting table machine on which the table may be swung to any angle. The table is rigidly held on the saddle by four bolts. The second machine is a heavy-duty drilling machine, the design of which combines a number of interesting features. There are nine changes of speed and eight changes of feed. Double back gearing is provided through gears which may be slid into engagement without stopping the machine. A feature of the machine is a ball thrust bearing under the bevel gear which is used to elevate the table arm.

Double Seaming Machine: Charles Leffler & Co., Brooklyn, N. Y. An automatic square double seaming machine primarily adapted for use in the manufacture of double seamed tin cans of the kind used in packing tobacco, talcum powder, etc. The machine is driven by a two-step cone pulley and friction clutch. The operator is merely required to place the can on the chuck and depress the treadle which causes the lower spindle to rise and engages the clutch, thus starting the driving shaft and the chuck spindle. The double seaming rolls are brought into action automatically while the can is making the required number of revolutions. The clutch is then disengaged automatically and the work is released.

* * *

OCCUPATIONS OF ENGINEERING GRADUATES

The College of Engineering of the University of Illinois has collected data relating to 2165 graduates in order to ascertain the branches of work in which they are engaged. It is of interest to note that 89 per cent are engaged in one way or another in engineering work, while 8 per cent have gone into other fields, the remaining 3 per cent having passed away. Out of every 100 engineering graduates of the University of Illinois, we thus find that 63 per cent are employed by corporations engaged in one way or another in engineering work; nearly 15 per cent have become architects; 6 per cent hold executive positions with engineering companies; 4.5 per cent are teachers in engineering colleges and nearly 1 per cent are consulting engineers. Of those engaged in non-engineering occupations, 2.4 per cent have turned to farming; 1.4 per cent are merchants; 0.9 per cent hold executive positions with mercantile companies; and a comparatively small number are lawyers, physicians, bankers, army officers, salesmen, real estate and insurance brokers and editors of non-technical journals. The percentages represented by these various occupations vary from 0.24 to 0.9 per cent.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The twelfth semi-annual convention of the National Machine Tool Builders' Association was held at the Hotel Bancroft, Worcester, Mass., April 23-24. The place of meeting was first fixed in New York City, but the fact that the convention of the National Metal Trades Association, whose membership includes some of the machine tool builders, was to be held in Worcester the same week, caused the management to make the change of place shortly before the meeting. That Worcester did herself proud in providing entertainment and accommodations was heartily conceded by all.

The meeting was called to order by President W. A. Viall of the Brown & Sharpe Mfg. Co., whose address of welcome sounded an optimistic note. He was confident that normal conditions of prosperity in the machine tool trade would be soon restored and counseled the members to plan for the future and take steps to improve manufacturing and selling facilities.

Charles E. Hildreth, the manager of the association, begged the members to respond to letters of inquiry and promised to see personally all of them in their places of business. He pleaded for more personal acquaintanceship and cordiality.

J. H. Drury, of the Union Twist Drill Co., reported the name of one new member, Williams White & Co., Moline, Ill. The committee report on standardizing grades of grinding wheels was a resumé of the factors to be considered and was decidedly discouraging as to the feasibility of establishing a uniform grading system. The number of abrasives, the sizes of grain, the varieties of bond and other factors to be considered make a vast number of possible combinations. That it will be possible to establish a system of grades which will be uniform for all makes of wheels seems doubtful.

Charles Fair, of the General Electric Co., presented an analysis of the conditions that must be met in standardizing electric motors for machine tools. This problem, too, seems difficult of solution, but something may be accomplished in establishing a near standard from which many differentiations of equipment must necessarily be expected.

The paper by J. C. Spence, superintendent of the Norton Grinding Co., "How Can We Induce Ourselves and Our Men to Earn More Money," was enthusiastically received and discussed. Mr. Spence got down to the fundamentals of personal relationship between employers and employes and pointed out how necessary it was to engender confidence of the men in the management to obtain the highest production. This paper will appear in a later number.

The afternoon of the first day was given over to committee meetings. In the evening a "Good Fellowship" dinner was given in the Hotel Bancroft which was attended by about 280. It was marked by no toasts or speeches, but a unique and most enjoyable entertainment was provided by talent of the Norton Grinding Co. The farce and minstrel show called "High Speed Steals," which concluded the evening, was received with uproarious applause.

Friday forenoon was given to committee meetings and the fourth session in the afternoon was occupied principally by an illustrated paper, "Safety as Applied to Grinding Wheels," by R. G. Williams, safety engineer of the Norton Co., and committee report on safeguarding grinding wheels.

The number registered in attendance to the convention was 169, which is more than was ever before registered at a semi-annual meeting.

* * *

The rack-and-pinion-type locomotives that haul cars to the top of Mount Washington, N. H., take water from a pipe along the track instead of carrying it in a tender. The water is pumped to the top of the mountain by duplex pumps near the base, which pump against a pressure of 2250 pounds per square inch. The pumps are located at 2540 feet above sea level and pump water to the summit at an elevation of 6280 feet. The pipe line to the summit is two inches in diameter and one-half inch thick for half its length and three-eighths inch for the remainder of the distance.

MAKING THE OSGOOD OIL-HOLE COVERS

The operations involved in making the Osgood oil-hole covers are interesting for two reasons: First, because the operations of turning and cross-slotting the brass shells, assembling the ball and retaining spring in place, spinning over the edge of the shell and cutting it off, are all performed in the turret lathe, without requiring the spindle to be stopped. Second, in developing this sequence of operations, a special cross-sawing attachment was designed for cutting the slot in the bottom of the brass shells.

The first operation consists of feeding the stock up to a stop, and the second and third operations are those of spotting, drilling and forming the seat for the ball. After the work has progressed to this point it must be slotted, and the cross-sawing attachment illustrated in Fig. 1 is used for this purpose. Referring to this illustration the barrel *A*, of which the flange *B* is an integral part, is screwed onto the nose of the turret lathe spindle. The four pins *C* which guide the plate *D* are secured in the flange *B*. The plate *D* is normally held in its outermost position by spiral springs *E*.

The tool *F* is clamped to the turret, the working parts of the tool being free to turn on the shank. The friction wheels *G* and *H* are carried by bearings at right angles to the turret-

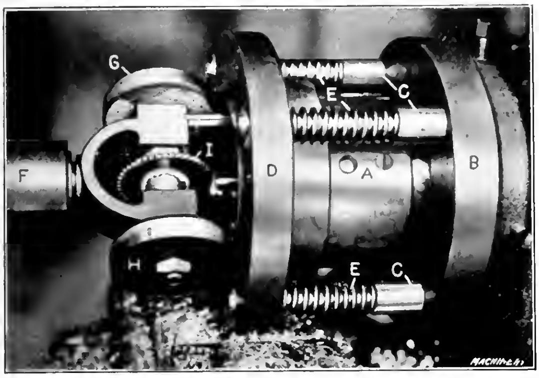


Fig. 1. Cross-sawing Attachment for slotting the Brass Shells

tool shank. These wheels are made to revolve through their contact with the plate *D*, which is revolved on the end of the lathe spindle. The friction wheel *G* simply acts as a balancing idler for the other wheel *H*. When the turret tool is brought up to the work, a lock on the turret tool engages a lock finger on the spindle nose attachment and causes the tool *F* to rotate in unison with the spindle. Pressure of the turret tool against the plate *D* causes this plate to move back

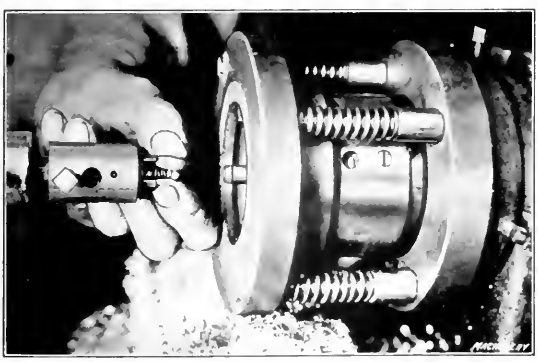


Fig. 2. Assembling the Ball and Spring in the Shell

against the tension of the springs *E*. At the same time the wheel *H* drives the saw *I* which cuts the slot in the brass shell.

After completing the slotting operation, the ball and spring are assembled, as shown in Fig. 2, and the edge of the shell is spun down to retain the spring in the shell. While this spinning operation is being performed, the slots in the shell are closed so that the work is not distorted. The cutting-off operation illustrated in Fig. 3 is next performed by operating the cam lever. This causes the cutting-off tools to move in and sever the completed oil-hole cover from the bar. As cut from the bar, the cover is ready for use and the time required to make a complete cover is about fifteen seconds. From this it will be readily seen that the operation of the slotting tool is quite rapid. The J. L. Osgood Co., 43 Pearl St.,

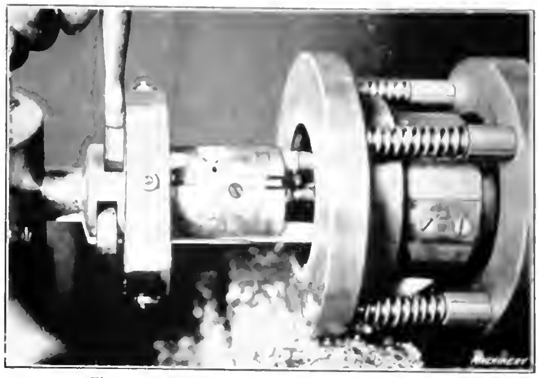


Fig. 3. Cutting off the Completed Oil-hole Cover

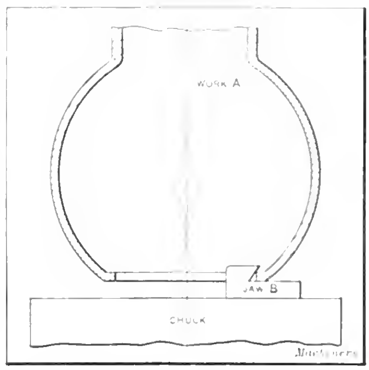
Buffalo, N. Y., is prepared to furnish the cross-sawing attachment described in this article to manufacturers who have turret lathe work for which it is adapted. The Osgood oil-hole cover is described in the New Machinery and Tools section of this number of MACHINERY.

* * *

HOLDING DEVICES FOR FIRST-OPERATION WORK

BY ALBERT A. DOWD*

Answering the criticism by F. H. Bullard in the February number of MACHINERY, regarding my article on "Holding Devices for First-operation Work" which appeared in MACHINERY for November, 1913, I wish to say that he is correct in regard to the expense of some of the fixtures shown. The first cost of a fixture is a minor item, however, in comparison to convenience and rapidity of operation when a large number of pieces are to be machined. Referring to the fixtures described in the article mentioned, it will be noted that Figs. 1, 2, 4, 5, 6, 7, and 10 are either component parts of an automobile or they are portions of accessories used in automobile construction. The smallest number of pieces in this group is 5000 and the largest 100,000 for a year's production. It must therefore be admitted that the first cost of the fixtures shown is a negligible item, when compared to the saving in time effected by their use. The manufacturer of today is looking for production first, last, and all the time, and he would not for a moment consider the use of a fixture which would involve any great amount of labor in setting the work in position, no matter how cheaply the fixture might be made.



Special Form of Jaw for Holding Ball Joint

Regarding Fig. 3, the fixture for which is rather harshly criticised by Mr. Bullard, the writer stated in the last paragraph describing this fixture that "a method of holding this work by the interior undoubtedly would have been more satisfactory," meaning some device similar to that shown in Fig. 6. Perhaps a slight explanation will make this matter somewhat clearer and will show why the device illustrated was used in this particular instance. A number of castings were sent by a foreign government, as sample castings for which

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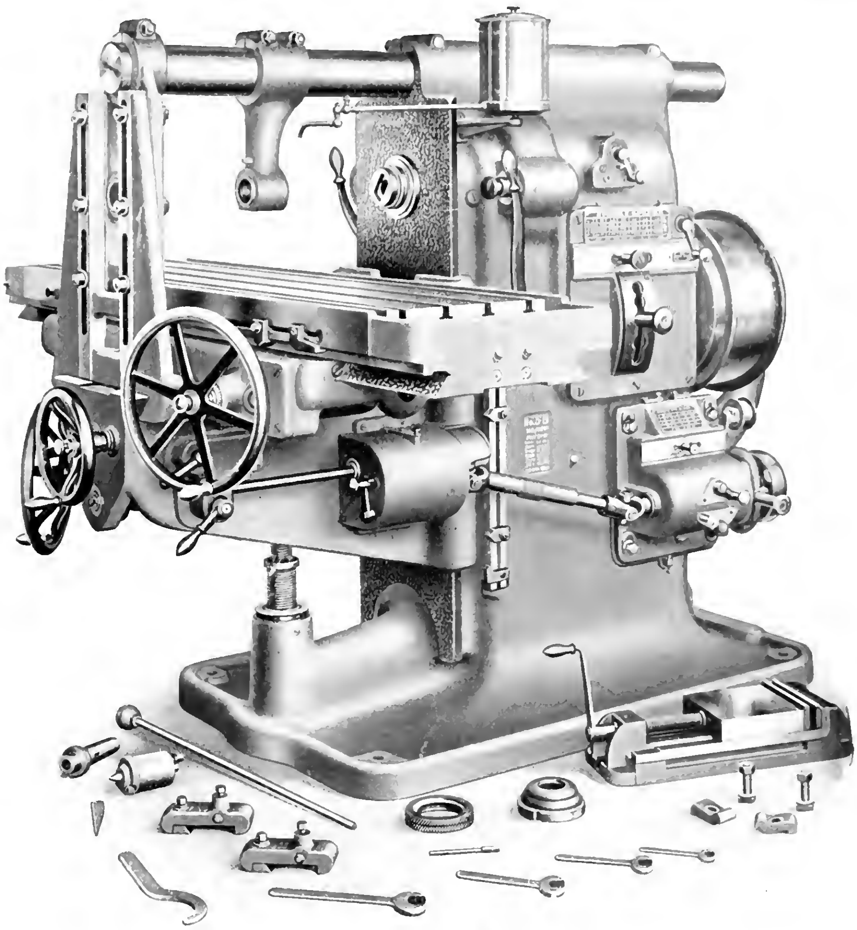

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The knee is efficiently clamped to the column from a single point at the front, saving time on shifting from roughing to finishing cuts.

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Gears which are often thrown into engagement have special pointed teeth so they always slip easily into mesh without bruising.

We should be glad to advise methods of handling your work.

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fixtures and tools were to be designed; and in view of the fact that the location of the plant to which machines and tools were to be sent was nearly half way around the globe, it is evident that it would have been out of the question to suggest changes in the pattern, as this would have necessitated a delay of two months at the very least. It will, therefore, be readily apparent that it was essential to handle the castings *just as they were*, without taking liberties with the design. The method suggested by Mr. Bullard of holding by the inside of a flange in a three-jawed chuck would hardly be practical on account of the narrow gripping surface provided for the jaws, unless these were of special design as shown at *B* in the accompanying illustration. This design would then have a tendency to crowd the work back against the face of the jaw so that it would be securely held. Even under these conditions, it is highly probable that there would be more or less "chatter," for with the method described in the original article there was a slight tendency to "chatter," although the manner of gripping was such as to prevent this to a great extent on account of the metal-to-metal holding method, which killed vibration of the casting to a considerable extent.

Regarding the use of the "bull center" as a support; this is obviously out of the question, as the casting is in the rough at the end where the center is used. This is used merely to approximate the cored center of the work while the hook-bolts are being tightened. Regarding the use of clamps for holding on internal lugs, as mentioned by Mr. Bullard, it would give the writer great pleasure to have the method fully described, showing how the clamps would be operated and set up firmly on the internal flange. This would be possible on a special fixture or by the use of a socket wrench for tightening, but I fail to see how the work could be centered by the plug at the same time. It would also be a difficult matter for the operator to see what he was doing, even if the work were set up on blocks to let in the light at the ball end of the work.

In connection with suggestions regarding desirable pattern changes, this matter can be very easily arranged when the factory designs the work for which it also makes the tools, but when an outside customer's castings are involved it is sometimes inadvisable to suggest changes, as a number of castings may be already on hand. The writer will not soon forget a pattern change which seemed desirable for chucking purposes, the work in question being a pot casting for a large automobile factory in the middle west. The suggestion was made and the answer came back: "10,000 castings on hand. Cannot change pattern." There was also an intimation that if we could not design a fixture to hold the work as it was, some other firm might be able to do so. Needless to say, the fixture was designed for the sample casting sent us, and nothing more was said about changing the pattern. It may be seen from this that it is not always wise to suggest changes, as some manufacturers do not take kindly to it. A knowledge of the number of castings on hand is valuable when changes are to be proposed and this information is not always available.

I fully agree with Mr. Bullard's statement that the "designer of any piece of machinery should not only be capable of designing mechanism that will perform the functions desired, but should so shape the various parts that they may be readily machined in ordinary machine tools with the least possible outlay for special equipment." I think, however, that he has not considered the matter from the point of view of the machine tool builder who is called upon to furnish machines and equipment for a great variety of work in which changes in patterns would not be permitted on account of the number of castings which might already be on hand. For this reason the writer does not quite see how he "has failed in just this respect," especially as the customers who received and used the devices illustrated were perfectly satisfied with them, and in several instances duplicated their orders within a short time after their receipt and trial. If this is a sign of failure, most of us would be glad to fail continually.

In regard to handling the larger ball joint shown, by either of the methods suggested by Mr. Bullard, I will say that as the weight of a single one of these castings would approximate 2300 pounds or something over a ton, it would be an expensive proposition to "scrap" one of them. Suppose there are two or three on hand which must be either machined in some way or "scrapped." It would undoubtedly be a difficult matter to hold the work with the flange side up, in any sort of standard equipment with which the writer is familiar. Neither a three- or a four-jaw chuck would have sufficient gripping surface to hold the piece securely unless very light cuts were taken. If, on the other hand, the work was held with the ball end up by means of clamps and dogs, then the second setting would present some serious difficulties in the matter of holding and driving. Again, supposing that it was permissible to change the pattern, as suggested, before any castings had been made, the jaws could then be brought up on the inside and additional screw dogs used to assist in driving. How could the screw dogs be tightened unless a special wrench were provided? And even then it is doubtful whether the work could be held securely. The fact of the matter is that so little frictional surface can be obtained on the ball end (due to its shape) that some sort of a seat which will conform to the shape of the casting is needed in order to provide the necessary surface. The use of ordinary clamps would be difficult and would be open to the same objections as those already mentioned. A set of cast-iron blocks could be bored out in position on the table of the machine and clamps used to draw the casting down upon them, thus providing frictional surface enough to hold the work, but even if this were done the clamping would be attended with some of the difficulties previously referred to.

In conclusion I will say that I believe the method shown in Fig. 12 is thoroughly practical and not excessively expensive in spite of the adverse criticism regarding it. Sketches illustrating the exact method proposed by Mr. Bullard would be greatly appreciated and would perhaps make clear some of the points which at present do not seem entirely logical or practical.

* * *

NOMENCLATURE OF ALLOYS

A committee of the Institute of Metals which was appointed in 1912 to report upon the question of the nomenclature of alloys has presented a report embodying its first series of recommendations. The work has been approached in a practical manner and the demands of industry and commerce have been borne in mind. It has been attempted to adhere, as far as possible, to existing names sanctioned by long usage, to avoid coining new names or adopting recently coined names, and to employ simple English names throughout. The committee has, in the first instance, confined its attention to the alloys of copper, and the terms defined in the report are "brass" and "bronze." When the word "brass" alone is used, it denotes an alloy of zinc and copper only, containing over 50 per cent of copper. When an alloy containing a third metal, such as tin, is to be denoted, the name of the additional element should be used as a prefix; thus, an alloy containing 1 per cent of tin, 29 per cent zinc, and 70 per cent copper would be called "tin-brass." The word "bronze" denotes an alloy of tin and copper containing more than 50 per cent of copper, additional metals being denoted as above. These two names represent by far the most widely used alloys, and the general adoption of the terms thus defined would do much to remedy the state of confusion which exists at the present time.

* * *

A material called "elianite," which has been produced in the electric furnace by Dr. C. Rossi, manager of a nitrate acid works at Legnano, Italy, is claimed to be proof against all acids. This material has about 75 per cent of the tensile strength and from 25 to 75 per cent of the compressive strength of cast iron. Its hardness is about 60 per cent greater than that of cast iron and its melting point is 2500 degrees F. Elianite can be cast and is suitable for use in large apparatus used in the acid-producing industries.

EFFICIENCY TEST OF A STOCKBRIDGE SHAPER

In connection with the experimental engineering work of the Worcester Polytechnic Institute, Worcester, Mass., tests were recently conducted with the view of determining the mechanical efficiency of a Stockbridge shaper and also the number of cubic inches of metal which the shaper was capable of removing for each horsepower hour of power supplied to the tool. For this purpose, it was necessary to equip the shaper with a special table upon which the dynamometer was mounted. The shaper equipped in this way is shown in Figs. 1 and 2 and Fig. 3 is a chart showing the results of the test.

The work upon which the tool was engaged during the test was held in a special chuck. This chuck had to be carefully lined up with the direction of travel of the tool in order that the full pressure might be applied to the dynamometer. The first table which was used to support the dynamometer was a little wider and considerably longer than the regular table of the shaper. This arrangement left a large part of the auxiliary table unsupported, with the result that vibration was set up which would have materially affected the accuracy of the results obtained. Several methods of overcoming this difficulty were considered, such as the use of a supporting chain secured to the ceiling. A number of people in the shop, who had not given the matter careful attention, suggested the use of jack-screws, overlooking the fact that the cross-feed of the shaper table was used during the conduct of the test. The difficulty was finally overcome by modifying the design of the table to reduce its length and the amount of overhang, with the result that vibration was eliminated.

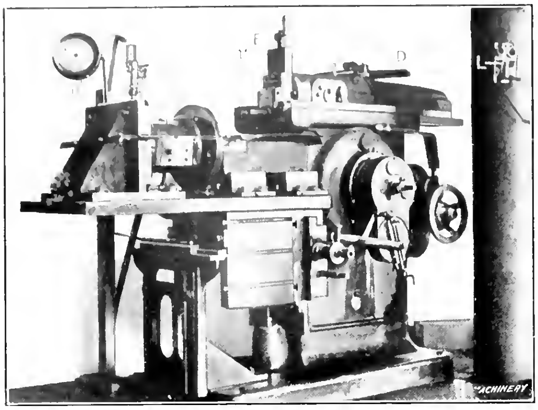


Fig. 1. Stockbridge Shaper equipped for conducting an Efficiency Test

The form of dynamometer *A* finally adopted for measuring the effective pressure of the tool consisted of a cylinder and piston, the cylinder being partially filled with oil. This simple though accurate dynamometer was used in connection with a pressure gage *B* and steam engine indicator *C*, as shown in Figs. 1 and 2. No calibration tests were necessary and it was a very simple matter to refill the cylinder with oil without admitting any air. This was done by removing the indicator, compressing the oil in the cylinder until it commenced to flow out, and then slowly drawing the piston back and pouring oil in rapidly enough to keep the cylinder filled at all times. The indicator was attached to the dynamometer cylinder in the same way as in the cylinder of a steam engine, and indicator cards were taken to determine the mean effective pressure. The results obtained were more accurate than those that could have been secured by reading the gage, as the latter fluctuated considerably, owing to variations in the hardness of the cast iron operated upon. A pantograph *D* was used as a reducing motion for the indicator and another difficulty was experienced in connection with this part of the apparatus. The indicator moved with the table when the cross-feed was in operation, and if the length of the indicator cord were adjusted when the table was in one extreme position, it would have been out of adjustment when the table was fed over two or three inches. Therefore a hook was fastened to the cord about 2 feet from the indicator, and instead of having one loop on the end of the cord attached to the pantograph, a number of small rings *E* were tied to the cord at intervals of 1 inch. It was then merely necessary to secure the hook to any one of these rings that gave the proper length of cord while a card was being taken.

One more difficulty experienced in connection with the dynamometer was that of providing means for rotating its piston to overcome the effect of static friction, the reason for taking this precaution being the same as that which leads one to spin the piston of a dead weight gage tester. The first method that was tried consisted of wrapping a wire around the piston rim, with one end terminating in a heavy weight and the other end carried over a series of pulleys and secured to the cross-feed reciprocating motion. This was a failure for three reasons: First, the sharp turns over the pulleys eventually caused the wire to break, and cord of any kind could not be used because it stretched; second, the reversal of the direction of motion of the cross-feed being slow, there were periods when the turning motion imparted to the piston was not active; third, the power required to rotate the piston could not be measured and so could not be considered in the results of the test. The next method that was considered consisted of placing a small pulley on a shaft directly above the dynamometer and carrying a belt from this shaft to the countershaft. A second belt from this intermediate shaft was connected to the rim of the piston *K*, in this way causing the piston to be rotated at a suitable speed. This rig would have required a considerable amount of time to set up and was replaced by a method which proved entirely satisfactory. This consisted of taking power from the platen of a planer *F* which moved at right angles to the shaper ram, to rotate the dynamometer piston. The mechanism employed for this purpose consisted of a piece of flat steel *G* bent to the shape shown in Fig. 2. One end of this link was bolted across the planer table and a straight flat link *H* was secured to the other end by means of a pin joint. The opposite end of this link was connected to a flat link *J* secured to the rim of the piston *K* by means of another pin joint. By running the planer on short stroke, the desired rolling of the piston was accomplished in a very satisfactory manner.

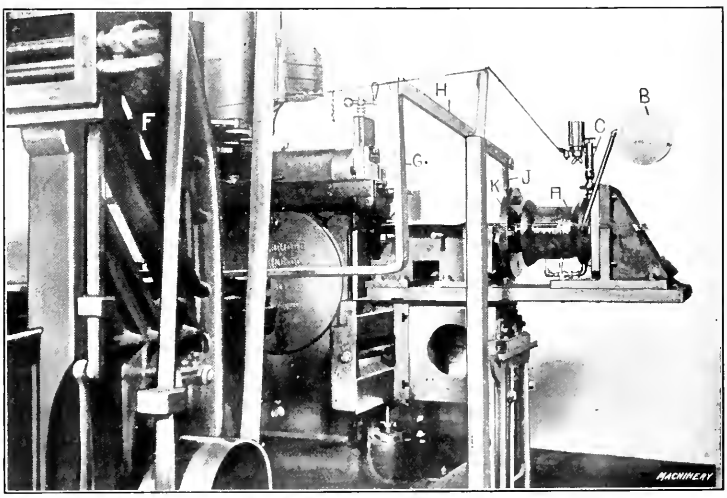
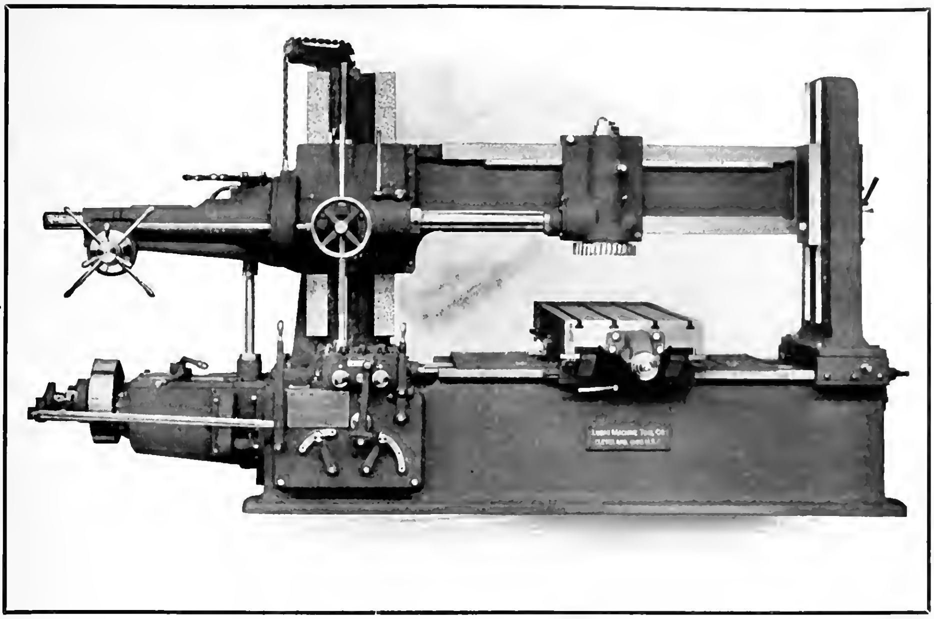


Fig. 2. Apparatus used for rotating the Dynamometer Piston

The shaper was driven by a 7½-horsepower direct-current Westinghouse motor, which was run at 975 revolutions per minute and belted to the shaper by a 3-inch double belt. The motor operated on 31 amperes at 220 volts. The center dis-



tance between the motor and shaper pulleys was 11 feet and the shaper pulley was of a size to run at 300 revolutions per minute. A brake test of the motor was made to determine its efficiency.

The integrating watt meter used to determine the power supplied to the motor was intended for a 110-volt circuit and the motor for 220 volts. Therefore, the necessary resistance was connected in series with the resistance already in the meter, so that the power in a 220-volt circuit could be measured after the meter had been calibrated to determine a new constant. The constant determined in this way was checked while the brake test of the motor was being made. The meter was so connected that it could be switched in or out without requiring the motor to be stopped, the switch L being provided for this purpose.

After preliminary tests had been made, it became evident that a more solid foundation than is ordinarily required for

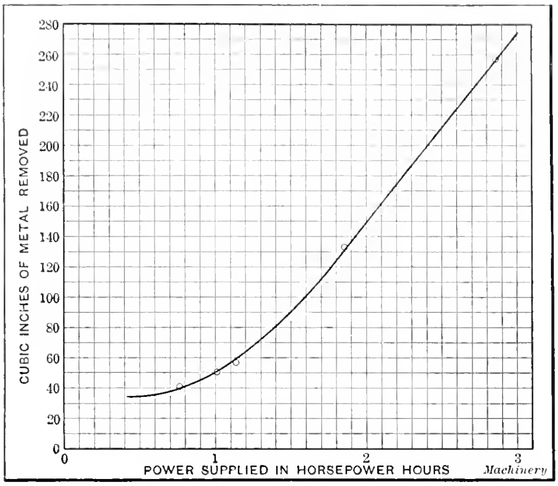


Fig. 3. Chart showing Relation of Horsepower Hours to Cubic Inches of Cast Iron Removed

a shaper was absolutely necessary if accurate results were to be obtained. The first foundation employed was not satisfactory, so a planer was moved in order to obtain the support of the brick piers under it, and the shaper set up in its place. Wedges were driven between the top of the piers and the beams to which the flooring was nailed and the shaper fastened in place by four ⅝-inch lag screws. The foundation provided in this way was perfectly rigid and enabled very satisfactory results to be secured.

The power supplied to the shaper was determined in the following manner. The total electrical power supplied to the motor during the test was recorded by means of the integrating watt meter and a brake test was made to obtain a curve of the watts-input to the motor as compared with brake horsepower. There was evidently a power loss in the belt drive but owing to the impossibility of reproducing the conditions of loading, a belt test was out of the question. Therefore this loss was assumed to be 4 per cent of the power at the motor pulley and a new curve was plotted, taking this belt loss into consideration. This gave the watts-input against horsepower delivered to the shaper pulley.

The power expended at the tool point was measured as follows: The pressure of the tool point against the work was obtained from indicator cards which, theoretically, should be rectangles. Owing to variations in the hardness of the cast iron, however, the upper part of the cards varied in height. The mean effective pressure in pounds per square inch was obtained from the cards, and knowing the area of the piston to be 20 square inches, the total force was calculated. The number of strokes per minute were recorded and also the duration of the test. This gave the force, the distance and the time, from which the horsepower was figured. For a given depth of cut and cross-feed, a number of short tests were made because five minutes was sufficient to feed the tool across the work. Therefore, at the beginning of a test the time was noted and the meter switch thrown in. Just before finishing the cut, the switch was pulled and the exact time noted. After completing such a test another cut of the same depth and cross-feed would be employed for a subsequent test, the operation being repeated until enough power was registered on the meter to insure accurate reading of the dials. The mechanical efficiency of the shaper was obtained by dividing the power expended at the tool—as determined by the dynamometer—by the power supplied to the machine by the motor. The number of cubic inches of metal removed was figured, and knowing the number of horsepower hours, the number of cubic inches removed per horsepower hour was figured. The results of this part of the test are shown in Fig. 3.

* * *

NATIONAL METAL TRADES ASSOCIATION CONVENTION

The sixteenth annual convention of the National Metal Trades Association, held at the Hotel Bancroft in Worcester, Mass., April 20-22, was one of the most successful in point of attendance ever held. The registration of members and others attending was 294, a number considerably larger than that registered at the last New York meeting. President W. A. Layman of the Wagner Electric Mfg. Co., St. Louis, Mo., presided, assisted by John D. Hibbard, the commissioner succeeding Robert Wuest, who had so ably conducted the affairs of the association for years. The report on industrial education by F. A. Geier was discussed by C. A. Prosser of the National Society for the Promotion of Industrial Education, Louis H. Buckley of the Worcester Independent Industrial Schools, and W. B. Hunter, who presented the Fitchburg plan of industrial education.

W. H. Van Dervoort presented a report on industrial accidents which was discussed by M. W. Alexander and W. H. Doolittle. The cause of accident prevention is growing and the movement is being greatly accelerated by educating the workmen to use their intelligence in avoiding dangerous acts. Justus H. Schwack of William Sellers & Co., Inc., Philadelphia, Pa., discussed the general subject of publicity.

The program for Wednesday forenoon and afternoon comprised "Results of Applied Scientific Management," by George D. Babcock of the H. H. Franklin Mfg. Co., Syracuse, N. Y.; "Basic Principles of Industrial Organization," by Prof. Dexter S. Kimball, Sibley College, Cornell University; "Work of the Bureau of Foreign and Domestic Commerce and the Plans of the Department for Its Development," by Albertus H. Baldwin, chief of the Bureau of Foreign and Domestic Commerce, Washington, D. C.; "Labor Legislation," by Walter G. Merritt, American Anti-Boycott Association, New York City.

The following officers were elected: President, Herbert H. Rice, Waverly Co., Indianapolis, Ind.; first vice-president, L. H. Kittredge, Peerless Motor Car Co., Cleveland, Ohio; second vice-president, George Mesta, Mesta Machine Co., Pittsburg, Pa.; treasurer, F. C. Caldwell, H. W. Caldwell & Son Co., Chicago, Ill.

The convention was closed with a banquet in the evening at the Hotel Bancroft, attended by over 250, at which W. A. Layman was toastmaster. Dr. J. Lawrence Laughlin of the University of Chicago and Dr. W. H. P. Faunce, president of Brown University, made the addresses of the evening.

* * *

Filing machines, while designed primarily for filing the clearance in dies, are used advantageously for lapping and filing parts to size. One well-known maker of drafting instruments employs filing machines for reducing German silver parts to size and shape. The parts are held in simple jigs and a boy runs the machine, moving the jig up to a stop and sliding it along until the work is finished. The filing machine is required to remove but little material and is especially advantageous on such work. The parts could not be held firmly enough to be milled without marring and distorting them, and the amount to be removed would make a milling operation almost absurd even if it were practicable. The same type of filing machine is used in armories for filing gun sights and similar parts.

PERSONALS

W. H. Sherman has been made superintendent of the W. P. Davis Machine Co., Rochester, N. Y.

Ralph E. Flanders has been made manager of the Jones & Lamson Machine Co., Springfield, Vt.

N. K. B. Patch has been appointed superintendent of the Lumen Bearing Co.'s plant at Buffalo, N. Y.

H. P. Parrock, manager of the Lumen Bearing Co., Buffalo, N. Y., has completely recovered from his recent illness.

J. B. Slagle, who worked in Harrisburg, Pa., and Muskegon, Mich., is requested to communicate with the Lyons Machine Works, Lyons, Iowa.

F. H. Brown, formerly sales manager of the W. P. Davis Machine Co., Rochester, N. Y., has been made secretary and treasurer of the company in place of C. F. Davis, who has resigned.

A. S. Baldwin, formerly general manager of the Alberger Pump & Condenser Co., Newburg, N. Y., has resigned his position, and will become manager of works of the Best Mfg. Co. of Pittsburg, Pa.

Leroy M. Curry, who was with the Aurora Automatic Machinery Co., Chicago, Ill., as tool designer, has resigned and taken a similar position with the Wood Turret Machine Co., Brazil, Ind.

Robert Wilde has resigned as superintendent of the gear department of the Warner Gear Co., Muncie, Ind., to become a consulting gear engineer. Mr. Wilde will give his attention to all classes of gear work.

Ludwig Swenson, for several years in the special machinery department of the Barber-Colman Co., Rockford, Ill., has been made secretary and general manager of the Rockford Lathe & Drill Co., Rockford. C. W. Holmquist, who formerly held this position, has resigned to take charge of his coal and lumber business.

Walter C. Allen has been elected vice-president of the Yale & Towne Mfg. Co. Mr. Allen has been general manager of the company for the past five years, and as such, has had charge of the sales policy and management in all departments of the business at home and abroad excepting the bank lock department. As vice-president and general manager, he will continue to perform the same duties as heretofore.

Frederick L. Hickok, formerly sales manager of the Ingersoll Milling Machine Co. of Rockford, Ill., has joined the staff of MACHINERY, and will devote his time to field service work for advertisers, cooperating particularly with them for the development of business. Mr. Hickok was born in Ashtabula, Ohio. He is a graduate of the Case School of Applied Science, Cleveland, and has an all-around mechanical experience that especially qualifies him for the line of work he has taken up.

* * *

OBITUARIES

John S. McLean died of pneumonia at his home in Readville, Mass., March 26, aged fifty-four years. Mr. McLean had been in the employ of the Prentiss Tool & Supply Co. at its Boston branch as selling representative for twelve years. He was a man of estimable character, well and favorably known in the machine tool trade.

COMING EVENTS

May 1-October 31.—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

May 19-20.—Annual convention of the International Association of Manufacturers, at the Waldorf-Astoria Hotel, New York City. George S. Boudinot, 30 Church St., New York City, secretary.

June 10-12.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

June 16-19.—Spring meeting of the American Society of Mechanical Engineers, Minneapolis and St. Paul, Minn. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

June 30-July 4.—Annual meeting of the American Society for Testing Materials, Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 15-22.—Second International Congress of Consulting Engineers, to be held in Berne, Switzerland.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. 1914 catalogue. 56 pages, 6 by 9 inches.

Northwestern University, Chicago, Ill. Annual catalogue 1913-1914. 485 pages, 6 by 9 inches.

Syracuse University, Syracuse, N. Y. Bulletin of the university for March, 1914. 503 pages, 5½ by 8½ inches.

Beloit College, Beloit, Wis. Beloit College bulletin for March, 1914, being the sixty-seventh annual catalogue issued by this institution. 168 pages, 5½ by 8 inches.

University of Vermont and State Agricultural College, Burlington, Vt. Catalogue for 1913-1914 and announcements for 1914-1915. 260 pages, 5¼ by 7¾ inches.

Columbia University, New York City. Bulletin containing announcements of the summer session which extends from June 3 to September 23. 175 pages, 6 by 9 inches.

Armour Institute of Technology, Chicago, Ill. Bulletin for May, 1913, containing general information on the calendar, curriculum, etc., of the institute. 192 pages, 5¾ by 8½ inches.

Massachusetts Institute of Technology, Boston, Mass. Bulletin containing 1914 reports of the president, treasurer and other administrative officers. 142 pages, 5¾ by 8¾ inches.

Rensselaer Polytechnic Institute, Troy, N. Y. Rensselaer Polytechnic Bulletin for December, 1913, giving general information on the undergraduate and graduate courses and student organizations.

University of Wisconsin, Madison, Wis. An engineering experiment station has been created by the board of regents. The organization will be established in the College of Engineering and will have general charge of the testing and research work of the college. The staff of the station will consist of the dean as director, and the members of the instructional staff in the various departments of the College of Engineering. In addition to these will be fellows, scholars and assistants who may be engaged in experimental and research work.

Department of Education, City of Waterbury, Waterbury, Conn. Form 51-B, giving information concerning the continuation school for machine shop apprentices. Apprentices from the various shops are eligible to membership provided their employers insist that they comply with all rules and agree to pay them while in attendance at the school. The subjects covered during the four years course are: shop mathematics, reports and discussions of special topics, articles from trade journals, etc., shop talks, history and civics, hygiene, drawing, mechanics and strength of materials.

Tri-state College, Angola, Ind. Annual catalogue 1913-1914. 125 pages, 5¼ by 7¾ inches. The Tri-State College comprises three branches, viz., the Tri-State Normal College, the Tri-State College of Pharmacy and the Tri-State College of Engineering. The college of engineering offers courses in civil, electrical and mechanical engineering, each of which requires but two years for graduation. A student may enter with an ordinary common school education. In addition to the regular courses, special courses are given in shop practice, wood, bench and lathe work, patternmaking, foundry work, forging, and tool-making.

Pratt Institute, Brooklyn, N. Y., holds its annual exhibition Thursday, April 30, from 2 P. M. to 10 P. M.; Friday, May 1, from 10 A. M. to 10 P. M., and Saturday, May 2, from 10 A. M. to 5 P. M. The exhibition is open to the public and a cordial invitation is extended to all interested in industrial and technical education. The students will be engaged at their regular work and an opportunity will thus be afforded to visitors to inspect the methods, equipment and general facilities of the school as well as the work of the students in the various courses. The School of Science and Technology should prove of special interest to men engaged in technical and trade pursuits. This school provides instruction in applied mechanics and machine design, applied electricity, applied chemistry and tanning, machine work and tool-making, carpentry and building, patternmaking, plumbing, foundry and forge work and sheet metal work.

University of Wisconsin, Madison, Wis. The demand for professionally-trained mechanics to teach in industrial schools has led the regents to create fifteen industrial scholarships. Each scholarship carries with it a special honorarium of $40 and the holders are to be organized into a mechanics' institute. The purpose of the institute, which will be held on the campus of the university from March 9 to April 9, will be to give intensive practice in special lines of shop work and drawing, and to give a detailed consideration of organization and teaching problems that confront industrial schools. The need for such an institute is manifested by the fact that men enrolled in the special industrial and trade teachers' courses given in Milwaukee and in Madison by the university for mechanics interested in teaching, have in many instances been urged to accept appointments to teaching positions before completing their preparatory work.

NEW BOOKS AND PAMPHLETS

Mechanical Drawing, Part I. Third revised edition. By Oscar E. Perrigo. 44 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

Mechanical Drawing, Part II. Third edition. By Oscar E. Perrigo. 44 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

Report of the Director of the Bureau of Mines for the Fiscal Year ended June 30, 1913. 118 pages, 5¾ by 9 inches. Published by the Bureau of Mines, Washington, D. C.

Gage Making and Lapping. MACHINERY'S Reference Book No. 64. Second Revised Edition. 40 pages, 6 by 9 inches. 39 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Tariffs on Machinery, Machine Tools and Vehicles. Published by the Bureau of Manufactures of the Department of Commerce and Labor, Washington, D. C., as No. 3 A of the Tariff Series. 34 pages, 6 by 9 inches.

Industrial Research in America. By Arthur D. Little. 23 pages, 6 by 9 inches. Reprinted by Arthur D. Little, Inc., chemists and engineers, Boston, Mass., from the "Journal of Industrial and Engineering Chemistry," October, 1913.

The Law of Patents for Designs. By William L. Symons. 300 pages, 6 by 9 inches. Published by John Byrne & Co., Washington, D. C. Price $3.

This work was prepared with particular reference to the practice obtaining in the prosecution of applications for design patents in the United States Patent Office as shown by the rules and decisions. It treats of the Design Patent Statutes; Subject Matter for Design Patent; Inventions; Novelty and Infringement; Applications and Letters Patent; and Procedure in the Patent Office.

Hydraulics. By Ernest H. Sprague. 184 pages, 4½ by 7¼ inches. 89 illustrations. Published by Scott, Greenwood & Son, London, England, and sold in the United States by D. Van Nostrand Co. New York City. Price $1.

This work was compiled chiefly from the author's lecture notes at the University Club, London. The aim has been to present the subject in a concise and useful form. Many examples illustrating the principles are given and the answers have been carefully checked. The work would appeal particularly to those studying at home were it not for the fact that the author has used the calculus quite freely. The contents by chapter heads are: Introduction and the Principles of Fluid Pressure; Liquids in Motion; Discharge through Orifices, Weirs, etc.; Flow in Pipes and Channels; Pressure of Water and Application to Motors; Pumps, Miscellaneous Examples; Useful Data; Mathematical Tables.

The Steel Foundry. By John Howe Hall. 271 pages, 6 by 9 inches. 37 illustrations. Published by the McGraw-Hill Book Co., New York City. Price, $3.

This book deals with the metallurgy of the steel foundry from the point of view of the engineer. It considers the classes of steel castings in general commercial demand and their characteristics from a manufacturing point of view. It deals with the common steel-making processes and their characteristic features, and explains the procedure in the shop, such as molding, coring, annealing, etc., in the light of its influence on quality and cost. The chapters of the book are headed as follows: General Considerations Governing the Choice of a Method of Steel Making; The Crucible Process; The

Bessemer Process; The Open-hearth Process; The Electric Furnace; Summary—Special Deoxidizers—Ladles; Molding, Pouring and Digging Out; Heat-treatment and Annealing; Finishing, Straightening and Welding; Laboratories; "Building up" Impurities in Steel.

Engineers' Costs and Economical Workshop Production. By Dempster Smith and Philip C. N. Pickworth. 248 pages, 5½ by 8½ inches. Illustrated. Published by Emmott & Co., Ltd., Manchester and London, England. Price, 4s. 6d., net.

The effort of this work is to give clearly and simply the principles of manufacturing costs with various problems and methods of solution. Particular attention has been given to methods of correct time fixing in determining the cost of machine operations. The contents by chapter heads are: Pig Irons; Wrought Irons and Steel; Copper and Copper Alloys; Specification of Materials; Wage Systems; Shop Organization and Management; Considerations Affecting Standard Times for Machine Operations; Considerations Affecting Standard Times—Machine Capabilities; Standard Times for Hand Operations; Inspection of Work and Classes of Fit; Establishment Charges; Reserve, Maintenance and Depreciation; Selling Expense; Railway Rates; Shipment of Goods; Cost Keeping; and Estimating.

Alloy Steels—Their Composition, Characteristics, Strength and Heat-treatment. By E. F. Lake. 47 pages, 6 by 9 inches. 16 illustrations. 13 tables. Published by the Industrial Press, New York City. Price, 25 cents.

This book is No. 118 of MACHINERY'S Reference Series. The important part which alloy steels play, at the present time, in the machine building and manufacturing trades will make a book descriptive of these steels especially valuable to the mechanical world. The book contains a number of comprehensive treatises on the most commonly used alloy steels, including nickel steel, nickel-chromium steel, vanadium steel, manganese steel, titanium steel, and natural alloy steel. In the case of each, their characteristics and peculiar properties are reviewed, and the uses for which they are adapted referred to. Their strength and the methods of heat-treating in order to obtain the best results from each steel are given. As there is no book on the market treating of these classes of steels in a similar manner, it will be especially welcome to all interested in this subject.

The Modern Gasoline Automobile. By Victor W. Page. 816 pages, 5¼ by 7½ inches. 575 illustrations. Published by Norman W. Henley & Son, New York City. Price, $2.50.

This is the third, or 1914, edition of this work, which treats of the design, construction and maintenance of the gasoline automobile. The major portion of the previous edition remains unchanged, but much additional matter has been included in order to keep pace with the progress of the automobile industry. Supplementary matter has been added relating to ignition and magneto-generators, as well as entirely new material on many important subjects. Mechanically interesting sections that have been augmented are those on the skew-bevel gear and two-speed, direct-drive rear axle, as well as the discussion on several new forms of worm-gear drive. It may well be said that, in general, this book presents a most comprehensive treatise on the gasoline automobile and may well be recommended both to owners and users of automobiles and to students, mechanics and repairmen. The treatment of the subject makes it also especially valuable as a reference book for draftsmen, designers and engineers.

Gear Cutting in Theory and Practice. By Joseph G. Horner. 391 pages, 5½ by 8½ inches. 367 illustrations. Published by Emmott & Co., Ltd., Manchester and London, England. Price, 7s. 6d., net.

Mr. Horner is a well-known British authority on machine shop practice and mechanical engineering work generally, of indefatigable enterprise. The number of articles and books annually produced by him is remarkable. In offering this book on gear cutting to the public, the author refers to the rapid developments of machine shop practice during the past ten years. Form planing and generating planing methods have come to be applied chiefly to bevel gears and the hobbing practice is widely used as a means of generating spur gears. The growth of automobile practice and the development of all-geared machine tools have brought the high carbon steels and the alloy steels to the front. The difficulty of cutting gears of these steels and the requirements for hardening have increased the demand for expert knowledge on the part of the modern gear maker. The work treats of: Elements of Tooth Forms; Tooth Curves; Pitches; Tooth Proportions; Gears Related to the Spurs; Bevel Gears; Method of Cutting; Form Cutters; Form Planing and Generating Methods; Machines Using Form Cutters; Form Planing; Machines that Generate by Planing Tools; Machines that Generate Bevels by Planing; Generating by Hobbing; Generating by Milling; Materials, Manufacture and Strength of Gears. The work treats modern gear making comprehensively and will be generally acceptable to the mechanical public interested in gearing.

NEW CATALOGUES AND CIRCULARS

Colburn Machine Tool Co., Franklin, Pa. Bulletin 54 on D-3 heavy-duty drill press of 24 inches swing.

E. J. Willis Co., 85 Chambers St., New York City. 1914 catalogue A, offering special cut-rate prices for automobile supplies.

Waterhouse Welding Co., Boston, Mass. Catalogue on welding and cutting plants, listing the parts that comprise the different equipments and prices of each.

Merrell Mfg. Co., Toledo, Ohio. Catalogue comprising bulletins 11 to 22 on pipe threading and cutting machinery of both hand and power types. 35 pages, 6 by 9 inches.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Leaflet giving price lists and dimensions of Hess-Bright ball-bearing ceiling hangers, floor stands, post hangers and pillow-blocks.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Pamphlet on push-button operated controllers for printers' machinery by which it is claimed a large increase of production can be obtained without increase in cost.

United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. Bulletin of electric polishing and buffing machines made in six sizes, ¼ to 5 horsepower, with alternating- or direct current motors.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin E-31 of Duntley electric sensitive drilling stand, and Bulletin E-32, superseding E-28, on Duntley electric tools for street and interurban railways.

Julius King Optical Co., New York City. Leaflets entitled "Don't Lose Your Eyes" and "Should Workmen be Compelled to Wear Safety Goggles," advertising the "Saniglas" shop goggles for protecting the eyesight of workmen.

National Machinery Co., Tiffin, Ohio. Circular 1010-B on National semi-automatic nut tappers built in 1- 1½- and 2-inch sizes. A special feature of this machine is the automatic raising and lowering of the spindles which eliminates the item of fatigue from treadling and allows an increased production.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 41010 on direct-current motors, types C and D. Folder 853 on laboratory ozone apparatus, describing ozonators, ozone mixers, air filters, etc. Folder 330 on electric fans, direct and alternating current.

Ironton Punch & Shear Co., Ironton, Ohio. Catalogue 12, descriptive of Ironton punches and shears. 48 pages, 6¼ by 9¼ inches. The line of machines illustrated and described includes vertical punches and shears, horizontal punches, universal shears, straightening rolls, bending rolls and multiple punches.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 242 entitled "Sprague Electric Control Systems for Newspaper and Rotary Magazine Presses." 31 pages, 8 by 10½ inches. Installations of the Sprague control system in a number of printing plants are shown.

Allen-Bradley Co., 495 Clinton St., Milwaukee, Wis. Bulletin B-531, describing Allen-Bradley Type G starting switches intended for use with small alternating-current motors that can be connected directly to the line without a starting resistance to limit the current. They are of the drum type, entirely enclosed in a dustproof case.

Charles H. Besly & Co., 120 N. Clinton St., Chicago, Ill. Card on the advantages of 15-30-C Besly grinder, showing the machine in operation. It is claimed that this machine so increased production as to save one-sixth of the pay roll in a large railroad patternshop. The card has a hole punched in the top and is intended to be hung up for reference.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletins 152, 153, 154 and 172 on "Chicago gatling" drills, the "Chicago sinker," the "Chicago stoper" and the "Chicago" plug and feather drill. The bulletins show clearly the application of these various types of pneumatic drills and their several advantages, and gives dimensions and prices for each.

Watson-Stillman Co., 192 Fulton St., New York City. Catalogue 91, descriptive of the Watson-Stillman line of hydraulic jacks. 96 pages, 6 by 9 inches. This line comprises plain hydraulic jacks, horizontal and swivel claw hydraulic jacks, pulling jacks, pit jacks, motor lifts and battery lifts. A miscellaneous section is devoted to repair parts and includes tables giving dimensions, prices, etc.

American Blower Co., Detroit, Mich. Bulletin 35, Series I, dealing with the pitot tube and fan testing. The construction, operation and application of the pitot tube are described and comparisons are drawn between "ABC" pitot tubes and other types. Tests show that very accurate results are obtained in measuring air pressures and volumes in fans by the use of "ABC" pitot tubes. The method of conducting fan tests with these tubes is also described.

Wiener Machinery Co., 50 Church St., New York City. Circular of "Hercules" bending machines for bending angles, beams, channels, rails and other shapes. The material is bent cold and perfect rings can be bent from angle iron, with legs inward or outward. These machines are especially adapted for the use of boilermakers, structural shops and manufacturers of mining equipment. Railroads and street railway companies should find the rail bending machines of interest.

Brown Instrument Co., Philadelphia, Pa. Catalogue 9 treating of the complete line of indicating and recording pyrometers made by this company. 64 pages, 8 by 10½ inches. This book is virtually a treatise on pyrometers, taking up their construction, descriptions of the various types and their installation in plants throughout the country. The catalogue is well printed and illustrated, and attractively made up. A leaflet containing 100 letters of recommendation of Brown pyrometers is also being distributed.

Russell Mfg. Co., Greenfield, Mass. Bulletin A on screw plates. 32 pages, 5 by 7½ inches. Screw plates include a set of stocks, dies and taps consisting of from one to twelve sizes or more. A new feature of the Russell plates is the double die which is made to cut from both faces. This allows the die to be reversed when worn, bringing into action a new set of cutting edges and thus materially increasing the life of the die. Attention is also called to the opening-die screw plate which greatly facilitates the work of threading bolts by hand.

Graton & Knight Mfg. Co., Norfolk & Suffolk Sts., Worcester, Mass. Catalogue No. 5 on leather belting and leather products. 114 pages, 5½ by 8½ inches. This catalogue supersedes all previous editions and contains a complete description of the various brands of leather belting manufactured by this company. There are also included many mechanical rules, tables, etc., suggestions for the proper care of belts, points on ordering belting, selecting the best belt for special conditions, and other information which should be helpful to all belting buyers or users.

Starrett Pump & Mfg. Co., Salt Lake City, Utah. Booklet entitled "A Modern Method of Pumping," describing the Starrett system of pumping by compressed air. In this pump the air is used expansively, that is, the power put into the air by compression is changed from pressure into speed by expansion in the discharge pipe. It is claimed that the Starrett pump will lift water any height with any desired pressure, which makes it particularly adapted for well pumping and mine work. Tests of these pumps conducted at the University of Utah showed a very satisfactory performance.

Wagner Electric Mfg. Co., St. Louis, Mo. Bulletin 104 entitled "A Manual of Electrical Testing." 48 pages, 8 by 10½ inches. Besides describing the line of portable instruments manufactured by this company, this publication describes various types of electrical instrument movements, the errors to which they are subject, and gives suggestions for their handling and care. The methods of making electrical tests on alternating-current and direct-current motors and generators and on transformers are described at length and illustrated by comprehensive and instructive diagrams. The publication is one that should be in the hands of everyone who has to do with electrical testing. Copies may be had upon application to the Wagner Electric Mfg. Co.

Colburn Machine Tool Co., Franklin, Pa. Catalogue on Colburn boring mills arranged in the form of a binder in which the new bulletins can be inserted as received. Bulletins thus far included are Nos. 46, 58, 60, 61, 63 and 65 which cover Colburn vertical boring and turning mills of 30 inches, 34 inches, 54 inches and 72 inches capacity. Bulletin No. 63 is devoted to special features of this line of machines, among which might be mentioned the helical gear table drive which, it is asserted, gives a smooth rolling effect that entirely eliminates vibration and chatter. The Colburn Machine Tool Co. is the first to use this type of table drive for boring mills, and considers it superior to the ordinary spur gear drive. These bulletins have the usual typographical excellence of this company's publications.

Max Ams Machine Co., Mount Vernon, N. Y. Year Book for 1914 entitled "The Seal of Safety." 206 pages, 6 by 9 inches. This is a book which should be of particular value to those engaged in the canning or food packing industry, but the information contained is of considerable general interest as well. A brief history of the canning industry from its inception is given, and it will probably be a surprise to many to know that the preserving of food began as long ago as 1795, and that packing in tin cans was done in 1810. It is even asserted that various kinds of preserved foods have come to light in the excavations of ancient ruins by archeologists. The Max Ams Machine Co. was started in 1868 as a canning and packing business, and this company made many improvements in the cans then being used. From this beginning was developed the present business of building can-making machinery, and the last section of the book shows the improved types of machines made by this company for producing the modern sanitary solderless sealed can. Articles are also included on "The Canning of Vegetables and Fruits," by Dr. A. W. Bitting, "New Method of Canning," by Dr. Koch, "Process of Salmon Canning," by the secretary of the Salmon Packers' Association, etc. Other sections of the book deal with the associations in the canning and packing industries, and legal matters of interest to canners. In the latter division is the Sherman anti-trust law, an article on U. S. patent law, by Oscar E. Perrigo and other matters of much interest. This book shows considerable care in its compilation and the result is a valuable and attractive publication.

TRADE NOTES

Detroit Steel Cooperage Co., Detroit, Mich., has been succeeded by the Detroit Steel Cooperage Works of the Pfaudler Co., Detroit, Mich.

Western Tool & Mfg. Co., Springfield, Ohio, has just completed a drop-forge plant and is now in a position to take on business in this line.

C. & C. Electric & Mfg. Co., Garwood, N. J., announces the removal of its Cleveland agent, Charles S. Powell, to new headquarters at 711 Illuminating Bldg., Cleveland, Ohio.

Norma Company of America, New York City, maker of "Norma" ball, roller, thrust and com-

MACHINERY

JUNE, 1914

VIBRATION IN MACHINERY AND ITS ELIMINATION*

THE BENEFICIAL EFFECT OF HERRINGBONE GEARS IN RUBBER WORKING

BY WALTER J. BITTERLICH†

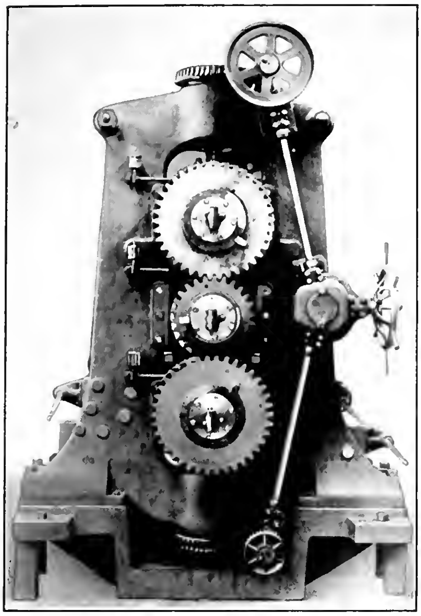


Fig. 1. Housing of Heavy-duty Calender and Roll Pressure Control

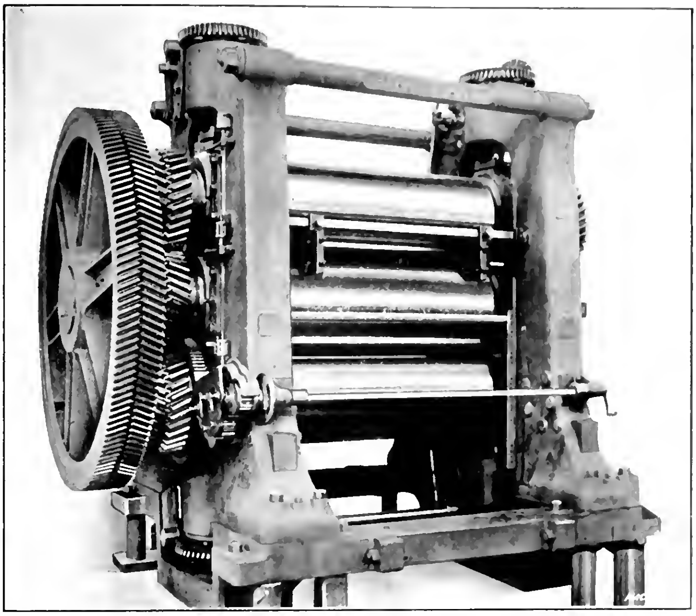


Fig. 2. Heavy-duty Three Roll Calender for Rubber Tire Work, equipped with Herringbone Gears

WERE the average person asked what feature of the mill-room in a rubber factory is the most distressing, he would undoubtedly reply "the odor." But this is not the case, as in the average rubber factory the vibration and noise are by far the most distressing features to be encountered. The sense of smell soon becomes accustomed to the disagreeable odors, while the effect of vibration and noise on the individual tends to increase rather than decrease as time passes. The noise in some departments of large rubber plants is nerve-racking, and at times one can feel the entire building tremble, even though the machinery is mounted on massive foundations, the power required to masticate the rubber being enormous. There are various sizes of calenders and mills, and the power required varies directly in proportion to the sizes of the rolls, all other conditions being equal. They are in almost all cases worked to their maximum capacity, making the noise very disagreeable.

Noise is produced by vibration, and in rubber machinery equipped with heavy spur gears it is due to the intermittent hammering action of the gear teeth. The use of pinions of rawhide or other soft material has lessened the noise considerably, but even these, when worn, produce noise. Everyone is aware of the effect of noise on operatives; it must naturally reduce their efficiency, decrease the output, and consequently increase the cost of production.

* See also "Power Transmitted by Herringbone Gears," MACHINERY, June, 1913, and "Herringbone Gears," January, 1912.

† Address: 27 Irving St., Watertown, Mass.

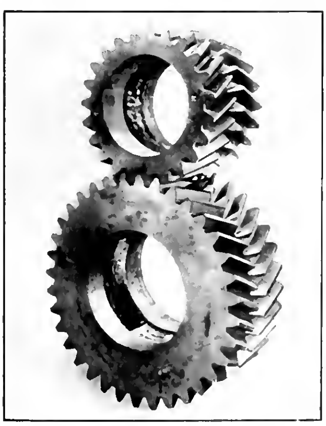


Fig. 3. Special Herringbone Gears

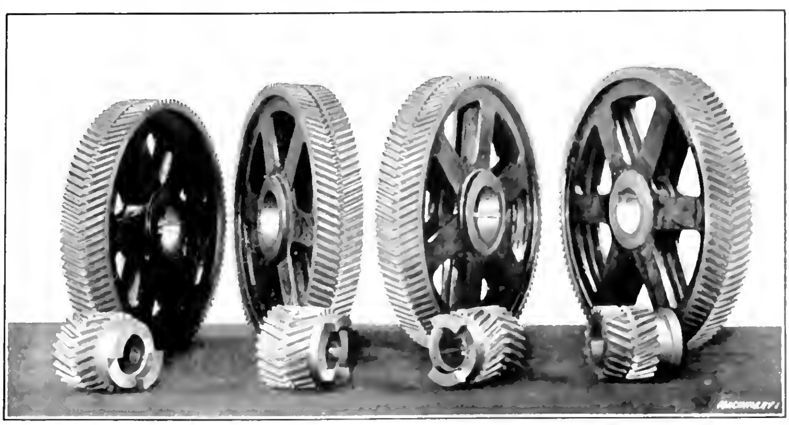


Fig. 4. Group of Wuest Herringbone Gears for Rubber Mills

Noise in buildings of slow burning construction is not so apparent as in the concrete building; this is because the wood of the former construction acts as a shock absorber, while the rigidity of the concrete building tends to enhance the noise. Since the progress of modern building is toward concrete construction, the elimination of noise should be given careful consideration.

The effect of vibration on rubber calenders and mills is detrimental to the life of the machines, as it causes rapid wear in the bearings, throwing them out of alignment and thereby increasing the frictional losses. There are also premature renewals of broken parts due to shocks, and since all the mills and calenders are equipped with steam and water pipe connections, these become leaky from the vibration. To sum up, the vibration causes increased depreciation, and adds to the maintenance and operating costs.

There is no type of chain or gear drive for transmitting heavy power that will entirely eliminate noise, although, by proper design, the noise and vibration can be minimized to a great extent. The best means for eliminating noise is by the use of properly cut herringbone gearing. Herringbone or double helical gears have been developed to such a stage in the last few years that with accurately generated teeth they cause less vibration than any other type of mechanical transmission. The principle that makes for superiority over other types is the smooth, continuous action of the teeth during engagement instead of the intermittent hammering action occurring in nearly every other type of drive. Worm-gear drives have been tried on rubber mills, but owing to their low efficiency when transmitting very high powers even when well designed, they are not a commercial success.

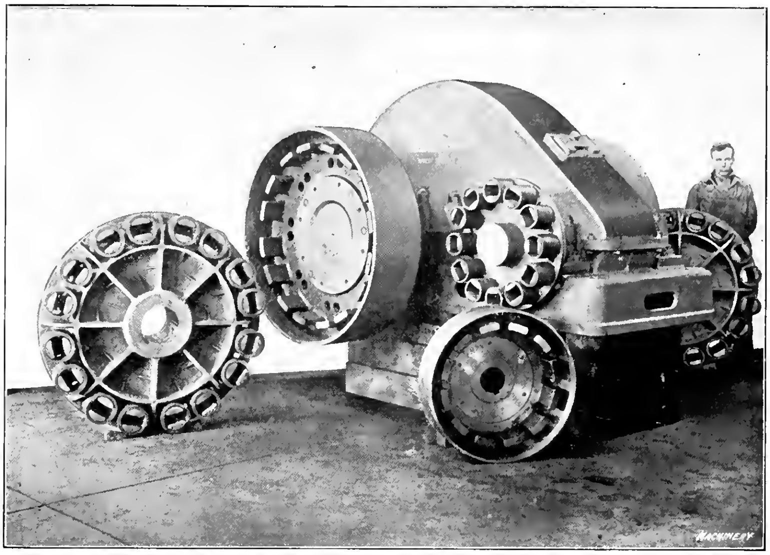


Fig. 5. Enclosed Herringbone Gears for Rubber Mill. Illustration shows also Flexible Couplings used in connection with Rubber Mills

The advantages of the herringbone gear in rubber machinery are as follows: Greater efficiency (98 and 99 per cent having been obtained in actual practice); noise reduced to a minimum; wear evenly distributed over entire tooth face, which cannot be obtained on straight spur gear teeth; reduced depreciation, maintenance and operating costs; the only positive drive possible where great speeds are used, due to its smooth action (the safe limit of spur gears and chain drives is far below the limit of speed permissible for herringbone gears); saving in power consumption; maximum output of machine because highest speed practicable can be obtained from the calenders and mills; use of higher speed motors without additional countershafts, due to the very high ratios possible in reducing with this type of gear, resulting in reduced initial cost of installation; smaller size teeth for same amount of power transmitted, because the maximum bending moment of any tooth under load is far less than that to which a spur pinion is subjected under equal conditions, owing to the fact that more teeth are in engagement in herringbone gears at the same time; and a better quality of the finished product in calendering.

It is absolutely essential that the connecting gears of the calender rolls be of the herringbone type, otherwise marks would appear on the finished product, due to backlash and vibration. These gears have until recent years been cast tooth herringbone gears, which were a development of the cast staggered tooth spur gear. The accurately generated herringbone gear is now displacing the cast tooth gear. Through the courtesy of the Falk Co. of Milwaukee, Wis., the writer is enabled to show some of the principal applications of the herringbone gear drives in the rubber industry. Many of the large rubber manufacturers of both Europe and America are now adopting this form of drive exclusively and equipping the calenders and mills throughout, from motors to the rolls, with herringbone gears. There seems little doubt but that herringbone gears, properly designed and cut, form the smoothest and most efficient drive known, and through their use and development we may hope for really silent machine drives. The field for the machined herringbone gear is great, its application being only in its infancy.

Figs. 1 and 2 show a complete herringbone equipment on a 26 by 72 inch three-roll calender. These calenders are usually driven by individual motors and the motor gear and pinion, together with the second motion pinion which meshes with the bull gear, are not shown. The effect of these gears on calenders is to entirely eliminate vibration and to enable the calenders to be run at much higher speeds and outputs than was formerly the case. With these gears it is impossible to produce flats on the calender rolls, a thing which quite frequently occurs on some classes of work where one roll has to be made of vulcanized rubber instead of cast iron.

The gears used for connecting the rolls of both calenders and mills are of special design and are illustrated in detail in Fig. 3. The teeth are longer than is usually the case for this class of gears and are generated in such a way that they are actually wider at the base than at the pitch line. This allows the rolls to be separated to any required extent up to a maximum of about 1¼ inch, while the gears work with absolute smoothness and without interference in all positions of the rolls within these limits. The peculiar shape of the teeth illustrated is of great value for resisting the heavy bending stresses imposed by carrying the drive near the tips of the teeth when the roll centers are extended.

Fig. 4 shows a group of Wuest herringbone gears that were applied to driving a number of mills on one lineshaft. The pinions are not keyed to the lineshaft, but are bushed so as to float freely thereon. The drive is taken through jaw couplings, as shown, meshing with corresponding jaws cut in the ends of the pinion hubs. The driving half of each coupling is keyed to the shaft and the drive is transmitted through the jaws, but allows the pinions a free end movement which enables each pinion to align itself correctly with the gear which it drives. This arrangement prevents binding of the pinions on one side of the teeth, which might otherwise occur through longitudinal expansion of the lineshaft.

Fig. 5 shows a completely enclosed gear unit as used for driving the main shafts of rubber mills from high-speed electric motors. The illustration also shows the Falk leather-link flexible couplings which are used for connecting these units to the motors and lineshafts. These couplings absorb all shock and give a certain degree of elasticity to the transmission which is desirable for this class of work. They also take care of slight defects in alignments of bearings.

ELECTRICAL SOLDERING

PRINCIPLES APPLIED IN OPTICAL FRAME MANUFACTURE

BY WARREN E. THOMPSON*

THE application of electricity in welding is understood by most metal workers, as it plays an important part in the manufacture of automobiles, wagon-tires, chain and other articles made of one or more different kinds of metal. There are two methods of welding in which the electric current is employed, *i. e.*, the arc and resistance methods. The arc is used to a limited extent for welding large broken parts and its application is considered more economical than any other process, but the danger of handling current at the high voltages that are necessary makes its scope limited. The other welding process, as invented and developed by Dr. Elihu Thomson, consists of causing a heavy current of electricity at a low voltage to flow through the abutting ends of the pieces of metal to be welded. This heats the metal at the joint to a welding temperature, the joint being the point of greatest electrical resistance, and by forcing the ends of the work together until the molecules of the metal, or metals, flow together, the pieces become as one. This method of welding is generally carried on without the use of any flux, the pieces having been previously cleaned of all scale, grease, or other foreign substance detrimental to the process.

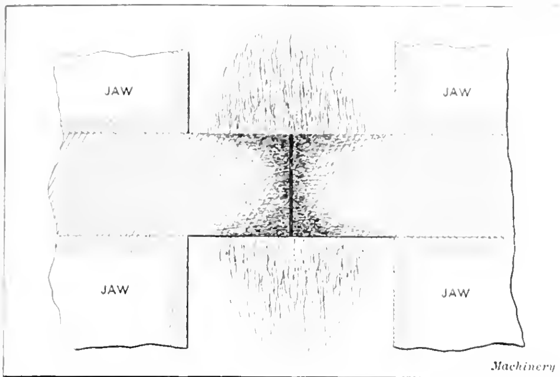


Fig. 1. Diagram showing Relative Volume of the Work that is heated by the Current

The underlying principle of this method of welding is based on the fact that any conductor of electricity offering resistance to the passage of the current will be heated if sufficient current is applied. This process is used extensively and the general advantages of cleanliness, simplicity, accuracy, economy, uniformity of product, safety to the operator, and general utility, tend to make it very popular wherever it can be applied. Exhaustive tests have proved that the electrically welded joint is from 75 to 95 per cent as strong as the original metal, and in cases where the upset or fin is not removed, the strength of the weld can be increased to above 100 per cent. It is also known that the electrical welding process is no more harmful to the homogeneity of the metal than any other heating process; probably less so, as the danger of overheating is eliminated.

What is true of welding is also true of the electrical soldering process about to be described, as in both processes the heat is developed by the same action, *i. e.*, the passage of a large current of electricity through the joint. This soldering process is a mechanical one and in operation the apparatus used is not likely to give any more trouble than any simple machine will. The wear on the clamping jaws makes it necessary to replace them periodically, but as they are comparatively inexpensive and constitute the only replacement necessary, the operating expense is very low. The amount of the current used in optical framework averages 1 K.W. hour per 1500 joints. This current can be purchased from the local lighting company or a generator can be installed which would probably reduce the current expense.

How the Process is Conducted

The general method of soldering consists of holding the pieces to be joined by clamping jaws with the ends of the work in firm contact. A heavy current of electricity, regulated to heat the joint sufficiently to melt the solder, is next passed through the work. The solder, in the form of tape or wire, is then applied to the joint. It flows in and around all parts heated to the proper temperature, as when using a gas flame, but an important difference is noted: the "life" or temper is retained in pieces that have been electrically soldered, instead of their being left in an annealed condition as when heated with a flame. One theoretical reason for this is based on the fact that alternating current electricity travels on the surface of a conductor, and so the core of the work does not heat to a temperature sufficient to become annealed. This condition is illustrated in Fig. 1. The heat varies from a maximum at the joint to the normal temperature of the machine at the jaws, and the heated section would take some such form as shown. As the length of the work that is heated is relatively short, the distance between the clamps usually being twice the diameter of the work, the heat has not had time to run into the work before the joint is made and the current shut off. This is shown by the fact that two highly tempered wires soldered together by the electrical process offer the same resistance to being bent at any other point as at the joint. The yield point or bending strength of the metal is practically as high as before heating.

Range of Electrical Soldering

Practically all the metals such as brass, copper, steel, German silver, gold, and silver can be soldered successfully in this way, and it is without doubt the most economical method for a continuous run of work. There are no noxious fumes or smoke produced in making an electrically soldered joint, and windows can be opened in warm weather without affecting the process in the least. The operator is thus able to do a full day's work each and every day, instead of experiencing the fatigue that is caused by breathing the carbonic acid gas caused by the gas flames. The joint is made almost instantly, the time required to heat the joint, apply the solder, and shut off the current being approximately from three to five seconds, depending on the cross-sectional area of the joint. As the gripping jaws of the holders are made as large as possible, the heat is drawn from the work almost the instant that the current is shut off, allowing the work to be removed immediately.

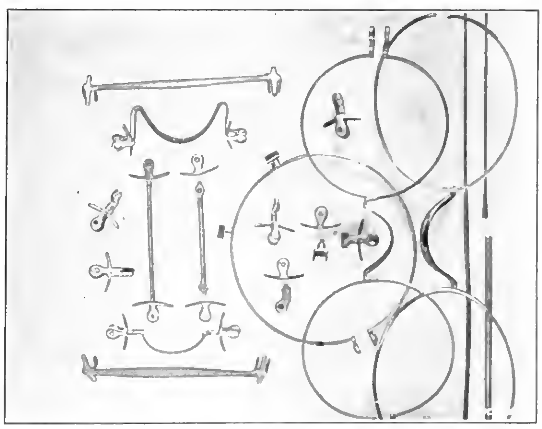


Fig. 2. Examples of Eyeglass Parts joined by Electrical Soldering

Examples of Electrically Soldered Optical Frames

A few samples of parts of eyeglass frames joined by this process are illustrated in Fig. 2. At the extreme right is shown a "cable-temple" before and after the joint is made. These

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cable ends are wound in a special machine and consist of two coils, right- and left-hand, one inside the other. The inner coil is made of brass wire wound on a steel wire arbor and then swaged to a specified diameter. The outer coil is made of German silver, gold filled, or any other stock that is desired, and it is pushed over the inner coil. After the assembled cable is soldered to the "temple," which is a solid wire with the center reduced, it is swaged to the final finished diameter. This leaves a very smooth and flexible earpiece, and at the same time a stiff connection to the lensholders. The soldering of the brass-German-silver cables caused some trouble through the brass fusing before the German silver would heat enough to flow the solder, but this was stopped by using a larger wire in making the secondary coil of the transformer.

Two specimens of "nose-pieces" soldered to "eyes" are shown to the left of the cable-temples. These eyes are formed by rolling a round wire to form a groove in it; they are then wound on an arbor and sawed apart. The end-pieces are sawed, assembled and peened in one machine, and they were formerly soldered by gas. Previous to soldering the "bridges" on by electricity, a long space was annealed on the eyes. This made a joint that could be easily bent, and various methods of striking in dies were resorted to in order to get back some of the temper. In all cases of soldering by electricity, the eye wire is left with nearly all of the original temper. Another eye with studs attached is shown encircling samples of "straps," "studs" and "end pieces" before and after assembling and soldering, and to the left of this eye are shown different forms of bridges and nose-pieces with straps, before and after soldering. Such parts, that have about the same cross-sectional area at the joint, are very easily handled. Electrical soldering is very valuable for straps, as considerable strain is brought on them by the lenses when worn or handled. This tends to bend them out of shape and the value of a strap with a high temper cannot be overestimated. Straps that are soldered by this process and struck inside have nearly the spring of tempered steel. Another noticeable feature is that the solder flows freely at a lower temperature than when heated by gas, as practically no oxidation takes place at the joint.

The Utilization of High Voltage Alternating Current

In the process of electrical soldering, alternating current is invariably used, although there is no fundamental reason why direct current can not be employed. For mechanical and economical reasons, however, direct current is not to be considered. To make this clear, suppose a joint having a cross-sectional area of 0.125 square inch requires a current of 130 amperes at a pressure of 3 volts to heat it properly, and that an ordinary plating dynamo rated at these figures is used to furnish the current. It will be noticed that the work heats practically solid from jaw to jaw. Then suppose a joint having a cross-sectional area of one-half the first one, or 0.063 square inch, is to be heated by the same dynamo. A suitable resistance must be interposed in order to reduce the current to a point where the joint will heat properly without melting. This resistance will use current as though it were doing useful work and the small joint will cost practically the same as the large one, as regards the amount of power consumed. On the other hand, it is claimed that the heating action of alternating current is more uniform, as it flows more on the surface; the heat is thus more intense on the surface and is evenly conducted to the core of the pieces, offsetting the effect of radiation and conductance.

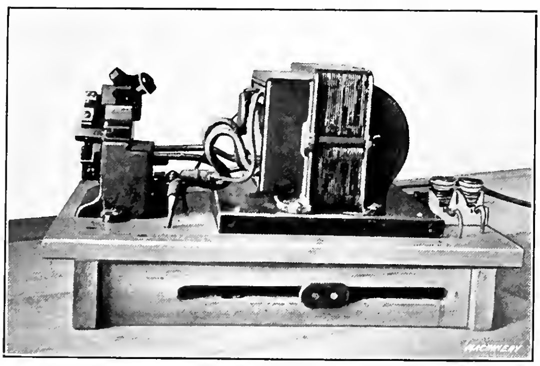

Fig. 3. Example of Unit Equipment for soldering Optical Frames

The current used for electrical soldering should be a single phase alternating current of any frequency between 40 and 60. A higher frequency could be used, but it is not good practice for various reasons. A step-down transformer of the shell-core type is preferably used to reduce the 110 or 220 volt feed pressure down to the $1\frac{1}{2}$ to 5 volts required at the machine jaws. It has been found that a pressure of from $1\frac{1}{2}$ to 5 volts is sufficient for all optical frame work, and from 75 to 500 amperes of current is consumed. The use of a large transformer for small work is wasteful, as, although the current can be regulated as desired without much loss of energy, the work heats much more slowly than when a transformer of the proper capacity is used. The machine transformer is usually connected in series with a single phase generator, but it may also be connected to one phase of a polyphase circuit or to either phase of a two phase generator.

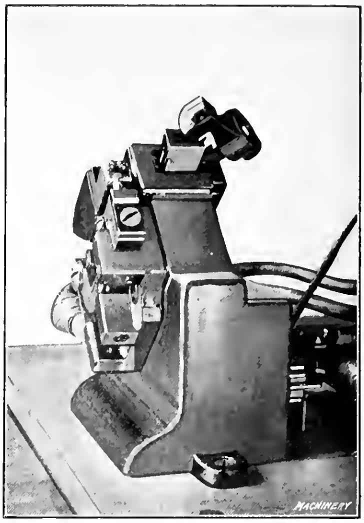

Fig. 4. Closer View of Work-holding Jaws shown in Fig. 3

The transformer is made by winding a coil of very large insulated copper wire around a core built up of iron sheets cut to shape by dies, each sheet being insulated from the others by shellac or some other medium. This coil, known as the secondary coil, is carefully insulated from the primary coil, which consists of a large number of turns of smaller wire wound around the secondary coil and its core. The number of turns of fine wire depends upon the number of turns of heavy wire and the current to be taken in and given out; also on the rules governing transformer design. The type of transformer illustrated in Fig. 3 is particularly well adapted for use in electrical soldering, as it can be used without changes with other work holders; and this would not be the case if it were built into the machine. As shown, it has the coils protected by an iron cover which not only acts as a case, but also as part of the magnetic field. Transformers of this type are very efficient—from 95 to 97 per cent of the current taken in being given out—and they are particularly suited for constant work.

Unit System of Electrical Soldering

The writer has developed a "unit system" of soldering and applied it very successfully in the manufacture of optical frames. This system consists in mounting all the working parts of the machine for each particular operation on a base-board or stand. Figs. 3 and 4 illustrate this idea; the transformer is mounted at the center, with a fuse box at the rear and the work holder at the front of the board. Under the base-board is located the adjustable rheostat operated by a sliding plate shown at the side. To set this machine up at any position in the shop, it is only necessary to run two wires from the feed circuit and attach a foot treadle to operate the clamp jaws and switch. This system allows the same transformer and other parts to be used with another machine in case of a change or the discarding of the original machine.

There are two practical methods of controlling the heat obtained at the joint; one is by introducing an adjustable rheostat into the primary circuit, as illustrated; and the other method is to introduce a reactive or "choke" coil into the same circuit. Of the two, the reactive coil is undoubtedly the better, as there is practically no loss of power and an infinite number of adjustments may be made, whereas the rheostat is limited to the number of contact points used. The difference in loss of current is an inappreciable amount more with the rheostat, but it can be made for little expense and for that reason has been used more than the choke coil. The writer uses the rheostat control on nearly all of his equipments on account of its simplicity, the ease with which it may be built and the simplicity of operation.

A machine for soldering straps to eye-pieces and bridges is shown in Fig. 5. This machine or holder consists of a base *A* with a vertical slide *B* working in a slot at the rear. A second slide *C* also works in another slot at the rear, the slot being inclined at 45 degrees to the base. This slide *C* is operated through a lever *D* which receives its movement from the slide *B*; the lever *D* is pivoted in the base. The slide *B* is provided with a spring tension which allows the lever *D* to keep a constant pressure on the slide *C* while the slide *B* continues to move. The lever *D* works in a slot cut through the slide *C*, this slide carrying a cam-operated swinging arm at its upper end to which the clamping jaws *G* are attached. This upper jaw is designed to swing away from the work and leave it clear to facilitate handling.

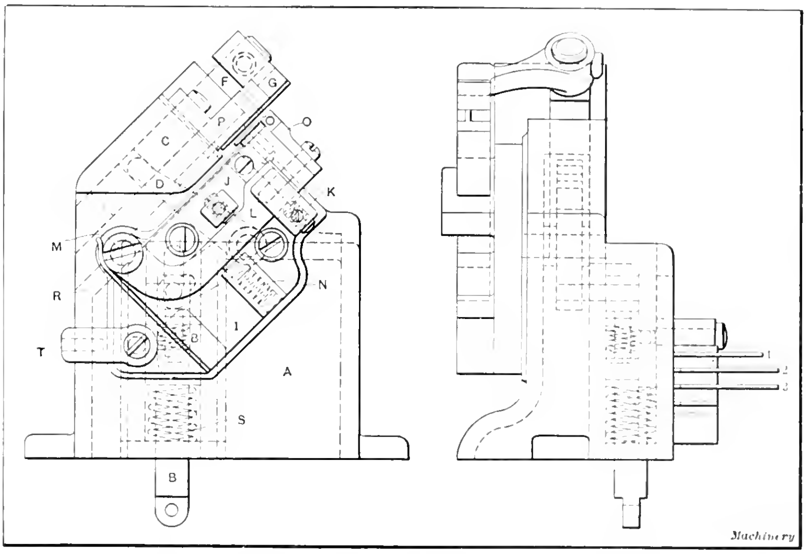

Fig. 5. Machine for soldering Straps to Eye-pieces and Bridges

At the rear of the machine and attached to the base there is a switch which is operated by a pin in the slide *B*. At the front of the base and insulated from it is the casting *I* which is milled to receive an arm *L* that is free to move on a pivot, but the motion of the arm is limited by the adjusting screws *J* and *K*. The arm is held against the screw *J* by means of an adjustable spring tension *N*. There is a jaw *O* at the upper end of the arm, which, in this case, holds the strap in the proper relation to the other part to which it is to be soldered. The contact of the jaw *O* with this strap is made by the pressure of the spring *N* against the arm *L*, and the strap is held against the part to which it is to be soldered, which is carried between the jaws *P* and *G*. The jaws are made interchangeable for different classes of work and may be easily replaced.

At the lower end of the casting *I*, one end of the secondary or low pressure circuit is connected by means of the terminal *T*, and a spring brush *R* is used to insure a low resistance contact between the casting *I* and the rocker arm *L*. The lower clamping jaw *P* is attached to the base *A* and the jaw is provided with a gage for aligning the part held in it. The slide *B* is held at the top of its movement by means of the spring *S*. Two points of the switch control the primary or high pressure circuit, and the other two points operate on the secondary which is in the circuit with the jaws of the machine. A chain connects the lower part of the slide *B* with a foot treadle which is placed under the bench in a convenient position for the operator.

The operation of this holder is as follows: Two pieces to be joined, previously covered with a non-scaling or protective mixture, have the joint end of one piece dipped into the flux. They are then assembled in the proper relation to each other in the jaws of the holder, which are so arranged that the rocking arm is away from its stop when the work is in place. The foot treadle next is depressed until the upper clamp jaw grips the work; in this case only one part is held rigid. The other piece—which is a strap—is guided by its form and a teat on the piece held in the rigid jaws. The solder, in the form of wire, is then placed on the junction and the foot lever depressed further until the current is connected. Almost instantly the solder flows and runs around the joint, when the foot treadle is released entirely, and the work, which is left free, is taken out with a pair of tweezers. On work which is very small and difficult to handle with the fingers, tweezers are used; but such work as soldering temples together, bridges to eyes, bridges to straps, or eyes to studs, is handled with the fingers. The heat is held at the joint instead of spreading as it does when heated with the flame, so it causes the operator no discomfort to take the joined pieces out as soon as the jaws are opened. The jaws are brushed clean at intervals, using a short hair stiff bristle brush for this purpose.

The idea of using a spring tension jaw was developed by the writer after having had considerable trouble caused by particles of dirt or burrs getting into the junction, also by not having the two ends fit together properly to form a contact of low resistance. When both pieces were held rigid, these particles or points would fuse and in most cases necessitated refinishing the points before a joint could be made. In some cases it was possible to release the parts, push them together with the fingers, and get the solder to take, but the method of clamping both parts rigidly always caused trouble and kept the actual production factor at a low point. By the use of the movable jaw, all of this trouble was eliminated as the constant spring pressure holds the ends in firm contact, automatically keeps the ends together in the case of burrs or other points fusing, and prevents any break in the contact while the current is being applied. In the welding process, the ends are forced together while at a welding temperature, but this changes the form of the ends and shortens the pieces; consequently it could not be applied to optical work, as there must be no change in the size or form of the pieces to be joined. The spring behind the rocking arm *L* in Fig. 5 is adjusted to provide just sufficient tension to keep a constant pressure on the junction without deforming or upsetting the ends, thus forming the joint when the ends become hot. The jaws of the holder are made as large and heavy as possible to allow of their working continuously without heating. These jaws are made of copper, which has been found best for this purpose on account of the low resistance of the contact made between them and the metal to be operated on. Copper is one of the best conductors of heat and electricity that is possible to use commercially, and for this reason will not only heat less by the passage of the current, but

will draw the heat away from the work quicker than any other metal.

Preparing the Work to Prevent Scaling

To prevent gold-filled metal from scaling or "burning" at the joint, it is customary to cover the work with some preparation to prevent oxidation. Probably the best, and at the same time the simplest, method of preparing the work is to place it in an ordinary flour sieve, cover it with commercial boracic acid, and then shake all loose powder out. This leaves the parts covered with a thin coating of dust which becomes liquid at a low red heat and prevents the air from coming into contact with the surface of the gold. Another method is to make a solution of the boracic

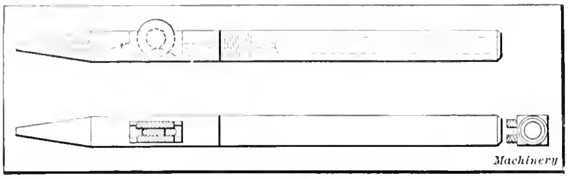

Fig. 6. Holder for applying the Solder by Hand

acid and water, dip the pieces into this solution, drain off the surplus and allow them to dry. In no case, however, should any solution be used that will leave a hard film over the parts, as this would prevent a clean contact with the clamping jaw, create a resistance that would cause an arc to develop, and spoil the surface of the work. The flux generally used is borax and it is prepared in the following manner: A piece of genuine slate, the green colored variety which is the hardest being the best, is thoroughly cleaned; a few drops of water are placed in the center and a thick, creamy mixture of borax is made by rubbing a piece of crystalline borax in the water on the slate until the desired consistency is obtained. The proper mixture is best determined by actual trial; a mixture that is too thin or too thick will either cause the solder to remain in one spot, instead of flowing through the joint, or create an unclean contact and interfere with the heating.

The solder in the form of wire may be held in the hand in a holder, as shown in Fig. 6, or some such arrangement as the one shown in Fig. 7 may be employed. This consists of a chuck at the top of a wire, bent about as shown, and having a metal ball at the lower end heavy enough to balance the wire and chuck in an upright position. This wire is held by a screw in one member of a universal joint which allows the chuck to be moved freely to any position in front of the clamping jaws and take a convenient position to allow the solder to be grasped by the operator. When a holder of this type is used, both hands are free to place and adjust the work and apply the solder quickly.

Considerable trouble, owing to the overheating of the joint, has been experienced and overcome by the rocking arm of the work holder. This heating caused the metal to become porous or "rotten" and the parts would break at either side of the joint upon the application of the slightest pressure. Some trouble was also overcome at the switch by making the contact points of pure silver. These points would fuse and weld together when copper was used, but the silver points stopped this trouble at once. Electrical soldering is a comparatively new process and has not been applied extensively as yet. It is the opinion of the writer, however, that this process is to become more popular and will be taken up by all large concerns that have a large number of interchangeable parts to braze or join.

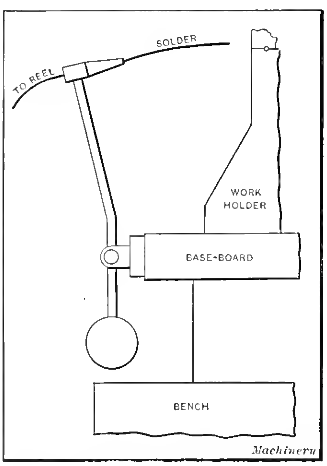

Fig. 7. Bracket for supporting Solder Holder on the Machine

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SAM AND HIS TROUBLES

BY A. P. PRESS

I have been forty years in the shop, twenty-five of which was passed as foreman and superintendent. Now my two boys are growing up and going "through the mill" themselves, and the troubles they run up against in their everyday work are usually brought home in some form or other and put up to "dad." In thrashing out what is new to them but old to me, it struck me that perhaps I might help out some other man's kid who is trying to fight his way through the ranks to the top, but hasn't any "dad" to fall back on. Although, to tell the truth, a boy who builds his own foundations has a better rest under his feet than one whose dad stands back of him. However, I will give you a few of their troubles and remedies, and the boy who seems to need the coat can put it on if it fits.

One of the boys is foreman in a large pattern shop, and the questions that come up are very similar to those that came up to me twenty or more years ago, except they seem to be a little more acute, and you have to be a little broader minded and use a little more diplomacy and "horse sense" in handling them now. One is the labor question. This I well know is a delicate subject, and should only be spoken of in whispers, but in spite of this fact it is eternally coming up. Sam came home one day, his face as long as his arm, and said:

"Dad, it's no use. I've got to have some advice whether you've got it to give or not. We have four big patterns half finished in the shop and the boys have all been working every night until 9 o'clock, and I've heard you say many a time you can't reason with a man whose worked thirteen hours a day. Now they've all hit me up for double pay for overtime, and the job won't stand it. What shall I do?"

"Are they all union men, son?"

"No, not yet, but soon."

"Well go back, and in the morning get the boys together, and put it up to them; tell them how the case is, just where you stand on the pattern work, what you're going to get for them, what they're costing you, and how much you'll lose if you have to pay them double time; and if they stand by you and see those patterns out, you stand by them; but if they won't, why 'buck' them."

Sam went back and took my advice. He had a heart-to-heart talk with the men. There were only ten of them, and out of the ten eight were willing to help him pull them through on the time-and-a-half basis, but the other two were not that kind. Well, you know. Anyhow, no need of my telling. It ended in the boys all walking out and leaving Sam with the errand boy, a helper, one good patternmaker who "wouldn't jack up his job for anyone," also, four half finished patterns on the floor. Sam was very solemn when he came home that night. He did not say a word, and I let him alone. Sometimes contemplation is good for the soul. But the next morning he got busy, and sent out some twenty letters to all the different patternmakers whom he knew to be good men and good workers, and, to cut a long story short, five of them came on and went to work and helped him out of the hole, and the next lot of patterns was taken at a price that would take care of the overtime work.

Before starting in on the new work, however, he had another talk with the men.

"Boys, it's like this: You are demanding the utmost of me in the way of wages, now I am going to demand the utmost of you in the way of work. Seven o'clock is going to mean seven o'clock right at the bench, and overtime means that there isn't going to be fifteen minutes out for lunch and your pay going on. It's going to mean, not only double time, but that every hour means sixty minutes of work." And so far it has worked out very well.

The moral of it, as I told Sam the other night, is this: Treat the men like men, and draw them if you can, but if they won't be drawn and want to be driven, well then drive.

EXTERNAL HOLDING DEVICES FOR SECOND-OPERATION WORK*

CHUCKS, FIXTURES AND LOCATING DEVICES USED IN LATHES AND BORING MILLS

BY ALBERT A. DOWD†

IN the majority of cases, work which is to be handled in more than one setting is so treated in the first of these that an interior surface can be used from which to locate the piece in the second setting. For work of this nature some kind of internal holding device, such as an expanding arbor or locating plug with clamps, is conceded to be of the greatest utility. (See "Arbors for Second Operation Work," October, 1913.) Frequently there are instances, however, which require an entirely different method of holding, namely, by some form of contracting device such as a set of collet jaws, a step chuck, soft jaws or some other scheme of a kindred nature. Obviously, one of these devices would only be found necessary when an outside finished surface was to be used as a locating point.

There are a number of conditions which affect the design of arrangements of this sort and a number of vital points in construction which should not be overlooked. In the first place, the form of the work itself and the material from which it is made, together with the thickness of the walls used as locating surfaces, are prominent factors which have a strong influence on the method of holding. The size and weight of the casting naturally determine to a certain extent the type of machine most suited to the work. The degree of accuracy required in the finished piece is also a factor in determining the type of holding device to be used. The types of machines most frequently employed on work requiring fixtures of this kind are the horizontal screw machine or turret lathe, the vertical turret lathe, and the vertical boring mill. A few of the most important points in the design and construction of this class of fixtures are given in the following paragraphs.

* For articles on this and kindred subjects see MACHINERY, November, 1913, "Holding Devices for First-operation Work"; October, 1913, "Arbors for Second-operation Work," and "Work Holding Arbors and Methods for Turning Operations"; August, 1913, "Knock-off Arbors for Threaded Work."
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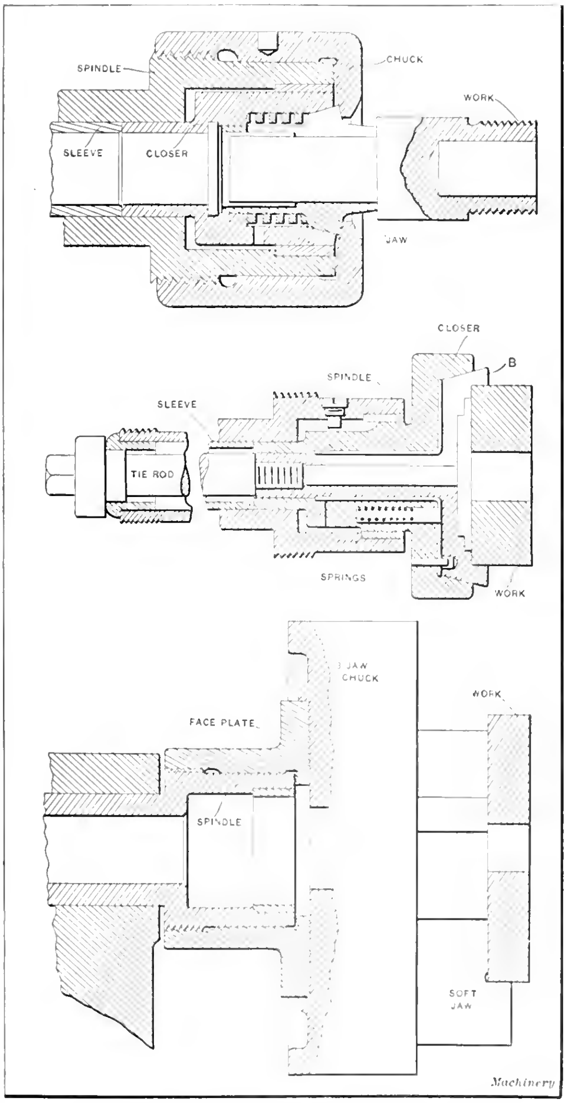

Fig. 1. Collet Chucks and Soft Jaw Chuck for External Holding of Small Work

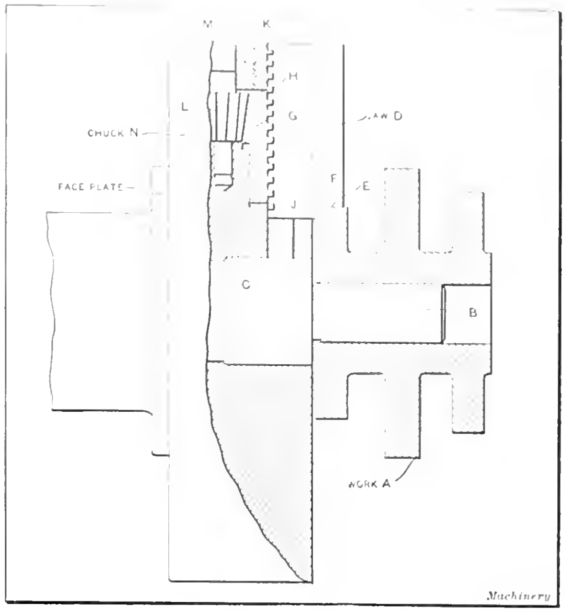

Fig. 2. Holding Device employing a Three-jaw Chuck with a Floating Scroll

Points in Design

1.—Decide on a method of holding which will not produce distortion in the finished work. Consider the thickness of the metal at the holding points, and note whether there is danger of crushing if considerable pressure is applied. Use a driver of some kind whenever possible, as this will be of great assistance in taking the thrust of the cut, and will therefore do away with the necessity for excessive pressure in holding. It may be permissible in some cases to drill a hole in the work for the express purpose of furnishing a place in which a driver can be inserted.

2.—Decide on the type of machine to be used, selecting that most suited to the work, taking into consideration the diameter and weight, and the speed at which it should be run to secure maximum production. In this connection it is well to bear in mind that the diameter to be cut determines the speed, irrespective of the outside diameter of the work itself. For example, a comparatively small hole in a hub might be machined when the outside diameter requires no machining whatever at this setting. In a case of this sort it would be advisable to select a machine capable of sufficient speed to produce maximum cutting speeds at the point where the cut is to be taken.

3.—Rapidity of operation is important; this requires accessibility of various clamps, screws, or other adjustable por-

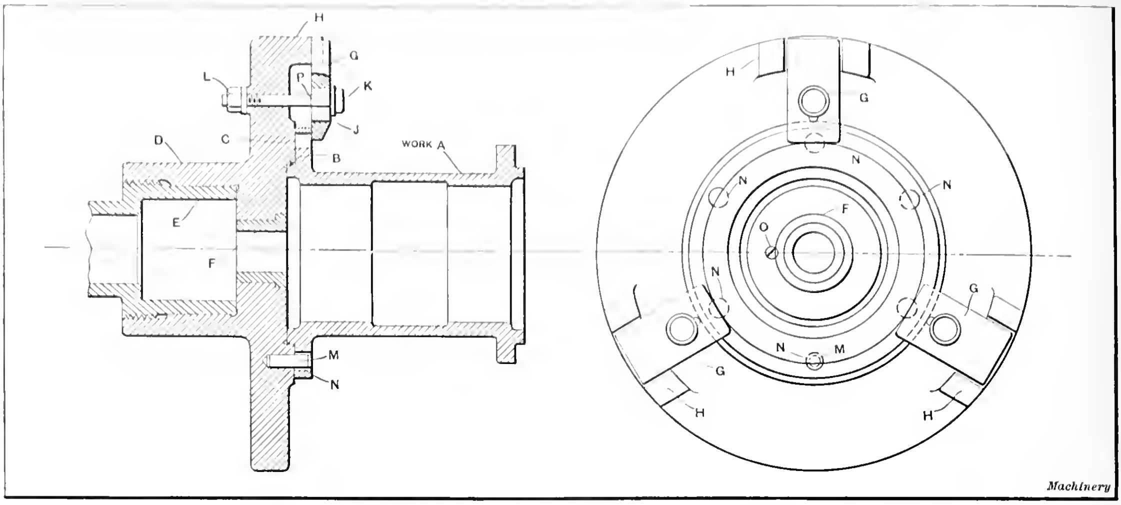

Fig. 3. A Fixture for Second Operation on a Motor Frame

tions necessary to the proper holding of the work. If a number of nuts are to be tightened, see that they are made of such a size that one wrench can be used for all of them. It is a very good idea to make nuts of the same size as some of the nuts on the machine itself, so that the regular wrench which goes with the machine can be used.

4.—Provide for positive location for the work, so that variations will not occur in shoulder distances when the piece is completed. It is well to make the locating points conveniently accessible so that they can be easily kept free from dirt and chips. Separate points, pads or studs should be used for locating, whenever possible, rather than unbroken surfaces.

5.—The accuracy required in the finished work should be carefully considered. When very close work is called for it is well to make suitable provision for wear in the moving parts and also to allow for grinding or lapping when making the fixture.

6.—Rigidity of design is important. It is well to remember that the closer the work can be held to the end of the spindle the less the overhang will be. Less overhang means less liability to chatter and also greater rigidity. Extra strength should be provided at points where there is excessive strain, and ribbing may be put in where needed. The balancing of the fixture should also be looked into, especially if it is to run at high speed.

7.—Safety of the operator should be considered and care taken in the design to provide guards over projecting lugs, set-screws, etc. Various methods will suggest themselves to the designer during the progress of the drawing, and a little thought on this point will be greatly appreciated by the operator. Projecting set-screws, exposed gears, etc., are growing more and more out of favor in machinery, and it is time that such things were done away with on fixtures also.

8.—The cost of the fixture should bear a certain relation to the number of pieces for which it is to be used; by this is not meant that it should be in a certain exact proportion to it, but that it should be taken into consideration while designing, so that the cost will not be too great as compared with the number of pieces to be machined. For example, if a fixture is to be used for only a hundred pieces, it should be designed as cheaply as possible, so that when the fixture cost is distributed among these pieces it will not increase the cost of production any more than can be helped. On the other hand, let us suppose the fixture is to be used for a lot of 10,000 pieces. It is then evident that an elaborate fixture having all possible provisions for rapid clamping, etc., would be in place, for the cost distributed among this number of pieces would be very small and the time saved would more than make up for the extra cost.

Outside Holding Devices for Small Work

There are several methods by which small work can be successfully machined when a second setting is necessary in

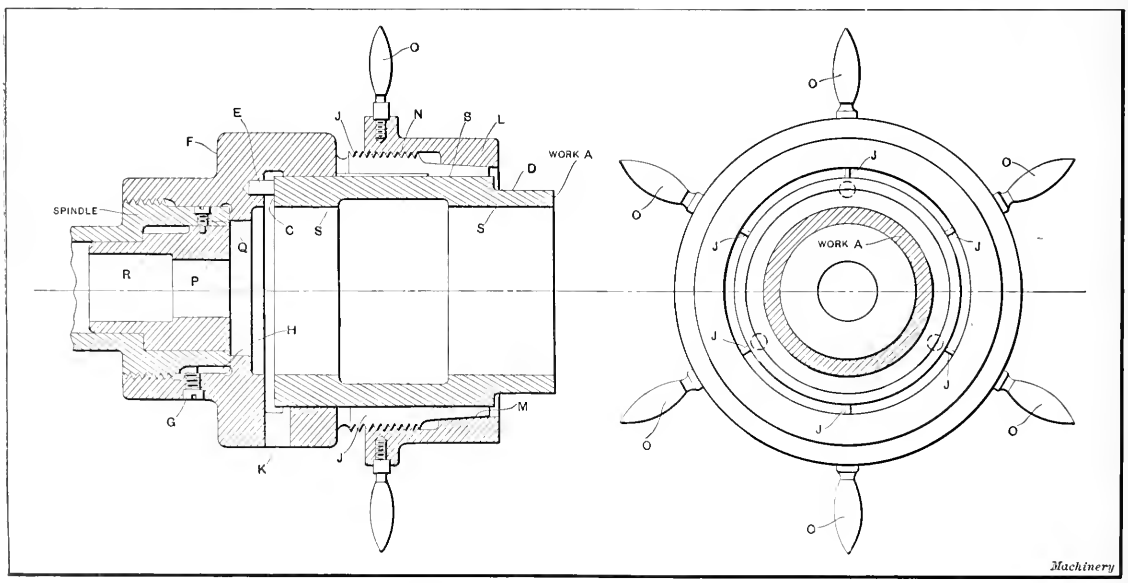

Fig. 4. Split Chuck used for a Bearing Sleeve

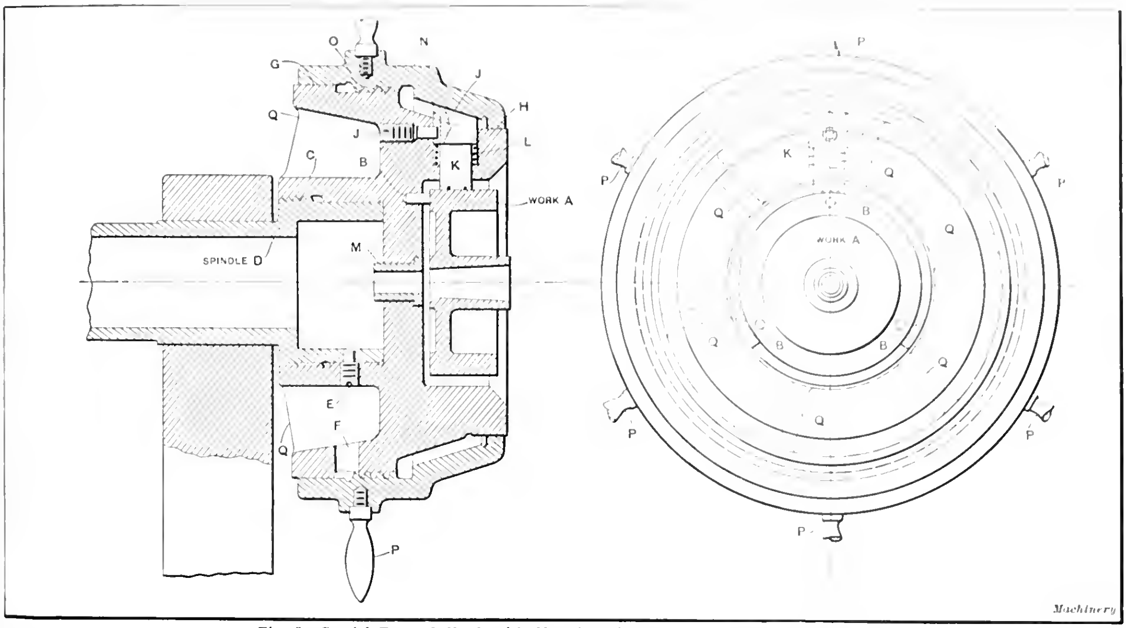

Fig. 5. Special Type of Chuck with Clamping Pins for a Small Flywheel Casting

which the work is held by the outside previously finished surface. The device most used is probably some form of collet jaws, such as is shown in the upper portion of Fig. 1. For second-operation work on bar stock, a method of this kind gives very satisfactory results and is too well known to require a detailed explanation. The collet jaws are closed in on the work either by drawing them back into a tapered body or by forcing a tapered body over them, thereby causing them to contract; the operating lever or wheel is at the rear end of the spindle. In the case shown in the illustration, the second of these methods is used. The machines supplied with this type of collet mechanism are the horizontal turret lathes made by the Pratt & Whitney Co., Hartford, Conn. A noteworthy feature of this collet chuck is the fact that the operation of the closing mechanism does not tend to move the stock lengthwise. It is therefore especially valuable for second-operation work.

Another method employing a step-chuck is shown in the second illustration of the same figure. This method is often used for second-operation work on gear blanks or pieces of a similar nature. The steel blanks *B* can be stepped out for several sizes, as indicated. The closing operation is performed by means of the collet mechanism, and it may be noted that, as in the case of the collet jaws, there is no longitudinal movement of the work. This method is less frequently used than the collet jaws, but it is very useful for many kinds of comparatively small pieces. This device is also a product of the Pratt & Whitney Co.

One other very widely used arrangement is shown in the third illustration, Fig. 1. This is a set of soft steel or cast-iron jaws which are bored out to the proper size, and then clamped onto the work by means of the regular chuck mechanism. Jaws of this kind are used for a great variety of work, both small and large. They are adapted for use in two-jaw, three-jaw, and four-jaw chucks, and are made up in a great many forms to suit peculiar conditions. In the two-jaw variety they are frequently formed to fit some odd-shaped piece. In the three-jaw type they are usually simply bored out and shouldered; the four-jaw style is not as common as the other two. In the operation of a four-jaw independent chuck with soft jaws, two of these are left set while the other two are used for clamping. One of these methods is in use in every shop or factory in the country.

Holding Device using a Three-jaw Chuck with a Floating Scroll

The work shown at *A* in Fig. 2 is an alloy steel jack-shaft gear for an automobile, part of which has been machined both inside and outside in a previous setting. As the size of the hole was too small to permit the use of an expanding arbor, the arrangement shown was decided upon. A regular three-jaw geared scroll chuck *N* of a standard make was selected

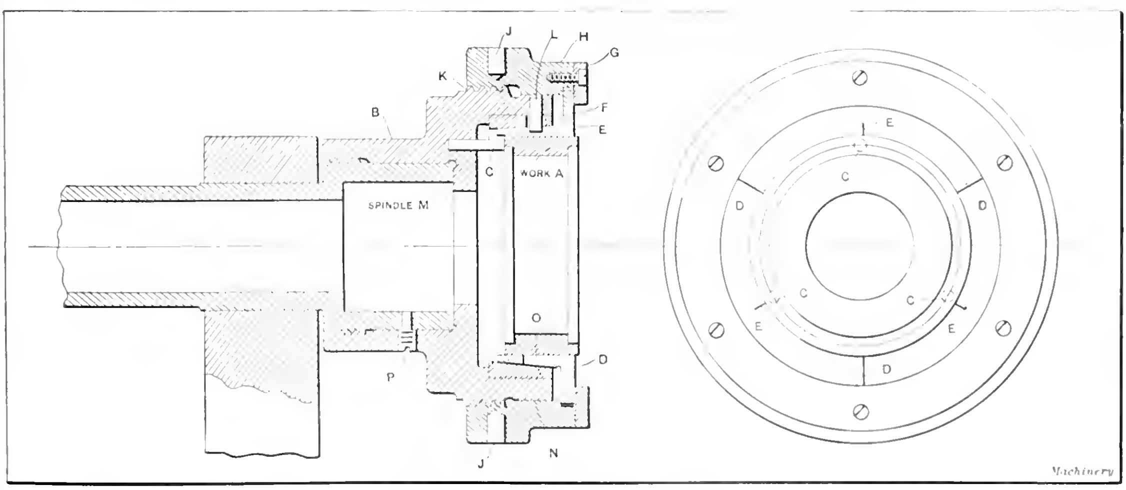

Fig. 6. Collet Chuck for a Steel Forging

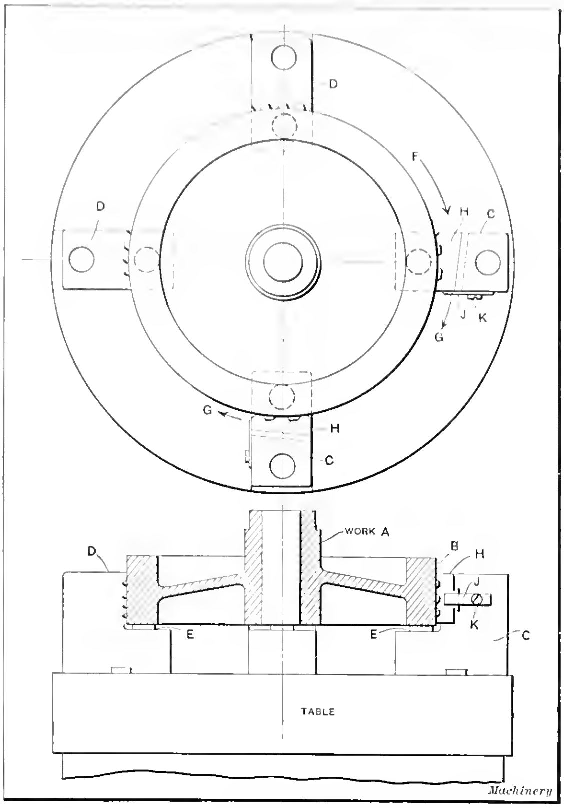

Fig. 7. Chuck for a Boring Mill having Special Secondary Jaws

for the work. The body of the chuck was bored out at *H* and *J* to a dimension 1/16 inch larger than the width of the scroll ring *G*, thereby permitting the scroll to float radially. The revolving motion of the scroll is accomplished in the usual manner by means of the pinion *L* which is squared at the end *M* to receive a socket wrench. The bushing *K* acts as a retainer. The radial movement of the jaws *D* is obviously accomplished by the revolution of the scroll ring which meshes with teeth cut on the under sides of the jaws in the regular way. The body of the chuck is bored out at *C* to fit the locating plug *B* which is ground to the size of the hole in the work. The jaws *D* are bored out at *E* to the diameter of the gear blank at this point, and they are recessed at *F* as a precaution against chips or dirt. It will be seen that while the locating is done by the plug, the jaws grip the work firmly and act as drivers without any tendency to throw any strain on the plug. The scroll, having a floating action, takes care of any inaccuracies. This arrangement is rather unusual, but its action was very satisfactory in this instance.

Locating Fixture for a Motor Frame

The work *A* in Fig. 3 is a casting of a motor frame which has been previously rough-bored and faced and shouldered on one end. This fixture was designed for finish-boring and facing the other end, and sizing the shoulder. This type of fixture is not uncommon for various kinds of work requiring a second setting. After the first setting, a drill jig is used to drill the flange holes *N*, so that a means for driving is provided. This is always an advantage, as less strain is imposed on the clamps. The body of the fixture *D* is screwed fast to the spindle *E*, and is recessed at *B* to receive the shoulder on the casting, which acts as the locating means. The body casting is also faced off at *C*, and the driving pin *M* inserted as a driver. This pin is made 1/64 inch smaller than the drilled hole to allow for slight inaccuracies in the drilling of the flange. The bushing *F* acts as a guide for the tools used. A screw *O* (shown in the end view), prevents the bushing from pulling out or turning around. The three clamps *G* are of the ordinary flat type, slotted at *J* so that they can be pulled back out of the way when placing the work in position. The bolt *K* passes through the clamp and body and is drawn up by the hexagon nut *L* on the other side, the portion *P* of the screw being squared up where it passes through the clamp to prevent its turning around when tightening. The lugs *H* are slotted so that the ends of the clamps will not tend to twist out of position. This type of fixture is quite effective, but depends for its accuracy on the fit obtained at *B*. When used for a great number of pieces it is advisable to make a hardened and ground steel ring instead of depending on the cast iron for accuracy at this point.

Split Chuck for a Bearing Sleeve

Fig. 4 shows a bearing sleeve which has been turned at *B* and *D* and faced at *C* in a previous operation. The fixture shown was made for facing the other end and boring the two surfaces *S*, but it was not entirely satisfactory, due partly to a tendency to remain closed after the clamping ring was unscrewed. A lack of spring in the chuck body was the cause of this; as it was made of machine steel, a great deal of elasticity could not be expected. Another bad feature was the position of the thread *N* which was so situated that considerable trouble was experienced in keeping it free from chips and dirt. This example is given to illustrate some of the faulty points in its construction, so that "what-not-to-do" may be clearly seen. The body of the chuck *F* was made of machine steel and was pack-hardened to obtain as much spring temper as possible. This body was screwed onto the spindle and held in place by the teat-screw *G*, which enters a slot *H* in the end of the spindle. Three pins *E* act as longitudinal stops for the work.

The inside of the chuck body is bored out to fit the work. It is threaded on the outside at *N* and tapered at *M*. Six saw cuts *J* are equally spaced around the periphery to allow for expansion and contraction. An operating collar *L* is threaded and tapered to fit the body, and six handles *O* screwed into place for operating purposes. These handles were afterward

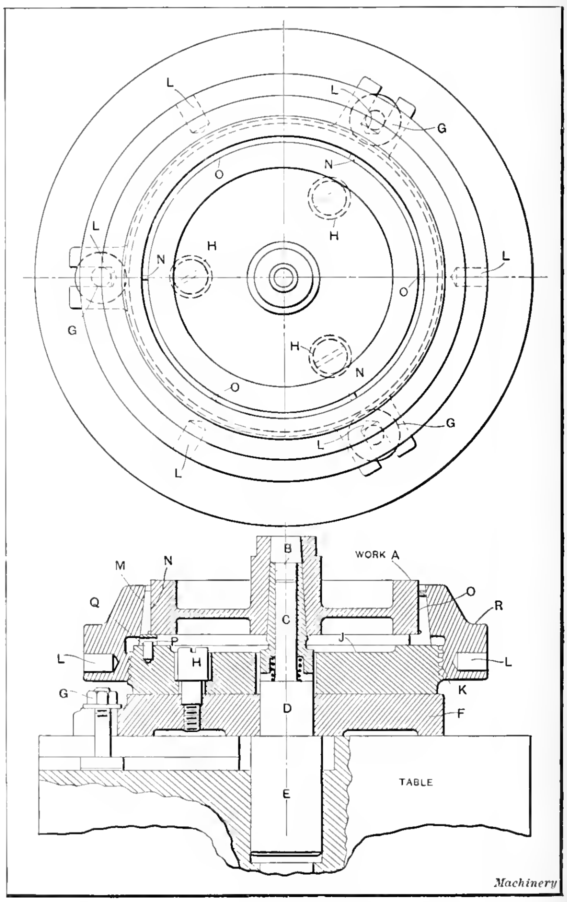

Fig. 8. Collet Chuck for Boring Mill having a Floating Action

removed by the operator (as a precaution against being injured by them) and a piece of drill rod used in the holes in place of the handles. A tool steel bushing was fitted to the spindle and held in place by screw *Q*. This bushing was relieved at *R* and ground to a running fit for the boring-bar pilots at *P*. Three holes *K* were drilled in the body so that accumulated chips and dirt could be readily brushed out. This entire chuck exhibits a lack of forethought in its design and forms an example of a poorly constructed device. As it was designed by the writer, he has no hesitation in condemning it rather forcibly, but would add that it was made a number of years ago. The recognition of its shortcomings has been of great assistance in subsequent designs.

Contracting Pin Chuck for a Small Flywheel Casting

A somewhat expensive device is shown in Fig. 5 for handling the small casting *A* on a horizontal turret lathe. It will be noted that the arrangement of the chuck is such that the weight is kept well back near the spindle bearing, so that excessive overhang is avoided. The body *C* is made of cast iron and is screwed onto the spindle *D*, where it is secured by the teat-screw *E*, access to which is obtained through the hole *F*. Three pins *B* serve as longitudinal stops for the work, and these are so placed that they can be very easily kept free from dirt and chips. The three jaws *K* are cylindrical, and are forced outward by the coil springs *L*. The teat-screws *J* enter slots in the jaws and prevent them from turning. The jaws are hardened, ground and lapped cylindrically, after which they are assembled in the chuck body and ground on the taper and also at their bearing points on the work. The operating collar *N* is a steel casting which is ground to a nice running fit at *H* and *G*, and threaded with a coarse pitch Acme thread (double) at *O*. It is ground to a taper at *J* corresponding to the taper on the ends of the jaws. It is well to note that the construction and accuracy of the chuck would have been materially improved by making a tool steel taper ring and inserting it at this point in order to minimize the wear and provide for means of adjustment. The handles *P* are a rather dangerous feature, but they permitted the operator to use both hands in tightening the jaws; this was

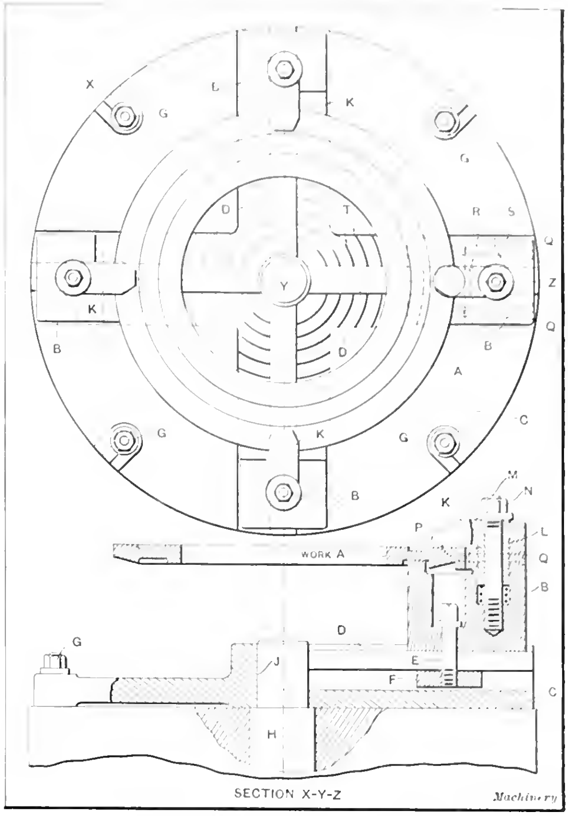

Fig. 10. Special Fixture for holding a Number of Different Sizes of Bevel Gear Blanks on the Boring Mill

of considerable advantage, as the power required took about all the strength he had. A more acute angle on the pins in their relation to the collar would have been of some assistance, but the thread diameter and frictional surfaces were large, so that ease of operation could not be readily attained. The bushing *M* acted as a guide for the tools used in generating the tapered hole. It should be noted that the threaded portion is made somewhat free and the fitting done at *H* and *G*. These closely fitting surfaces are also of assistance in keeping chips and dirt out of the mechanism.

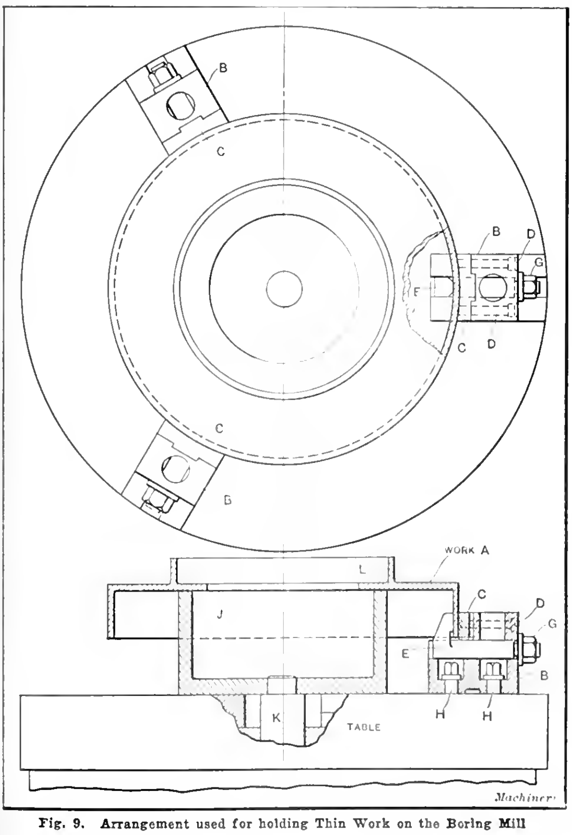

Fig. 9. Arrangement used for holding Thin Work on the Boring Mill

Spring Collet Chuck for a Steel Forging

The work shown at *A* in Fig. 6 is a steel forged collar which has been previously turned and faced on one end. The body of the chuck *B* is screwed onto the spindle *M* and is prevented from turning by the teat-screw *P*. A hardened and ground steel ring *O* is forced into the body of the chuck, and is tapered to coincide with the outside of the spring collar *F*, which is prevented from turning by the pins *L* that act as drivers in the elongated slots shown. Six slots are cut alternately at *D* and *E* to permit uniform contraction and expansion. It will be noted that the first-mentioned of these slots pass through the flange and part of the collar to a point close to the end, while the alternate slots are cut from the rear end toward the front but do not pass through the flange. In passing, attention is called to the fact that a slight tie is left at both ends of all the slots, this tie being cut out, at the end intended to be cut through, with a thin wheel after the grinding operation. If this were not done great difficulty would be experienced in grinding. The operating collar *H* is made of cast iron and is threaded at *K* with an Acme thread, 4 per inch. A recess is cut at the forward end to receive the flange of the spring collet. The cover plate *G*, made of steel, is screwed fast to the end of the operating collar. Six holes are provided around the periphery so that a piece of drill rod can be used to revolve the collar, thus forcing the collet in or out and causing it to contract or expand. The cylindrical bearing at *N* insures accuracy. Three stop-pins *C* are used to locate the work in the chuck longitudinally. One

of the disadvantages of this kind of a chuck is the difficulty of keeping it clean and free from chips. It must be taken apart occasionally and washed in gasoline and brushed out, after which it can be re-assembled and oiled on the wearing surfaces. A few moments time is all that is necessary, however.

Vertical Turret Lathe and Boring Mill Fixtures

As the class of work which is usually handled on machines of this type is of a heavier variety, it naturally follows that the fixtures required are much more massive, and also that they must possess ample driving means, on account of the heavier cuts taken. As the fixtures lie flat on the table of the machine, the weight is of no particular importance, but rigidity and proper protection against chips must be carefully considered in the design. In addition to this it is well to remember that outlets for chips are also of importance, so that the latter can be brushed out. If some provision is not made for this, it will be necessary for the operator to scoop out the chips from time to time, and this is an unnecessary waste of time. Outlets can nearly always be provided so that the matter will not be troublesome.

Special Jaws for a Large Motor Gear

The work *A* shown in Fig. 7 is a steel forging for an electric motor gear. Both the first and second settings of the pieces were accomplished on a vertical turret lathe; the operations were roughing cuts to within approximately 1/8 inch of the finished sizes. The blanks weighed something over 350 pounds and were rough-finished all over in these two settings, about eighty pounds of metal being removed. The blanks were composed of alloy steel containing a high proportion of carbon and manganese, thus making them very tough. The speeds used were about twenty to twenty-five feet per minute, and the feed from 1/16 to 1/8 inch per revolution. It will be seen from this that chuck jaws of the regular type would be put to their utmost capacity to hold the work without chance of slipping. A few of the blanks were machined in the regular type of jaw and there was more or less slippage of the work when the heavier cuts were being taken.

The method shown was suggested by the writer, but was not used on account of the few pieces to be handled at the time. The idea, however, is of some value. The two jaws *D* are of the regular type and are left set to form a sort of V-block arrangement for locating the work. The other two jaws *C* are of special design and are operated independently. Each of these jaws is fitted with a sub-jaw *H* sliding in a dovetail slot in the main jaw. This slot is cut at an angle of 15 degrees from the tangent to the work, and the jaw is kept in its normal position by means of the flat spring *J* which bears against it. The screw *K* holds the spring in place. The jaws are all provided with raised buttons on which the work rests. It may be readily seen that the pressure of the cutting tools would tend to move the piece in the direction indicated by the arrow at *F*, in case any slippage were to occur. Assume, then, that this takes place during the progress of the work; a wedging action would immediately begin at the points where these special jaws are, and this would prevent further slipping.

Large Spring Collet Chuck having a Floating Action

The flywheel casting shown at *A* in Fig. 8 represents a rather unusual condition, for the shoulder on the upper part of the hub is to be machined concentric with the tapered hole which has been machined in a previous setting. The rim, web and body of the hub are also to be machined in the second setting. A tool-steel, hardened and ground plug *E* fits the hole in the table and is a forced fit in the base *F* at *D*. The upper part of the stud is turned down at *C* to receive the sliding taper bushing *B* which is of the same taper on the outside as the hole in the hub. A coil spring supports the bushing and keeps it snugly in place in the hub. It will be noted that slight variations in the hole do not affect the locating, as the sliding movement of the taper bushing equalizes them. The base *F* is of cast iron and is fastened down by the three bolts *G* in the table T-slots. The upper portion *J* of the base is made of steel and is held down by the three special screws *H* which are fitted with clearance enough to permit a slight radial movement or "float" to the plate, and at the same time act as drivers. Acme threads, 4 per inch, are cut on base *J* to engage the operating collar *R*. A thin steel taper ring is slotted in six places *N* and *O* in the same manner as that shown in Fig. 6, and driving pins *Q* are provided which engage the slots *P* in the ring. The operating ring *R* is of cast iron, tapered at *M* to fit the spring ring. It is revolved by a drill rod handle set into any of the holes *L* in the periphery. In using the device, the work is dropped down on the spring tapered plug, which automatically adjusts itself to the hole and allows the rim of the flywheel to rest on the flange of the spring ring. It is then only necessary to revolve the operating ring, which clamps the work securely, the floating action taking care of slight inaccuracies.

Arrangement for Holding a Piece of Thin Work

The thin steel casting shown at *A* in Fig. 9 was held in the first setting by the thin flange *L* in a set of hook-bolt jaws. (See MACHINERY, July, 1913.) During this setting the large diameter was machined both outside and inside, the inside of the web faced, and the hole through the web bored. In the second setting a cast-iron pot *J* is located on the table by means of the centering plug *K* which fits the center hole. This pot is used as a support for the work while facing and turning, and also locates the piece vertically. A set of jaws *B* is provided with hook-bolts *E* which are drawn up against the work on the inside by the nuts *G*. The soft steel sub-jaws are inserted in place and fastened by the screws *D*. These soft jaws are bored out to the correct size to fit the finished work and are brought up lightly against the casting before the hook-bolts are tightened. The screws *H* enter shoes which fit the T-slots in the table jaws. It will be noted that the soft jaws can be easily replaced, thus making the life of the main jaws almost unlimited.

Special Fixture for Holding Several Sizes of Bevel Gear Blanks

The work *A* in Fig. 10 is one of ten blanks, ranging in size from 12 to 20 inches in diameter, and the fixture shown was made to handle all these sizes, by the simple expedient of moving the main jaws to an approximately correct position and inserting a set of soft jaws which are then bored to the exact size of the outside of the ring. The body *C* of the fixture is located centrally on the table by the plug *H* which fits the fixture at *J*. The four bolts *G* hold the casting down on the table. Four T-slots are cut at *D* and the main jaws are clamped in their proper positions by bolts *E* which enter the shoes *F* in these slots. Approximate locations are determined for the jaws by the radial lines *T* scored on the finished pads. Both the main and sub jaws are of machine steel, the former pack-hardened and the latter left soft. The main jaws *B* are tongued on their lower sides to fit the slots. The soft jaws *P* are made up in a long strip and then sawed up into separate pieces. They are tongued at *R* to fit the main jaws and jig-drilled for the screws *Q* which hold them in place. The hook-bolts *K* are of tool steel, hardened and drawn to a blue on the hook end, to lessen the chance for breakage. The body *L* fits the hole in the jaw and the coil spring supports it. The stud *M* is screwed tightly into the jaw and is threaded at its upper end to receive nut *N*, which operates the hook-bolt. Attention is called to the manner in which the hook-bolts are backed up by the jaw, thus greatly stiffening the clamping arrangement. The backing is partially cut away at *S* to allow the hook-bolt to swing clear of the work. This fixture was made within the past year and gave excellent results at the time of testing.

* * *

Some tests have recently been carried out at the works of Alfred Herbert, Ltd., of Coventry, England, to ascertain the comparative efficiency of ordinary and ball bearings for line-shafts. The tests showed that 5½ horsepower was required to turn over 62 feet length of 2½-inch shafting, running without belts in seven adjustable self-oiling bearings, with two ring-oilers to each bearing. In the new factory of the company, where ball bearings are fitted to all the shafts, only 2½ horsepower was required to turn a shaft of the same length. On this shaft there were seven ball bearings placed at 10-foot intervals.

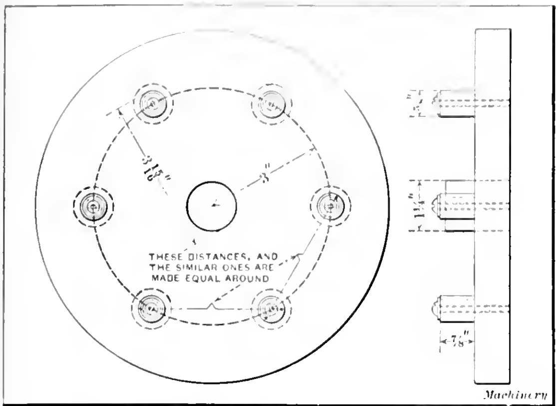

Fig. 1. Flange Templet showing Arrangement of Buttons

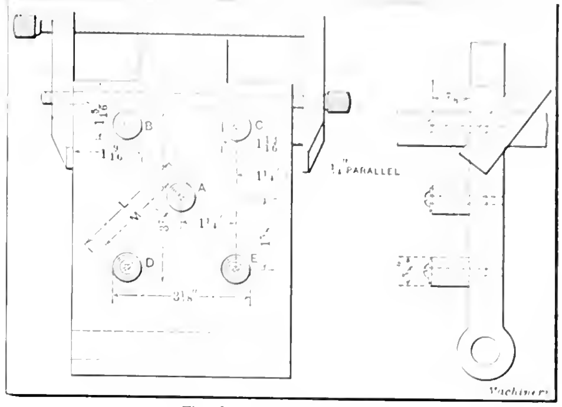

Fig. 2. Hinge Jig Templet

LOCATING HOLES IN TEMPLET PLATES BY THE BUTTON METHOD*

BY D. DALTON†

The use of buttons for locating holes in templet plates, or bushings in drill jigs, is a very accurate method even when only a fair degree of care is taken in locating the buttons; and when considerable care is taken, it is the most accurate method and, sometimes, the only one which can be employed. The increasing use of multiple spindle drills in the machine shop calls more and more for the application of this method when locating the holes for the drill bushings.

The Buttons

The buttons are shown in the side view in Figs. 1 and 2. A convenient size is from 1/2 to 5/8 inch outside diameter, and from 3/8 to 1/2 inch inside diameter. If a No. 10, 24 threads per inch screw is used this will allow plenty of adjustment. The length should be from 3/4 to 7/8 inch; it is well to have the buttons a good length, so that the indicator can be used conveniently.

The buttons should be made of tool steel and hardened. They should be ground on the outside, and both ends should also be ground off square. Care must be taken to see that they are ground to *exact* size. A 1/2-inch button must be 0.500 inch and not 0.499 or 0.501 inch, for these little errors cause considerable inaccuracy in the work. A set of buttons should be part of a toolmaker's kit.

Method of Using Buttons

Fig. 1 shows a templet plate which formed part of a fixture for drilling holes in flange plates. It was necessary to space the six holes equidistantly, so that the holes in the flanges would match up in any position and thus make the flanges interchangeable. First a plug was turned so that it fitted snugly in the 1 1/4-inch hole in the center of the plate, and projected above the top about 3/4 inch. A center was located in this plug, and from this center a circle of 3 inches radius was drawn; around the circumference six divisions were laid off. Small 1-inch diameter circles were then drawn at each of these points to indicate the outside circumferences of the bushings to be placed in the holes. These circles act as a guide when placing the buttons in position; they can be located much more quickly in this way.

The centers of the holes were next carefully prick-punched, and holes drilled and tapped for No. 10, 24 threads per inch machine screws. It is well to do this work carefully, so that the tapped holes are as near as possible in the exact center, as this will facilitate the starting of the boring of the holes for the bushings. Having now the six tapped holes around the circle, place a button at each point with a small washer on top, and fasten it approximately in the correct position; then tighten the screw sufficiently to hold the button firmly, but so as to allow it, at the same time, to be moved by tapping lightly. The radius of the circle being 3 inches, that of the plug 5/8 inch, and that of each button 5/16 inch, we find that the distance from the outside of the center plug to the outside of any button must be 3 15/16 inches. Also, since there are six buttons around the circle, the distance from center to center is equal to the radius, and the distance between the outside of any two buttons will be 3 5/8 inches.

We now have the distance each button should be from the center, and also the distance they should be apart. Then, by the use of micrometers, and by tapping the buttons gently all these distances can be correctly fixed. As each button is brought near to its correct position, it should be tightened down a little, so that it will finally be snugly located.

The work is next strapped on the faceplate of the lathe, and one of the buttons made to run true; this should be done accurately by means of an indicator. When the button is made to run true, the No. 10 machine screw may be loosened and the button removed. It will be found that in nearly all cases the small tapped hole will not be running true, and if a drill is used right away it will probably break off. A lathe tool can be used to cut away the front of the hole and so give a true start to the drill. This process is repeated for each button, and if care is exercised, the holes will be accurately located.

Fig. 2 shows a method of locating a button from the side of a plate. It will readily be seen from the illustration that the buttons *B*, *C*, *D* and *E* could not have been located with certainty from the center alone, for while they could have

* The following articles on this and kindred subjects have previously been published in MACHINERY: "Three-disk Method of Locating Holes," July, 1913; "Method of Accurately Locating Drilled Holes," May, 1913; "A New System for Locating Holes to be Bored on the Milling Machine," April, 1912; "Drill Jigs," January, 1907; "Drilling Jig Plates," October, 1902. See also MACHINERY'S Reference Book No. 3, "Drill Jigs."

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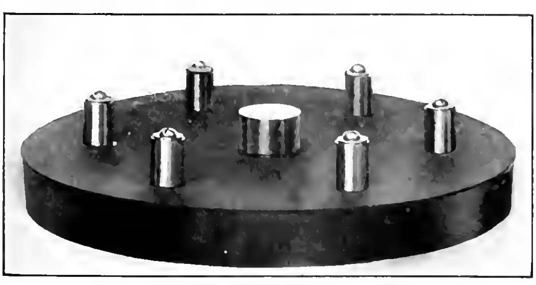

Fig. 3. Flange Templet shown in Fig. 1

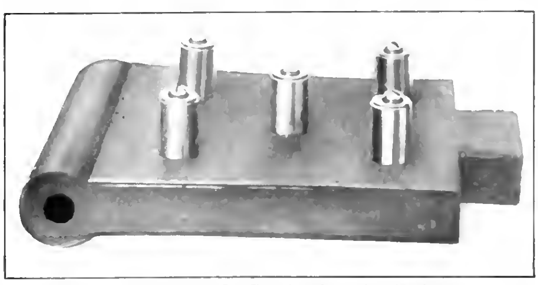

Fig. 4 Hinge Jig Templet shown in Fig. 2

been located the correct distance from the center, they probably would not have had their correct position with respect to the fixture as a whole. It was necessary, therefore, to work from the side and the center.

The width of the plate was carefully measured and found to be 5 inches; then, since the center to center distance of B and C was $2\frac{1}{2}$ inches, that left $1\frac{1}{4}$ inch from the center of B, C, D and E to the outside of the plate. A $\frac{1}{4}$-inch parallel was clamped against the side as shown in the illustration, and then the distance from the outside of each button to the outside of the parallel, 1 13/16 inch, was used in conjunction with the distance L. Distance L was obtained by first solving for M by the use of the right-angle triangle, as follows:

$M^2 = 1.25^2 + 1.625^2$ or

$M = \sqrt{1.25^2 + 1.625^2} = \sqrt{4.024}$.

Therefore, M = 2.050 inches, and L = 2.050 + 0.625 = 2.675 inches.

In this case the center button was first located correctly from the sides and end, screwed down tightly, and not moved while the other buttons were being located.

* * *

Steel passenger cars are built with double walls and insulation between. The insulation deadens the sound and acts as a non-conductor of heat, thus making the cars warmer in winter and cooler in summer than they would be without it. The application of the insulating material was formerly accomplished by attaching it to galvanized sheet steel strips with nails clinched. The strips were attached to the framing by stove bolts. The drilling of holes and placing of the bolts and strips was a slow, tedious and costly job. The method has been displaced by a much simpler, cheaper and neater one that depends on the electric welding process. The car is placed in a circuit of 220 volts, the circuit being completed when the workman applies the head of a special nail to the steel side of the car. The nail is held in a pair of pliers provided with insulated handles and connected to the electric cable. The speed with which the nails can be welded to the car is very great and the cost of fixing the insulation in this way is reduced to about ten per cent of the old method. The insulation is applied by pressing it against the nails which penetrate it, and they are then clinched to hold it in place.

HARDENING BOLTS BY THE TON

The best grade of carriage and machine bolts is made from a low carbon steel about 0.15 per cent carbon, low in sulphur and phosphorus. This steel, while it will not harden by heating and dipping in water, is made much tougher and its elastic limit considerably increased by the proper heat-treatment. In order to secure a uniform heat-treatment and to turn out large quantities of machine and carriage bolts, the National Screw & Tack Co., Cleveland, Ohio, has installed a very interesting hardening equipment that is used for this purpose. Fig. 1 shows two of the furnaces used and gives a general idea of the method of handling the bolts when hardening, dipping and washing. The bolts, before being conveyed to the heat-treatment department, are sorted and all those of similar sizes and styles are placed in boxes, each box holding about 75 pounds. They are then conveyed to the heat-treatment department, piled up beside the entrance to the furnace, as illustrated in Fig. 2, and gradually fed through the furnace, which is of the drum type and kept in continuous rotation. The inside of this tubular furnace, which is from 10 to 12 feet long by $3\frac{1}{2}$ to 4 feet in diameter, is lined with firebrick arranged in such a manner that a conveyor screw is formed by the convolutions of the firebrick. This drum is rotated by two friction rolls on one side, and rests on two rolls on the other side. The two friction rolls on the right-hand side of the furnace are driven by a shaft which, in turn, is driven through gearing from the overhead works. The drum is rotated at a speed of one revolution in fifty seconds.

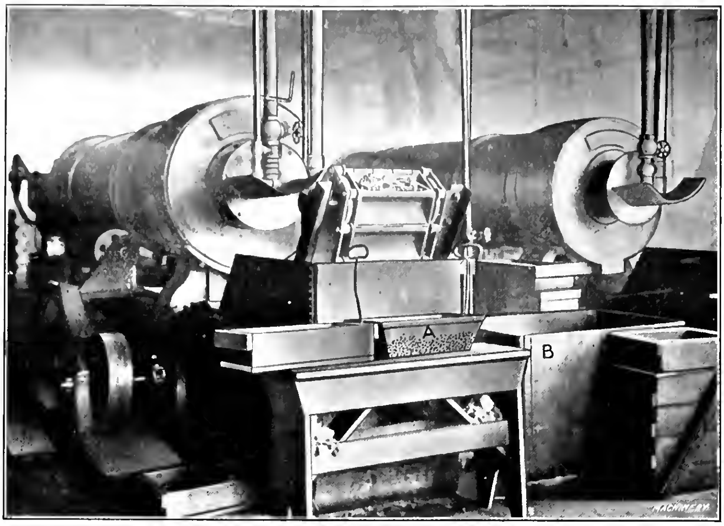

Fig. 1. Two Rotary Hardening Furnaces for heat-treating Carriage and Stove Bolts

Fig. 2. The Feeding End of the Rotary Furnace, showing Conveyor Method of carrying Bolts from Boxes to Screw in Furnace Drum

The inside of the furnace is kept at a uniform temperature of about 1400 degrees F., by a burner which burns natural gas. The bolts are started through the furnace in the manner shown in the illustration Fig. 2. The operator dumps the bolts into the hopper A, through which a conveyor B is continually passing that is rotated through belting and gearing from the overhead works. This conveyor passes down the other side and deposits the bolts in a chute, through which they pass into the screw or conveyor in the furnace.

This screw gradually carries them toward the other end and in passing they are heated to a temperature of about 1400 degrees F. It requires eight minutes for them to pass through the inside of the furnace. The smaller the bolts, the greater the number that can pass through at one time. On carriage bolts, ⅜ inch diameter by 3 inches long, about 1180 pounds are hardened per hour. The furnace, of course, is kept working continually for twenty-four hours per day, as it would require a considerable time to get it up to the proper temperature after it had once cooled down.

As the bolts gradually work to the emptying end of the furnace, they drop out into a bath of water which is heated to a temperature of almost 212 degrees F., that is, it is kept boiling. This cools the bolts off slowly, does not harden them,

Fig. 3. Conveyor used in taking Boxes from Hardening Room to Packing and Shipping Departments

but just toughens them. The conveyor works through this bath, carries the bolts up again as illustrated in Fig. 1, and deposits them in a steel pan *A*. When this is almost filled, the operator removes it and drops it in the bath *B*, which is composed of soda and oil mixed with water. The bath is also steam heated and is used to give a good finish to the bolts after hardening; that is, it brightens the bolts and gives them a dark glossy coating. This soda and oil bath also makes the bolts rust-proof and gives them a very good looking finish.

After the bolts have been dipped in the bath as previously mentioned, the steel pan is removed, the bolts deposited from it into a wooden box and the box then placed on the esculator shown in Fig. 3. This, as can be seen, is arranged to take a box of the desired width, which it carries up to the next floor, and as each box passes the point *A* it operates the counter so that every box passing from the hardening department to the packing department is kept track of. This method of handling bolts reduces the manufacturing cost to a minimum, and what is more, a uniform heating and hardening effect is secured at almost no cost. On a bolt that is ⅜ inch in diameter by 3 inches long, a production of 28,320 pounds, or almost 13 tons, is secured in twenty-four hours. D. T. H.

* * *

Trials have been made in Germany to ascertain the possibility of using the oxy-acetylene torch for removing the scale in boilers. These are reported to have been successful. The deposit is immediately removed without injury to the plate.

MANGANESE STEEL CASTINGS

Considerable secrecy has surrounded the making of manganese steel castings. Only a few concerns have been engaged in this industry and they have guarded the methods used with great care. In an article in the April number of *Foundry*, F. R. Zerhansen gives some information relating to the composition of manganese steel and the methods used in its production.

In making manganese steel castings, the metal is refined in a bessemer converter from which it is poured into a ladle in which the proper quantity of ferro-manganese has been previously placed. Either a standard bessemer or a tropenas or other modified type of converter may be used. The molding equipment is similar to that necessary for the production of unalloyed converter steel castings, and similar raw materials, including low phosphorus pig iron and selected steel scrap, are used. From a metallurgical standpoint there is nothing to prevent the successful production of manganese steel in open-hearth furnaces, and it is possible that there may be some developments in the future along this line, although at present the converter process is strictly adhered to.

The alloying material added is commercial, 80 per cent ferro-manganese, which is melted in crucibles in oil-burning furnaces. The quantity of manganese required varies somewhat with the nature of the castings, but 12.5 per cent is a good average figure. To produce castings that will show this amount of manganese upon analysis, it is necessary to add about 312 pounds of 80 per cent ferro-manganese to each net ton of steel. This is done, as previously stated, by placing the melted alloy in a hot ladle before the steel is poured from the converter. After the steel has been added to the alloy, the ladle is allowed to stand for a few minutes to permit the ferro-manganese to remove the oxygen and other gases and impurities from the metal, leaving it homogeneous and dense. The excessive accumulation of slag is then removed by skimming.

The shrinkage of the metal is unusually great, but otherwise the principles of ordinary steel foundry practice apply in making the patterns for manganese steel castings. The shrinkage amounts to 5/16 inch per foot. Ordinary steel shrinks only about 3/16 inch. Patterns, therefore, must be specially made for this material, as otherwise the castings will be under size. Abrupt changes in section are more objectionable with this steel than with other kinds. The molds must be made from sand containing a high percentage of silica, and are usually oven-dried, although in some cases skin-drying is sufficient.

Manganese steel castings are generally allowed to cool in the mold and are then annealed from three to twenty-six hours at temperatures ranging from 1800 to 2000 degrees F. At the conclusion of this process, they are removed red-hot from the annealing oven and are quenched suddenly in cold water. Some castings, however, need a preliminary treatment to remove cooling strains, and in this case they are taken from the sand while still hot and slowly cooled in an oven, after which they are reheated for annealing and quenching as described.

Unannealed manganese steel castings are exceptionally brittle and almost glass hard. After the heat-treatment, they are tough and ductile with a tensile strength of about 90,000 pounds and an elastic limit of about 60,000 pounds per square inch. The ductility of the metal is indicated by the elongation and reduction of area, frequently amounting to about 28 and 29 per cent, respectively. It is possible to satisfactorily anneal manganese steel castings having a thickness up to about 5½ inches. After the castings are annealed, they are cleaned and finished on grinders. Castings which must be accurately finished to given dimensions cannot be machined by ordinary methods on account of their toughness, but must be ground to size.

* * *

A boiler inspector in the middle west writes: "Farm hands would be more numerous here if this state had an engineer's license law, it occurs to me."

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ON SETTING UP MACHINE TOOLS

Probably the builders of machine tools in general receive more complaints that are due to the fault of the purchasers than other machinery builders. The reason is that lathes, planers, boring mills and other machines of precision must be set level on even foundations in order to produce accurate work. A slight twist in a lathe bed will prevent it turning or boring straight. The user must set his machine up properly in order to obtain satisfaction. Not many machine tool builders, however, have as exasperating an experience as one whose machine was set on a foundation covered with rust cement.

Rust cement composed of iron borings and sal-ammoniac was much used in the early days of engineering in the construction and erection of machinery. A foundation covered with this cement might have been good when machines were small and not over-accurate, but today it is a different matter. This machine tool builder had furnished a boring mill to a customer who was very particular as to the accuracy of the work produced. The machine was shipped and set up, and after it had been in use a few days an urgent letter of complaint was received, stating that it was boring a taper hole and requesting that a man be sent to correct the fault.

The superintendent went to the plant and looked the machine over, including the foundation. When he saw that the purchaser had set the mill on rust cement he immediately suspected that the cause of the trouble was the slow expansion of the cement due to the rusting process, but could not convince the purchaser that this could be the cause. The table was lifted and the track scraped a little, the wedges under the machine readjusted, when the machine bored a perfect hole. In a week another complaint was received and again the superintendent went and corrected the fault. He again told the purchaser that the cause was the lifting action of the cement but was not believed. A third time was this episode repeated and then the purchaser was induced to remove the rust cement and float in a grout of hydraulic cement. This stopped the trouble as the superintendent had predicted.

It hardly seems necessary to say that any medium underneath a machine likely to change is undesirable. Ordinary cement is cheap, easily obtained and can be depended on to maintain its integrity under normal shop conditions.

EFFICIENT JIG DESIGN

A walk through many American manufacturing plants will demonstrate to one familiar with the best machine shop methods that there is still much to be done in cutting out useless and time-wasting movements. The superintendent who has to provide equipment for producing a comparatively small number of parts is likely to order jigs and fixtures made as simply as possible. This usually means primitive clamping devices—nuts and bolts, for example. Often these clamps are inconveniently placed and the operator loses time in making many unnecessary movements.

Now it does not require a highly trained efficiency expert to avoid such mistakes. Applied common sense is the secret of good engineering, whether it be the building of a jig or a great bridge. Both the jig and the bridge are but means to secure an end. A toolmaker can generally make a simple fixture convenient to use as easily and quickly as an unhandy trap. The first is efficient, the second may be a time-waster to such a degree as to be a costly device before worn out or superseded.

In general, a jig should be self-contained, requiring no detached parts or wrenches for operation. If, in addition to a wrench, a hammer must be used to set up the clamp firmly, it is a poor device.

* * *

BALANCED DRILL CHUCKS

A manufacturer of a very good sensitive drilling machine running at the usual range of speeds had been using a standard line of drill chucks for a good many years with satisfaction. Recently he developed a high-speed drilling machine operating at several thousand revolutions per minute. His concern prided itself on the good work it did in aligning its spindle bearings and every spindle was tested for alignment before leaving the factory. When the new type of machine was first operated, he applied chucks of the usual type, but found that under the high speed the spindles ran out considerably. With the drill chucks removed, the spindles ran perfectly true again, showing that the trouble lay in the drill chucks themselves. Out of a lot of fifty chucks, only three were found to run in balance at high speed. In a word, the chucks that ran satisfactorily at 1000 R. P. M. ran out badly at speeds of from 5000 to 10,000 R. P. M.

The chuck manufacturer when called in to examine the machine learned a new lesson in chuck requirements, and on the next lot of chucks special care was taken that the individual parts were balanced, the result being that no more trouble has developed from this source. The balancing of chucks for use on high-speed machines is highly important, though a point usually overlooked by machine builder and chuck maker alike.

* * *

AFTER THE MACHINE HAS BEEN SHIPPED

Not many hundred miles from New York City there is a manufacturing concern making a special machine which performs but one very simple operation—so simple that in the minds of the builders there could be no cause for complaint about its performance. In fact, they had been building the machine for years without receiving serious criticism.

Recently, a friend of the manager of this company, whose work takes him into many shops where the machine is in use, pointed out that whenever he saw one of these machines he noticed invariably that one of its bearings was kept covered with a heavy piece of paper tied on with a string. In every case this piece of paper was oil-soaked, so the visitor rightly concluded that the paper was to stop the spattering of oil from this bearing. The factory manager saw the point immediately, and the result will be a change in the design of this part of the machine.

The moral to this little incident is that no matter how simple a machine or specialty may be it is to a manufacturer's interest to follow his machines to the place where they are operating. An occasional trip around the trade to see how his product is working out will benefit him, his machine and the general users of his product.

HOMEMADE SCIENTIFIC MANAGEMENT

When "efficiency engineers" are employed to introduce methods of scientific management in a factory, their work is usually hampered by opposition from the employes. It is only natural for foremen and mechanics who have spent a number of years in acquiring a knowledge of the methods used in their work to feel that they are more familiar with the practical details than the so-called "efficiency experts" who are called in to improve them. The result often is that the men in the shop give little or no assistance to the efficiency engineers; but are rather inclined to throw obstacles in their way. This means that the engineers must spend a considerable amount of their own time and their client's money in cultivating the good will of the factory staff before they are able to get down to actual work.

Scientific management has been aptly defined as "the application of common sense in manufacturing methods with the view of increasing efficiency." The name sounds formidable, but the methods are often very simple. In most cases, efficiency engineers are called in to increase production rather than to improve the quality of the work; and their services are needed because the factory staff has devised carefully thought out ways and means for producing work of the required perfection, but has depended largely upon physical effort to keep the rate of production up to a satisfactory standard. The importance of eliminating lost motion and useless effort in turning out the maximum amount of product for a standard day's work has not been appreciated. This is what the efficiency engineer strives to do.

In efficiency engineering, as in other fields, experience is of value; but while the efficiency engineer may produce satisfactory results with his knowledge of general conditions, he is likely to fail through lack of specific information concerning the industry in which he is temporarily engaged. This lack of specific information often leads the efficiency engineer to recommend methods which he has applied successfully in one line of work, but which may prove a complete failure in another line because they conflict with existing conditions which have been overlooked. Men who have spent years in learning the details of one particular kind of work are naturally familiar with the practical conditions governing its production, and if such men could be taught to undertake the development of plans for increasing efficiency, there would be little danger of failure on account of their methods being unsuitable for the purpose for which they were intended.

One of the greatest drawbacks in the departmental method of factory administration is that it is responsible for killing ambition among the employes in a shop. Men are hired to run a drill press, milling machine or other tool and are kept on such work continuously, with the result that they lose interest and fail to develop the initiative which will fit them for more advanced positions. Any plan that can be adopted to remedy this difficulty directly benefits both the employer and the employe, and it appears that "homemade" methods of scientific management could be developed in this connection to very good advantage.

Some men in a shop have good ideas in regard to methods of reducing production costs, but diffidence prevents them from placing such ideas before the management. Other men are capable of developing valuable ideas, but lack incentive. Both of these classes could be reached by using a suggestion box in connection with some effective method of reward. In the case of shops working on a bonus system, the interests of employer and employe are both benefited by any method which increases efficiency, so that in such shops the necessary incentive already exists. In other cases, the reward might take the form of cash prizes for ideas of sufficient merit to be used in the factory, or better still—a record of useful ideas submitted by each man might be preserved in the office and this record made the basis of promotion. The application of this system would be the direct means of counteracting the effect of the departmental method of manufacture in killing ambition among the men in the shop.

* * *

The most effective safety appliance yet discovered is a careful man.

EXPORT AND IMPORT TRADE*

BY O. S.

Having been engaged in the export and import business both here and abroad for the last twelve years, I am almost daily confronted with questions from American manufacturers concerning the possibilities of exporting American manufactured goods to foreign countries in all parts of the world. With the present changes in tariff and the new democratic administration, this question of "export" has become more prominent than heretofore, and has attracted even the attention of the general public. A few remarks dealing with the fundamental principles of exporting are therefore quite timely.

It is a striking fact that whenever an American business man mentions export to foreign countries a considerable change takes place in his general attitude. No matter how confident and self reliant he may be about his business ability at home, his splendid system and organization, his up-to-date manufacturing methods, his efficiency, etc., his confidence in himself and the whole American nation seems to fail when it comes to the question of export. "Well," said one prominent American to me a few days ago, "look at the Germans; they are better business men than we, they are doing an export trade of manufactured goods to every little corner of the world. Why it is preposterous to think that even in countries like the Philippines, Cuba and the South American Republics, we depend on the German export houses to handle our own goods." Some blame it on the government; others attribute it to the fact that the young American has no liking for absorbing foreign languages.

Neither is the true cause. I venture to state at the outset that the average business man in America is at least equally, if not more progressive in all branches of business than his German or English cousin. The reason that his export trade is not developed in the same high degree is due to quite natural circumstances; in fact, it is due to an almost insurmountable natural law, as I will try to explain in the following.

I will begin with an explanation of the meaning of the word "export." Usually, for the manufacturer who has done no export business at all, or only a little occasionally, the word export has quite a charm. He pictures in his mind an order mailed to him from a foreign country with a strange looking envelope, stamp and order sheet. When he has that order, all that is left to do is box up the goods, follow shipping instructions on the order sheet, and collect money in New York by means of draft attached to bill of lading. No trouble at all, not even as much as is sometimes experienced at home when furnishing machines to a neighbor, where the superintendent is "the best mechanic in the country." Unquestionably, it is a desirable business with no expense attached, to speak of; and as a general rule, I must admit that the American manufacturer is very exacting about carrying out instructions properly, and boxing and carefully inspecting the goods he sends out into foreign countries. He is proud to do an export business. But the word "export" has an incomplete meaning; in fact, it signifies only half or third of the entire transaction. The other half is the word "import." That is to say, the foreign country to which the machine is shipped is importing it. Therefore the whole word should be "export-import." But this import part of the transaction rarely receives any consideration whatever; usually the manufacturer does not even know the name of the importer on the other side of the ocean, and is not interested in his general welfare after the goods are shipped and paid for. Here is one point at which the American business man can develop more action. If the prospects for selling many machines are not sufficiently large to warrant the expense of a personal visit, write your importer from time to time, calling attention to improvements made in construction; write him about the talking points of the machine; give him examples of production and examples of application to new lines of business. In short, teach him by mail how to handle your

* For additional information on export trade and allied subjects, see "Packing Machine Tools for Export" published in MACHINERY for February, 1906, and "Packing Machinery for Export," July, 1909.

line of goods the same as you would instruct one of your agents or traveling salesmen at home.

In case your line of goods has good selling possibilities in foreign countries on account of patent protection or superior features of either quality or lower price, a personal visit to your importer from time to time is by all means desirable. Do not hesitate to go because you cannot speak a foreign language. Your importer will speak English. It is part of his vocation to speak a few foreign languages, the same as you must know something about a planer even though you build a lathe. When there, convince yourself that your importer is the right representative for you; that he has the facilities to cover the country and the means to finance his deals. Importers have to give credit to their customers, and if your man is limited in capital, he will be limited in accepting orders.

After being fully convinced about these matters, do not leave your importer until you have injected into him and his salesman an enthusiasm about your machine, the same as you have yourself. Assist him wherever you can; consider carefully his suggestions; make changes, if required, to suit the particular wishes of the user. Do not think that if you sell it that way in the United States, it is good enough for other countries. Other people think differently from you, and you will have neither the chance nor the time to educate the importer and his staff after you have left. On the prices for export business do not figure all your overhead expenses and domestic advertising and selling expenses. Consider that your importer has to advertise and sell on his own account, and that he has to add his expense to his cost. No importer can expect to stay in business with 10 or 15 per cent commission and be successful, any more than you could be if you were to add 10 to 15 per cent to the actual manufacturing cost of a machine, and cover with this the salaries of your office force, salesmen, traveling, advertising expense, etc.

Anything more that I could offer in the way of suggestions would be details into which I do not intend to go at this writing. I will therefore answer now the question, "Why do we Americans mostly depend on foreigners to sell our goods even in countries like the Philippines, Cuba, Argentine, etc." As already indicated at the beginning of this article, the cause is a natural consequence of a natural law. Let us suppose that, starting from tomorrow, the American people would begin to teach foreign languages in public schools and succeed in making excellent linguists out of their youngsters. Would the export trade of the United States improve, and would the Americans do the business themselves? The answer is, "No." There would be, perhaps, other things being equal, a small increase in business due to a little more interest; but the majority of the business would still be done through foreign import houses, principally English and German. Why this is so is very simple indeed. There are almost no American born importers in foreign countries, and their number is not expected to increase in the near future. The young American is not going to foreign countries to work and be satisfied for any length of time.

By way of contrast, take as an example the German nation. You will find its representatives in every country in the world, even on the littlest island in the South Sea. These Germans, however, did not originally go there because they intended to make the Fatherland great by building up a large export for Germany. They went because they could earn more money and afford a higher standard of living there than at home. The Italian may go to Germany, the German to England, the English to the United States, but the American will stay at home. There is no country for him where he can earn more money (a few specialists or experts are paid high salaries) or get a higher standard of living. The stream is never flowing in the opposite direction. Take the conditions within the boundaries of our own country. If in Rochester, N. Y., a young mechanic is paid 30 cents an hour, and he reads that in Detroit the wage for his kind of work is 50 cents an hour guaranteed, and lots of people are in demand, he will pack up some day and go to Detroit. A farmer in the east, if he hears that raising corn is easier and more profitable in the west, will move some day. This is the natural order of things. English and German people have early begun to go to foreign countries, and they are now established and acquainted with conditions. Their governments have ably assisted them in every way, by means of brains and power.

If the voluntary emigration of German or English people becomes less, because of better wages and an improved standard of living at home, the established merchants will make efforts to get them by promising an even better salary than they are getting at home.. If the merchant cannot afford to pay more, the business will in time pass into the hands of the natives or the representatives of some other nation. If, on account of the new democratic regime, the United States' scale of wages should decrease and the standard of living become lower than in any other country, the young American, the same as the citizen of any other nation, would begin to emigrate to foreign countries. He would, the same as others, be satisfied with his better wage for three, five or ten years, as an employe for another firm, then establish himself as an importer.

As the matter stands now, I believe Americans have no reason to desire the emigration of their young people, if it would have to be at the sacrifice of the present high standard of living and good wages for everyone. Americans can increase their export trade by getting in touch with established export houses, regardless of what nationality the owners are. Importers are business men in the strictest sense and do not know any feeling of antagonism against any other nation, no matter what the newspapers write to the contrary.

* * *

MATERIAL IN CAST-IRON FLYWHEELS

Attention is called in *The Travelers' Standard* to the danger of using cast iron containing too much phosphorus for flywheels and pulleys. Flywheels sometimes burst, without any apparent cause, at low speed, the running conditions being normal at the time of the accident. When the material is examined, it may be that no defects can be discovered on the fractured surfaces, and that no cracks, blow-holes, nor discolorations can be found. Furthermore, when the fractured parts of the wheel are tested for strength, there is often no physical evidence of inferiority in the material.

An accident may sometimes result from internal stresses in the material, due to faulty design or to careless cooling of the casting; but severe internal stresses seldom occur except in wheels made in one piece. Some other explanation must therefore be sought for accidents of this nature, and the cause will often be found to be the use of improper raw material in the foundry. Chemical analysis frequently shows that the iron is not of a grade suitable for machine castings. This is particularly likely to be the case in wheels from small foundries that turn out all kinds of work, because in such places the same grade of raw material is likely to be used for castings of all kinds. A considerable part of the output of a foundry of this sort requires metal that will flow freely, so as to fill the forms well. In making ornamental work, for example, it is highly important to obtain a sharp impression. Such iron invariably contains a large percentage of phosphorus. Phosphorus lowers the melting point, but makes the iron brittle; and machine castings should never contain more than 0.4 per cent of it.

There is on record a case where a pulley burst under ordinary running conditions, and where no defects could be discovered in the broken wheel by a visual examination; but an analysis of the iron showed that it contained 1.37 per cent of phosphorus, or nearly 3½ times the maximum that should have been allowed. There is little doubt but that brittleness of the metal, due to this high percentage of phosphorus, was the cause of the break. From a safety point of view, it is exceedingly important to make cast-iron wheels of material with a low percentage of phosphorus.

* * *

Don't forget when drilling a hole on an angle, that the drill is going to come through on one side of the work first, and that care should be taken to let it through carefully or it is likely to be broken.

PRESSED VS. MACHINE FINISHED PARTS

BY P. O. URBANI-PUSCHMANN

In the manufacture of interchangeable parts such as are used in the assembly of adding and addressing machines, registers, scales, typewriters, etc., a large quantity of duplicate pieces of a tubular or hollow cylindrical form are used. These must not only be absolutely concentric but interchangeable and yet low in production cost; hence it becomes quite a problem for the shop superintendent to decide which is the best, quickest and cheapest way to produce such parts. If the quantities required are small, say not over one thousand pieces per lot, and the lots are far between, and if cheapness need not be a prime factor in his calculation, the superintendent will invariably decide in favor of screw machines, either automatic or hand operated. The percentage of perfect or interchangeable parts that will be obtained from a given lot depends largely upon the condition of these machine tools, the skill of their operators and the stringency of the inspection limits.

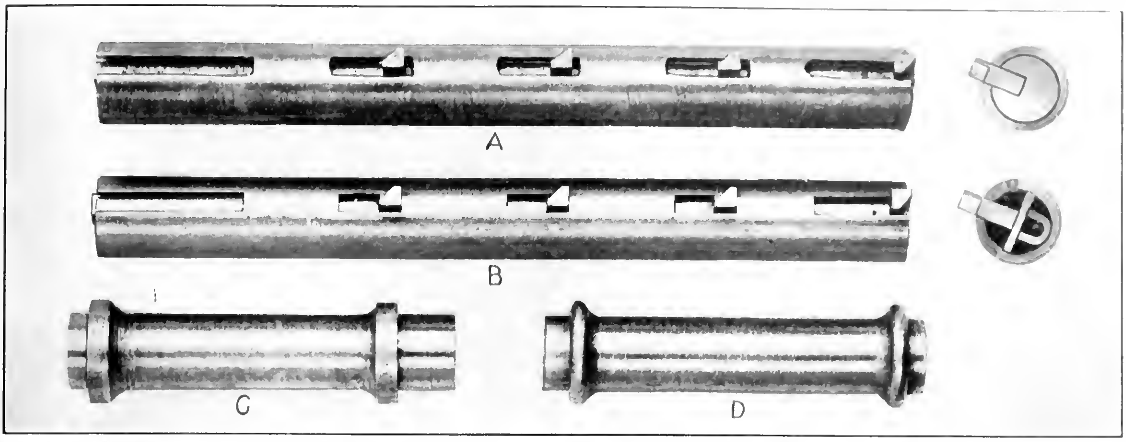

Fig. 1. (A) Part machined from Bar; (B) Same Part produced from Sheet Steel in Dies; (C) Machined Spacer Tube; (D) Die-formed Spacer Tube

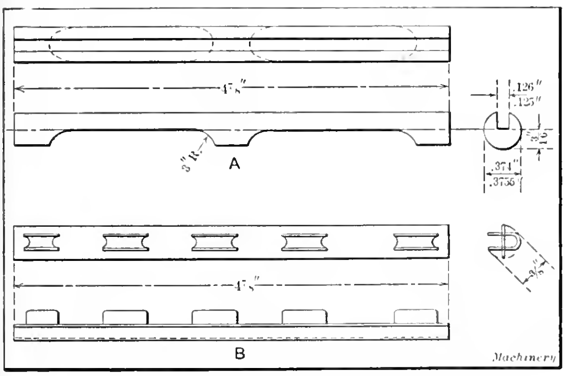

Fig. 2. (A) Slotted Rod for Hollow Shaft shown at A, Fig. 1; (B) New Method of producing Part to replace Solid Rod A

Another reason why screw machines are generally favored for this class of work is because of their adaptability to various forms of cylindrical work without a great investment for special tools, except a nominal figure for forming tools and reamers. This factor is perhaps the trap in which many otherwise shrewd shop managers are caught, because they see only the low initial cost for tools and overlook entirely the loss per lot due to slow production, to work spoiled or not passing inspection, and the fact that their screw machine department becomes overtaxed with work that could be done advantageously with special tools in punch presses or special machinery. Therefore they deprive themselves of the use of their screw machines and milling machines for work that cannot be done to advantage in any other way.

The accompanying illustrations show examples of work which will illustrate the idea referred to in the foregoing. Fig. 1 (View *A*) represents a hollow shaft with slots running parallel to its axis, and Fig. 2 (View *A*) shows a slotted filler for this shaft. Fig. 1 (View *C*) shows a spacer tube, and Fig. 3 (View *A*) illustrates a threaded housing for a ball race.

After a superficial examination of these illustrations, nearly every practical man would assign these parts to the screw machine for the first operation, to be followed, where required, by a slotting operation on the milling machine. The fact is that these parts have been made for years in just this way in our factory until we realized that they were costing considerably more than their allotted allowance in the assembly of the machines. On account of the very close limits on length and concentricity of the outside with the hole, the inspection loss had been very great and the time of production slow, so that the screw machines fell behind with other work. This necessitated working overtime and employing night shifts at higher wages, which meant an increase of pay roll, an increase of power and light bills and raised our entire overhead charge, affecting directly the production cost of the screw machine department in total.

The parts shown at *A* and *C*, Fig. 1, were first made of seamless steel tubing of sufficient wall thickness to allow machining the pieces both inside and outside. The hole was first bored and reamed to size, but since tubing having such a wall thickness coald not be secured absolutely true and the drill and reamer followed the old hole subject to the law of least resistance, we could not get concentric work until we finished the outside surface by a later operation. This was done by driving the pieces on arbors and turning them between collet and center. By this method the work was made true, but the finish depended, of course, on the sharpness of

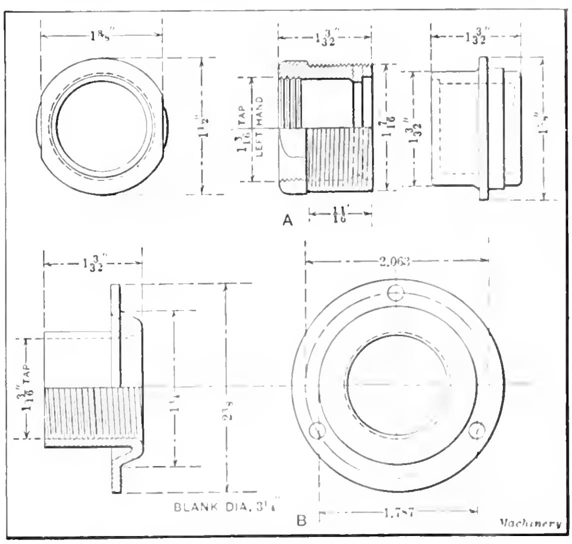

Fig. 3. (A) Ball Race Housing machined in Gridley Automatic; (B) Ball Race Housing pressed from Sheet Steel

the cutting tools and the cutting speed of the machine. Anybody acquainted with machining unpickled steel tubing knows what that means.

Finding this method unsatisfactory we changed the material and made the parts of cold-drawn steel shafting of the largest diameter of the finished pieces, depending upon the accuracy of the stock for the outside surface, the size of the reamer and copious lubrication for the size and smoothness of the bore, and on good luck for the truth with which the drill and reamer would come out on the other end, or rather meet in the center, inasmuch as our automatics have only a 2-inch feed and we had to add another drilling and reaming operation on a hand machine.

On account of the lower price for cold-drawn shafting, as compared with steel tubing, and because the machining of the outer surface of the hollow shaft *A*, Fig. 1, was omitted, the final cost of these pieces was about one-third lower when made of cold-drawn shafting, in spite of the additional drilling through the center. However, even at this reduction, the price was too high because of the large inspection loss due to eccentric work, as well as to rough or oversize holes. The part shown at *A*, Fig. 3, was also made of cold-drawn shafting on a Gridley multiple-spindle automatic. The thread had to be absolutely true with the bore and was chased on the lathe.

The part shown at *A*, Fig. 2, was made of special gaged cold-drawn shafting, cut off on a hand screw machine and then slotted and milled, at great expense, in two operations. View *B* shows how this part was produced by the new method. The appearance is somewhat modified, but it serves the identical purpose. In manufacturing this part by the new method we finally dispensed altogether with the expensive and unreliable screw machine and milling operations, leaving these machines available for other jobs, thus avoiding the expense of overtime and night work and, incidentally, reducing the cost of the products to a surprising extent.

All of these parts, with the exception of the one shown at *D*, Fig. 1 (which is die-formed of seamless steel tubing of a gage to give the correct diameter at the shoulders and requiring no machining or finishing) are now formed of cold-rolled open-hearth sheet steel in special dies and require either no machining or very little. In spite of their great cheapness, the pressed products are far more satisfactory, uniform, and, therefore, interchangeable, than the expensive machined pieces were. An added advantage of the pressed pieces is their smoothness and wearing qualities due to the rolled surface of the raw material. To produce these pieces from cold-rolled sheet steel, instead of from bar steel in the screw machines, required an investment of about five hundred dollars, but the saving on the first lots repaid for this expenditure and left a profit besides.

The examples referred to in the preceding, while based on facts, are by no means suggested as a criterion by which other conditions should be regulated. They merely indicate one man's opinion and illustrate how we dealt with perplexing conditions and remedied them to our entire satisfaction. If this article has suggested ways and means by which others confronted with similar troubles will be benefited, it has served its purpose.

* * *

COAL RESOURCES OF CANADA

From time to time sensational writers hold up to view the horrors of the conditions that will arise when the fuel supply of the world gives out, and many have placed the time when this will happen as only about a couple of centuries distant. However, as time passes on an increasing number of coal deposits are being found in districts at the time not suspected as coal bearing. The Geological Survey of Canada gives the following figures for the actually known deposits of coal in the province of Alberta alone: Anthracite, 668,000,000 tons; bituminous, 3,200,000,000 tons; semi-bituminous coal and lignites, 385,000,000,000 tons. In addition, there are *probable* deposits of 100,000,000 tons of anthracite; nearly 200,000,000,000 tons of bituminous coal; and close to 500,000,000,000 tons of semi-bituminous coal and lignites.

RENEWING DUMMY AND GLAND STRIPS IN A PARSONS STEAM TURBINE*

BY N. I. MOSHER†

The method of renewing the dummy and gland strips in a Parsons steam turbine presented in this article outlines the shop practice of the Boston Navy Yard, and a method of procedure is also described which can be followed with satisfactory results when it is not convenient to dismantle the turbine and send it to the shop for repairs. Part of the section of the rotor with the dummy rings is shown at *A* in Fig. 1, and the dummy ring strips are shown at *B*. The strips are made of hard bronze and act as a baffle and

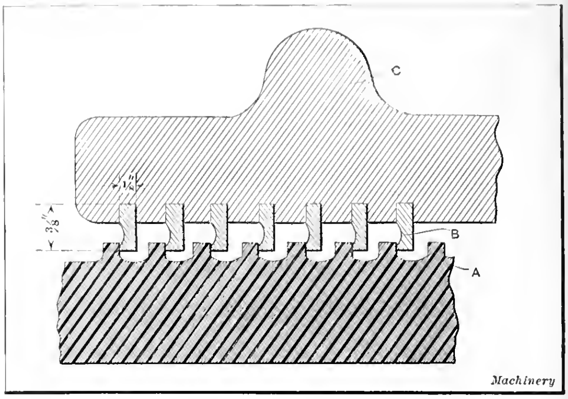

Fig. 1. Arrangement of the Gland Case Dummy Ring Strips and Dummy Rings

packing between the revolving rotor and the fixed cases. These dummy strips become worn from unequal expansion between the cases and rotor or from improper thrust adjustment, causing the strips to rub against the dummy rings. The adjustment between the dummy rings and the strips is ordinarily 0.012 inch. By the proper manipulation of a micrometer instrument, the correct location of the dummy rings in relation to the dummy strips can be determined while the turbine is in motion with a great degree of accuracy. The turbine considered in this article has thirty rings, which are cut into the rotor to a depth of 3/16 inch, and the rings are 3/16 inch wide on the steam entering end of the rotor.

The dummy ring strips are secured in a casting, which, in turn, is secured to the inside end of the turbine cases and machined diametrically true from the axis of the journals. These strips are 4 inches long and rectangular in shape. Fig. 2 shows a detailed view of one of the strips.

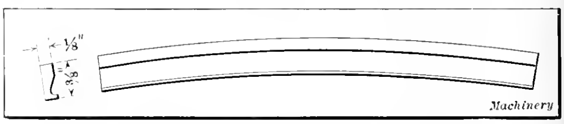

Fig. 2. Detail of one of the Finished Dummy Ring Strips

The following method of renewing these strips was adopted. Standard plates of bronze 24 by 48 inches in size were sawed into strips 4 inches wide, making eleven pieces 24 inches long by 4 inches wide. Eight of these pieces were next secured to the boring mill platen, running out radially from the center. Then a tool was forged and its end machined to the desired shape, as shown in Fig. 3; and the tool-holder was moved the required distance on the rail to give a diameter of 31 3/16 inches. The tool was then fed down into the revolving pieces on the boring mill platen, forming and cutting off eight of the required shaped strips. With the tool remaining in its original position, and by simply unstrapping the brass plates and moving them out the required distance, another set of eight strips was cut off, and so on until the plates were entirely cut up. This method wastes very little stock and the operator can easily cut 150 pieces in eight hours.

* For additional information on this subject, see "Re-blading a Parsons Steam Turbine" published in the December, 1913, number of MACHINERY.
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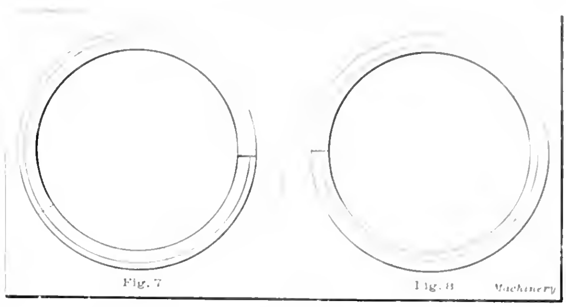
The variation in the thickness of the bronze plates was found to be from 0.001 to 0.007 inch, and to overcome this a sizing die was made which sheared the pieces all to one thickness, namely, 0.125 inch. This completed the machining operations, leaving the pieces finished all over to the proper thickness and diameter. The grooves in the gland casing *C*, Fig. 1, were approximately 0.123 inch wide, or just enough smaller to afford a snug driving fit when the finished strips were forced into them. For performing this operation, a set was machined to the same radius and length as the dummy strips, as shown in Fig. 4. These strips are set about 0.012 inch apart to allow for expansion. After having the 600 strips forced into the grooves, a set was used to calk the metal and fasten the strips more securely.

Having completed the dummy strips, we now turn to the gland strips. Fig. 6 shows the rotor spindle strips and the gland strip casing and strips. It will be noticed that the gland strips are of a different design (see Figs. 7 and 8) from the dummy strips. The edges are machined to a knife edge and the spindle strips just touch the inside of the case that supports the fixed strips; the fixed strips, in turn, just touch the spindle, less a clearance of 0.002 inch. The material for the gland strips is purchased from the mills in rectangular shaped pieces 1/8 by 3/8 inch in size, rolled up in coils about the diameter of the spindle and the gland cases. These coils are cut up into the required pieces, which are forced into the grooves of the spindle and gland cases. Ordinarily about five sections to each ring are set in with a clearance of 0.012 inch between each section, which is to allow for expansion. Having the sections securely calked in both the spindle and cases, they are then machined to the proper diameter and formed, as shown in Fig. 6. The casing that holds the gland strips is detachable from the main turbine case and can be set up in halves on either a horizontal or a vertical boring mill, enabling the machining operation to be performed very satisfactorily. The operation on the spindle is purely a lathe job.



Figs. 7 and 8. Fixed Gland Rings and Spindle Gland Rings

The preceding paragraphs describe the method followed when a turbine rotor and cases are delivered to the shop. When the work is to be done on board ship, however, without the use of a full equipment of power-driven tools, the following operations are required: First, cut the gland strip stock, 1/8 by 3/8 inch in size, into rings of the proper diameter. Second, with a suitable holder on the lathe faceplate, finish these rings to the correct diameter and form. Third, cut the rings into the required number of pieces (see Figs. 7 and 8); they are then ready for inserting in the spindle and gland cases. For this purpose two tools are made, one machined as shown in Fig. 5 for the spindle rings, and the other machined to fit the gland rings for the cases. Experience has proved that these tools stand up best when made from a soft steel of suitable carbon that will toughen under oil tempering; and with careful manipulation of the tools, a very satisfactory job may be done by this method without sending parts to the shop.

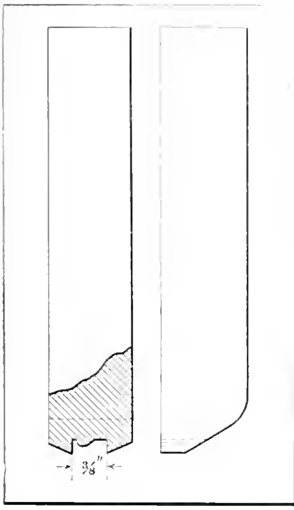


Fig. 3. Tool used for machining the Strips in the Boring Mill

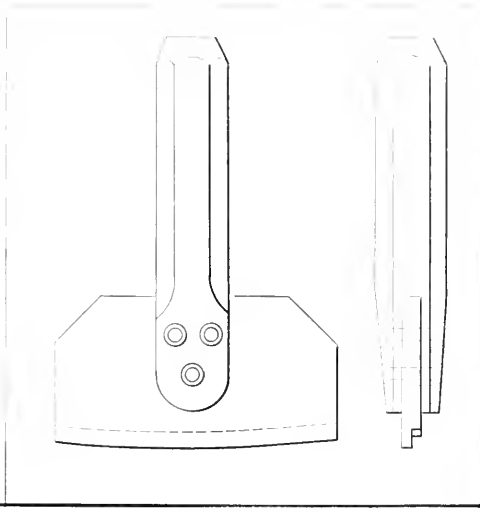


Fig. 4. Type of Tool used to set the Finished Dummy Strips in the Gland Case

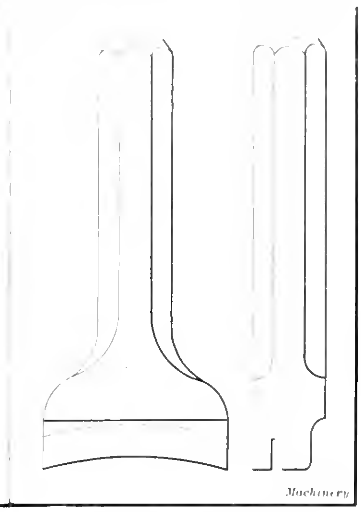


Fig. 5. Type of Tool used to insert the Finished Gland Rings

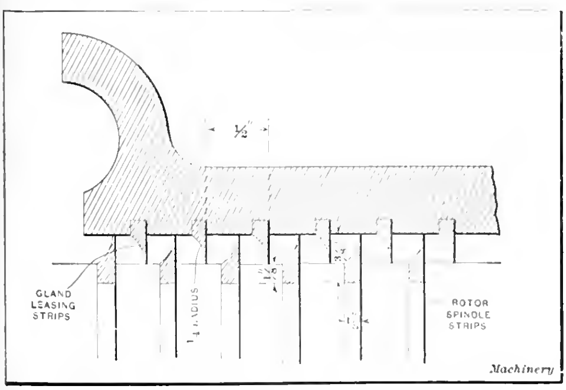


Fig. 6. Spindle of the Rotor and the Gland Strip Casing

* * *

It has frequently been claimed that the great number of young men graduated yearly from the higher technical institutions in Germany tends to create an over-supply of highly educated men in the industries, and to lower the rate of compensation of the whole engineering profession in that country. During the past year the number of students at the eleven higher German technical institutions was still on the increase. At the institution in Berlin there were close to three thousand students on the lists. At Munich there was about the same number, and at several others about fifteen hundred students. In all, there were about seventeen thousand students at these eleven institutions, an increase of 3.4 per cent over the attendance during the previous year.

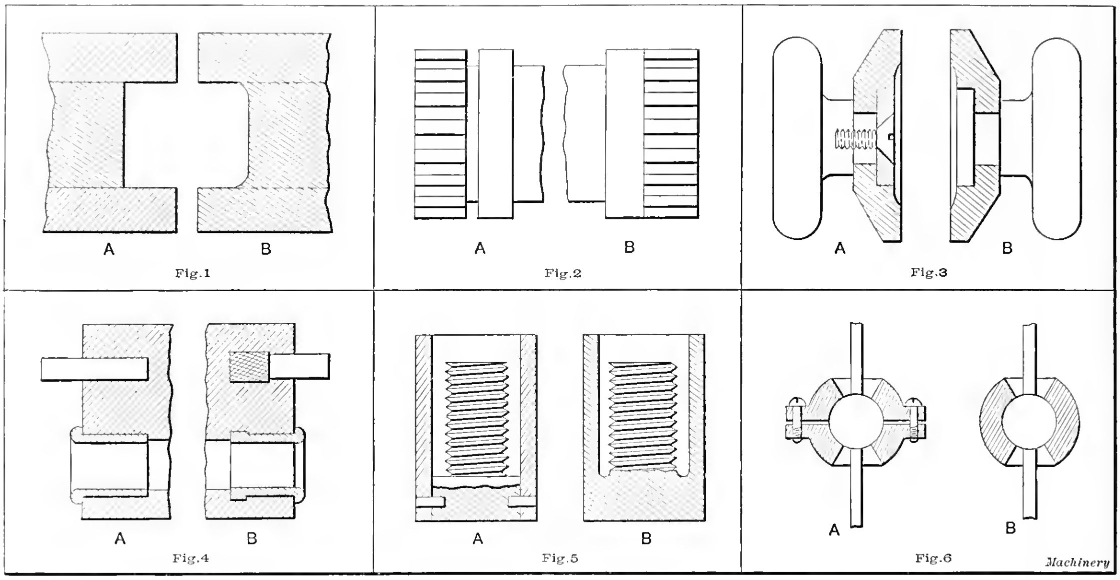
DEVICES MADE POSSIBLE BY DIE-CASTING*

ADVANTAGES OF THE DIE-CASTING PROCESS TO THE DESIGNER

BY CHESTER L. LUCAS†

DIE-CASTING has done a great deal for the designer and manufacturer of small metal articles. By a proper knowledge of what may be accomplished by this process, the work of the designer is greatly facilitated, and by taking advantage of the different points in his favor, he may produce a superior product. Some of the advantages of die-casting are diagrammatically shown in Figs. 1 to 6. These views illustrate the results that can be obtained by this process. In these illustrations the ordinary method of securing a desired result is given at the left, while at the right is shown how much better a result is secured by die-casting. Take, for instance, Fig. 1: at *A* is shown a very ordinary construction, in which two plates are laid over a central block in cases where, because of the difficulty in machining between the plates it is not possible to make the entire piece solid. By die-casting, this piece can be made solid, as shown at *B*, with fillets in the corners which greatly strengthen and finish it. In Fig. 2 is shown the usual method of cutting gear teeth up to a shoulder. This is invariably provided for by cutting a recess into which the gear-cutter may "run out." At *B* is shown the possibility of die-casting for work of this kind. The dies may be constructed so that the gear teeth run up close to the shoulder, strengthening the teeth and simplifying the construction. In Fig. 3 is shown a knob construction, in which the knob must turn within the plate. This is usually done by making the knob itself of two pieces, as at *A*, with a flange that is screwed into place after assembling. By die-casting the flange, as at *B*, and coating the contact surfaces with a graphite paste, the knob may be cast in place and still be freely turned when finished. This is an advantage of die-casting that is being made use of to a very great extent.

In Fig. 4 at *A* is shown a method of inserting steel pins or bronze bushings in another base metal, the whole dependence for strength being placed on driving fits. At *B* is shown the method employed for inserting steel pins or bronze bushings in die-castings. As the metal is cast around the insert, the ends of the rods may be knurled and the bushings may be turned with projecting flanges so that the die-casting metal will embed itself thoroughly around the inserts and effectively prevent pulling out. Of course the shrinkage of the die-cast metal helps to hold these inserted parts even more firmly in place. Fig. 5 shows a case in which die-casting can be used to great advantage. The construction shown at *A* cannot be secured with ordinary machining methods on an integral piece. With one-piece construction it would be impossible to cut the thread on the central stud, as the space between it and the walls would be insufficient to use a die. The only solution would be to make the central threaded section on a separate piece and pin the outer casing over it. At *B* is shown the result that may be readily obtained by die-casting. It is only necessary to put a core in the die, and after the die-casting has been finished the core may be unscrewed from the casting. Turning now to Fig. 6 we see at *A* the familiar ball and socket construction in which the halves of the sprocket are necessarily made separate and screwed together about the ball. At *B* is shown the die-casting method of securing this result by first making the ball and casting the socket around it. By using the proper alloys for the die-casting metal any desired degree of friction can be secured.



Figs. 1 to 6. Design Advantages to be gained by Die-casting

Aside from the construction advantages that die-casting gives, there are often cases where a designed article could not be manufactured at all, except at a prohibitive cost, were it not for die-casting. Two excellent illustrations of this point are in evidence in the two types of "Stoco" instruments shown in Figs. 7 and 11. These are made by the Standard Optical Co. of Geneva, N. Y., and are two of their line of high-grade opticians' instruments. After this company had designed these instruments, it found that it had manufacturing problems that could only be solved by die-casting of the highest order. The H. H. Franklin Mfg. Co. of Syracuse, N. Y., was given the proposition and is now making practically all of the parts for these instruments. When the die-castings reach the Standard Optical Co.'s factory they must be ready for assembling, and as no machining operations are performed save tapping and plating, the work must come from the dies finished in every sense of the word. One of these instruments is shown in Fig. 7. This device is a tilting lens chuck, and is used when boring the holes in spectacle lenses of any curve or thickness. The lens may be tilted in any position or held horizontal without the necessity of a special adjustment for each position.

* For additional information on die-casting practice see "Van Wagner Mfg. Co.'s Die-casting Practice" 1 and 2, published in the January and February, 1913, numbers of MACHINERY and articles there referred to. See also MACHINERY'S Reference Books No. 108 "Die-casting Machines" and No. 109 "Die-casting Dies and Methods."

† Associate Editor of MACHINERY.

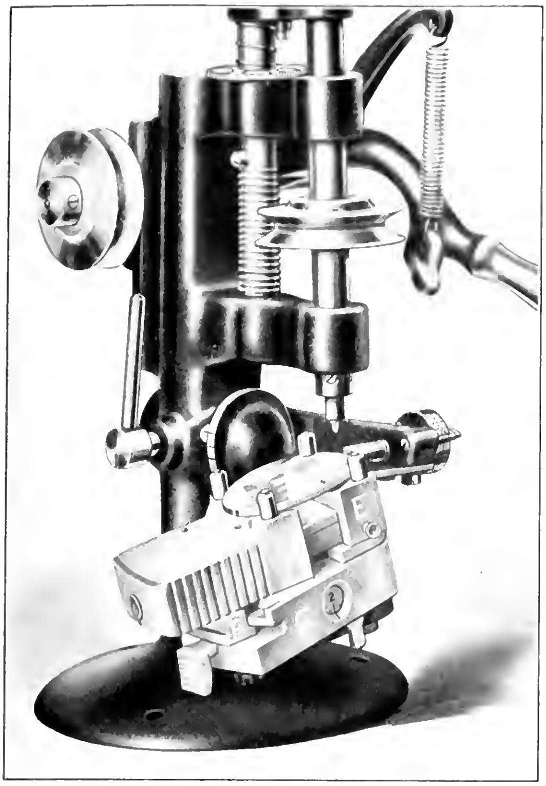


Fig. 7. "Stoco" Lens Chuck in Use

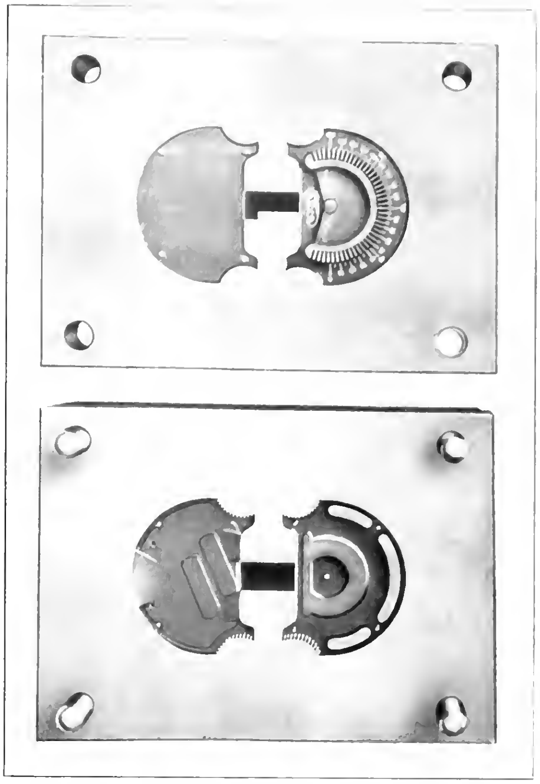


Fig. 8. Die-casting Mold-halves for "Stoco" Inclinometer

As many lenses require boring at a certain distance, in millimeters, one side or the other from the actual center, this lens chuck may be adjusted by the small lever, using the graduated scale so that the entire chuck may be swung sideways to accomplish this. Lenses are drilled half way from each side, and with this chuck the lens is quickly relocated after the first half of the hole is bored. The chuck may be taken apart for cleaning without any tools whatever.

The lens chuck is also shown assembled at *A* in Fig. 9, and the succeeding six views show the parts of the device separately. By referring back to Fig. 7, it will be seen how this instrument is used for drilling. To give an idea of the complicated mechanism, it should be noted that jaws *D* and *E* may be moved independently of each other for locating the lens longitudinally on the device. The jaws slide on a swiveling sub-base *B* and these three parts may be swiveled about a central axis by depressing locking bolt *F*, which, as shown in Fig. 9, has teeth that engage those in sub-base *B*. There is also a limit stop *G* for locating the fixture any desired amount off center. These parts, of themselves, comprise good examples of die-casting, because there are under sections, gear teeth and other difficult points of construction to be taken care of. When it is considered that, in addition to their individual difficulties, these pieces must be die-cast so that they will slide together perfectly and work freely without excessive play, it will be realized what possibilities die-casting has.

A description of one of the die-casting molds used on this job should be of interest, and we have selected the mold or die used for casting the base of this device. This base is shown at *C*, Fig. 9, and the working drawing of the mold is shown in Fig. 10; its construction is as follows: The face-plate *A* is a plain flat plate that is clamped to the working face of the die-casting machine; upon this plate the mold is built. Resting on the upper side of plate *A* is plate *B*. Plate *B* is an important part of the mold, as it contains the outline of the piece and through it work the three cores *C*, *D* and *E* that form the under cut sections of the piece, and the round beveled edge hole at the front. These may all be observed at *C* in Fig. 9. Upon plate *B* is imposed upper die-plate *F*, in the face of which are the projections necessary to form the recesses and slots in the top of the die-casting. As with other types of die-casting molds, the metal enters the mold cavity through gate *G*. The supply is cut off and the sprue is severed by sprue-cutter *H* that works within the gate *G*. The end slides *C* and *D*, as well as the core-pin *E*, are operated by toggles *I*, *J* and *K*, respectively. The slides and core must, of course, be removed from the casting after each piece has been made. This allows the casting to

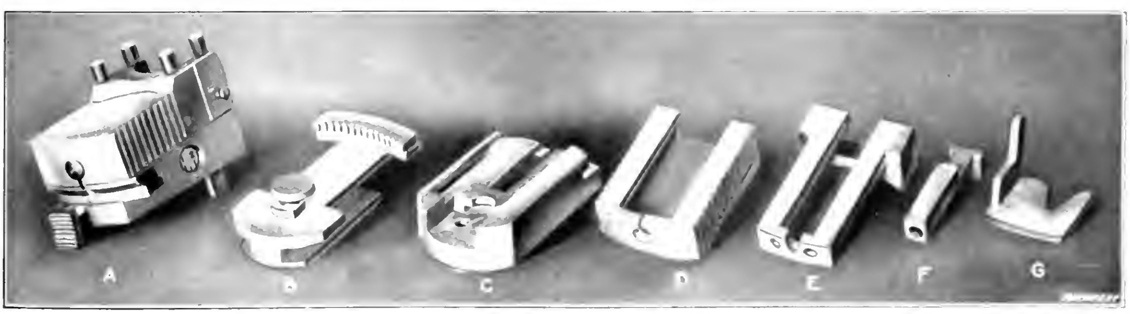


Fig. 9. The Lens Chuck and its Principal Parts

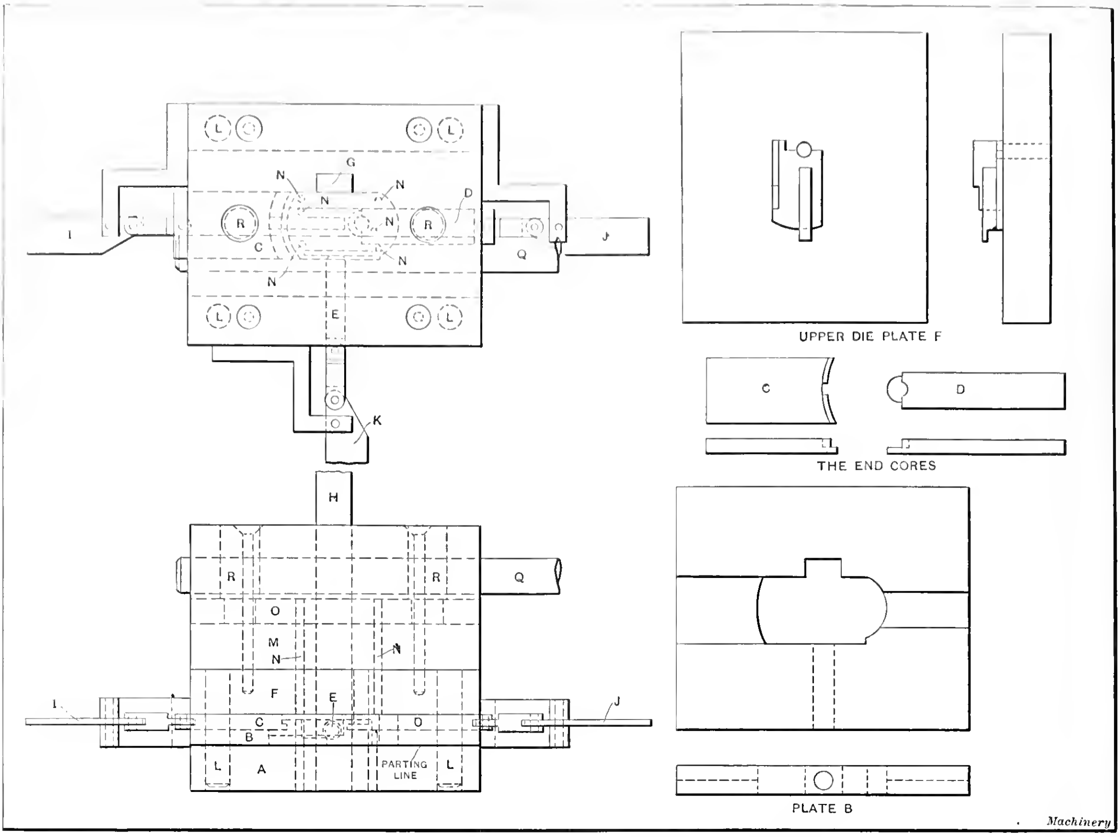


Fig. 10. Die-casting Mold for the Lens Chuck Base shown at C, Fig. 9

be taken from the mold, after which the slides are put back into position for the casting of the next piece. It should be explained that the mold parts between the plates *A* and *B* as indicated. Driven through plates *A*, *F* and *B* are the four dowel-pins *L* that work through holes in plates *B* and *A*, insuring perfect alignment of the parts. Plate *B* is permanently attached to plate *F*. At the right-hand side of Fig. 10 the principal parts of the mold are shown separately.

The above description refers to the die-casting mold proper, but the mechanism for ejecting the casting from the mold is also interesting. It consists of the ejector box *M* and ejector pins *N*, held at their upper ends in ejector plate *O*. After the casting has chilled, and the mold has been opened at the parting line, the toggles *I*, *J* and *K* are operated and the cores and slides pulled back. Then crank *Q* is turned, which advances the ejector plate *O* by means of racks *R*, meshing with teeth on the crank, and therefore causes the ejector pins to push the casting from the die cavity.

Another Die-cast Instrument

Fig. 11 shows another of the "Stoco" instruments for opticians' use. This is an inclinometer, used for determining the axes of lenses. In use the instrument is held between thumb and finger, and the lens jaws, nominally closed by spring pressure, are opened by pressing the finger lever at the bottom and the lens inserted. By tilting the instrument and lens until the marked axis of the lens coincides with the vertical line, the inclination is readily found. The pendulum is free to find its own location by gravity while the instrument is being inclined, and when the lines coincide the instrument is tilted backward, thus causing the pendulum to find its bearing in the serrated portion of the instrument. By noting a center line on the pendulum in connection with

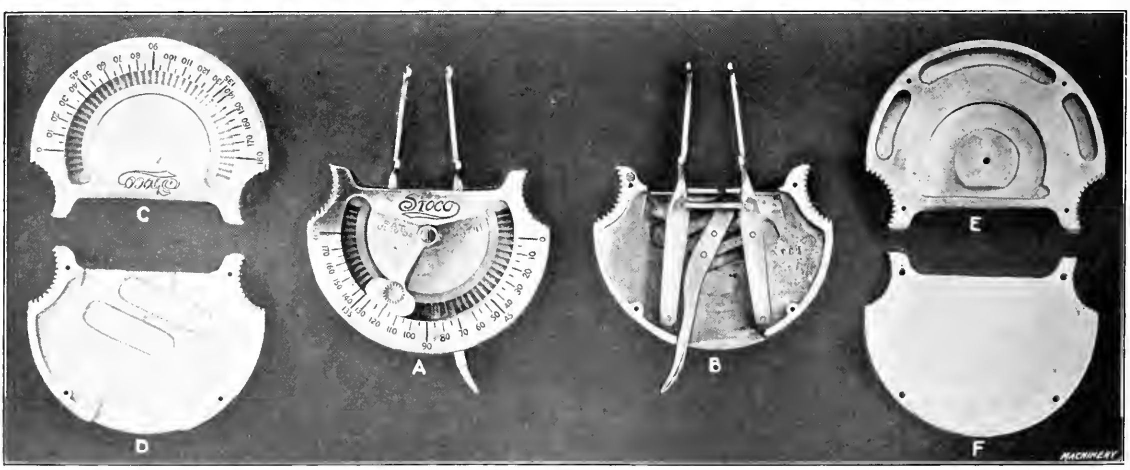


Fig. 11. "Stoco" Inclinometer with Face and Back Views of its Parts

the graduated arc on the body of the instrument, the angle of the lens axis may be observed. Fig. 11 shows at *A* the assembled instrument; at *B* the instrument with the cover removed; at *C* and *D* the outsides of the two main castings; and at *E* and *F* the inner sides of the same pieces. The levers that work inside the instrument, as well as the pendulum, are die-cast, using an alloy that is stiff enough so that in case of injury the levers will break before bending. Should they bend, the accuracy of the instrument would be impaired, while in case of breakage they could be replaced at slight cost.

The illustration Fig. 8 shows the working faces of the die-casting mold used for producing the two halves of the body of the instrument. As will be seen, these two castings are cast in the same die. In one mold-half is the impression of the rear side of each piece, while in the opposite mold-half the front sides are reproduced. The metal enters the mold cavities through the square opening or gate at the center, and after the die cavity has been filled the sprue cutter working in the same opening severs the sprue from the casting and pushes it out of the gate. At each operation of the die two complete pieces are made. The fact that the lettering and figures must be depressed in the finished casting means that they must be raised in the mold cavity. This impression is much more difficult to produce than it would be if the figures and letters were to be made raised on the casting.

These "Stoco" instruments of the H. H. Franklin Mfg. Co. are excellent examples of the possibilities of die-casting, and they should serve as reminders to the designer that die-casting is one of the modern processes at his command, and if properly made use of may prove the solution of some of his manufacturing problems.

* * *

Diesel engines are broadly divided into two classes, namely, the two-stroke and the four-stroke cycle. In both types a cylinder full of air at atmospheric pressure is compressed by the piston at the top center till its pressure becomes about 500 pounds per square inch. The compression raises its temperature to about 1000 degrees F. At this instant a small quantity of oil fuel is blown into the very hot high-pressure air by means of a blast of air at still higher pressure. The oil is broken into a fine spray and its admission lasts only for one-tenth of the downward stroke. During this short time much of the oil is burned in the hot air. The aim is that the compression shall proceed at the critical rate which shall permit the increase of volume occupied due to the motion of the piston and the increase of temperature to be so balanced that the pressure will remain constant until all of the oil has been burned. After this the expansion of the hot gas will still further push the piston down and the pressure will rapidly decrease. The maximum temperatures actually obtained in the cylinders are very high, approximating in some cases nearly 3000 degrees F. It is these exceedingly high temperatures which occasion much of the special difficulties of Diesel engines, and it is necessary to keep the rubbing surface of the metal exposed to the hot gases sufficiently cool to permit of their retaining their lubrication; it is also necessary to prevent all the metal with which the heat comes in contact from becoming so overheated as to impair its strain-resisting properties.—*J. T. Milton, in paper "The Marine Diesel Engine," read before the Institution of Naval Architects, April 2, 1914.*

THE DESIGN OF BRONZE BUSHINGS

BY B. D. PINKNEY*

A branch of machine design that I have not seen treated is the proportioning of bronze bushings for shaft bearings. For several years I was engaged in the design of machinery on which large numbers of bronze and phosphor-bronze bushings were used. It was important to get the bushings just thin enough so that their stiffness was not impaired while being forced in place, owing to the high cost of bronze and phosphor-bronze. A bronze bushing of 5 7/16 inches bore by 8½ inches long by ¼ inch thick was distorted in being forced into a box with sufficient pressure to warrant its being secure. This bushing had the appearance of having been bruised with a hammer, an exaggerated idea of its condition being shown in Fig. 1. The high ridges appeared very soon after the shaft was rotated in the bushed box. A bushing of the same bore and length but ⅜ inch thick was forced in with the same pressure and showed no sign of distortion.

The following rules for forcing bushings into place were formulated from the results of a series of experiments on bushings from 1 to 6 inches bore and of lengths varying from one to six diameters:

First: The thickness of the bushing varies approximately as the square root of the product of the bore and the length.

Second: The amount that the bushing should be oversize to obtain a substantial force fit varies as the square root of the bore.

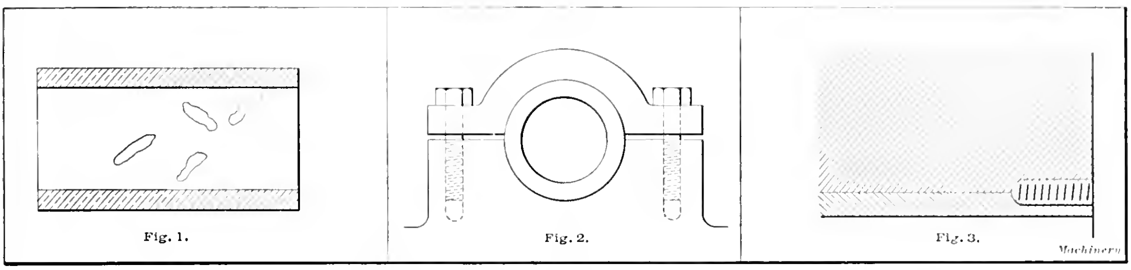


Fig. 1. Fig. 2. Fig. 3.

Figs. 1 to 3. Bushing damaged while being forced into Place and Two Methods of securing Bushings

$$T = 0.05\sqrt{BL} + 0.05 \text{ inch} \qquad (1)$$

$$O = 0.0008\sqrt{B} \qquad (2)$$

where T = thickness of bushing in inches;
B = bore of bushing in inches;
L = length of bushing in inches;
O = amount bushing is oversize in inches.

For bushings that are not forced into place, but are held in position by friction clamps in order to facilitate removal, as shown in Fig. 2, or for bushings which are placed in a pocket in a frame and held in place by babbitt, the thickness is obtained from Formula (3), where it will be seen that the length is not a factor:

$$T = 0.125\sqrt{B} \qquad (3)$$

It is well to provide means for fastening a bushing in the box to guard against the possibility of rotation—particularly in the case of those of 1 15/16 inch bore and over. The writer uses one or more screws, depending upon the size of the bushing, fastened "half and half" in one end as shown in Fig. 3. The number of screws that are required may be found by means of Formula (4), using the next larger whole number. Thus, if the required number of screws N = 1.35, use two screws.

$$N = \sqrt{B} \qquad (4)$$

I have used these formulas for several years with the best of results and, no doubt, many of MACHINERY'S readers will be pleased to get some information along this line.

* * *

An International Congress of Inventors and Industrial Artists will be held in Lyons, France, August 17 to 21, this year. The congress will discuss questions relating to international patents, the exploitation of patents, proper means for encouraging inventors and the cost and duration of patents.

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THE USE OF GAGES

BY F. W. GATES*

A few months ago a body of automobile manufacturers from abroad visited this country to inspect our American manufacturing methods in their industry. While visiting one of our large plants they were given a list of finished parts that make up a complete car, and in passing through the plant they marked, with a specially colored chalk, one piece taken at random from each pile of completed parts. Workmen, following the party, took the marked parts to the assembling department and when the visitors had completed their round, they were escorted to the street in front of the office building and there stood the pieces which they had selected, assembled, mounted, motor running—everything ready to take them for a spin. Any American who is not proud of an achievement like that is a fit subject for—well, some other country.

Anything approaching a feat of this kind would be impossible without the use of gages. Every single part from the tiniest screw to the motor casting had to pass through its particular gage, so when parts reached the assembling floor they "went together" without any filing, grinding, fitting or grumbling. It was so often the case that all the profits made by the rest of the factory lost themselves in the assembling department, that careful gaging is now a practical necessity in almost every factory producing tools or machinery. It is absolute folly to expect interchangeability of parts if different workmen measure different parts in different ways, using different tools made by different manufacturers. A measuring tool may be ever so fine and accurate, it is still a tool and not a gage. The difference is that a tool is an adjustable device for taking the dimension of various articles; while a gage is a standard to which one article must be fitted. A tool will measure a whole range of sizes, having adjustable points of contact. A gage measures its one size or shape only and has fixed points of contact.

But there are occasions when the use of standard gages may, instead of bringing about economy, so add to the production expense as to make them positively objectionable. This is the case where close accuracy is not needed to produce interchangeability. For instance, I once inquired of the superintendent of a small machine shop working on a very ordinary class of work what limits he allowed. "Limits!" he exclaimed in indignant surprise, "we don't use any limits—every piece is brought to dead accuracy." Apparently he had not yet learned that "accuracy" is a variable term. Go into one shop and they figure and think in sixty-fourths of an inch and believe that that is close. Go into another shop and they speak of one-thousandth of an inch as if it were half a mile. Now the superintendent mentioned was trying to make all of that common work absolutely exact. He spent a great deal of time in doing it and thought he was succeeding, but I could find a difference of 0.002 inch on one cylindrical projection. The fact is, anywhere within 0.005 inch would have answered the purpose fully as well, and had he been willing to admit the point and put limit gages on the job instead of standard gages, he would have saved at least 25 per cent of his labor cost.

There is no question but that limit gages enable any shop to produce uniform work that will interchange with perfect satisfaction; but it often requires not only careful planning, but also a thorough practical knowledge of the cutting action of certain tools to lay out a system of limits that will bring the parts together without a "hitch." Take the very excellent A. S. M. E. screw thread system. Opposite No. 24 they give the maximum pitch diameter for a screw as 0.3314 inch and the minimum tap corresponding to this size as 0.3334 inch, allowing a difference for a working fit of 0.002 inch. On paper this looks fairly close, but when you are using commercial taps, as most shops do, you will never find a tap that cuts down to its measured pitch diameter. The sharpening always throws up a fine wire edge along the cutting faces and the tap will cut (on a No. 24 size or thereabouts) from 0.001 inch to 0.003 inch over its size as ascertained with a thread micrometer or pitch diameter gage. Hence, if you should follow the standard literally, you would find a difference between maximum screw and minimum tap hole of from 0.003 inch to 0.005 inch. Even this would not be so bad in the majority of cases, but the standard further provides a tolerance of 0.002 inch on taps and 0.003 inch on screws. So if you should bring together a *minimum* size screw and a *maximum* tapped hole, the difference between them would be from 0.008 inch to 0.010 inch—too loose for anything but very coarse work. We are very apt to forget that tables of limits, such as that referred to, are generally given to show the widest possible range of tolerance and cannot take account of the cutting action of the tools used, even though they may give dimensions for the tools, as in the A. S. M. E. thread standard. The figures are limits, not ideals.

As to the types of gages in general use, too little attention appears to be given to the question, "Is this type adapted to my uses?" Generally speaking a gage should not be of such a design as to necessitate taking it in the hand. It is far better to have gages which can be placed on a standard or base, or fastened to the bench or machine. If this is not practicable, by all means let there be a projecting handle (perhaps screwed into the body part) and cover the handle with a non-conducting fiber. Then the question of "touch" is an important item. Some men think it is incumbent upon them to force the part between the contact surfaces if it is a physical possibility to do so. Others, with a less vicious disposition, touch very lightly. Both extremes can be avoided if it is made a rule that the weight of the part being gaged determines the "touch." That is to say, with the gage opened upward, lay the piece upon it. If its weight carries it down between the contacts, well and good; if it will not go through, consider the part too large. By carrying out this idea, both cylindrical and screw thread work will improve in uniformity greatly.

The ordinary questions of size and touch, which are comparatively simple in cylindrical work, become complicated when screw threads are reached. Here we have both diameter and lead to contend with, and a changing angle of helix adds to the difficulties. I recently saw a machine operator testing ½ inch U. S. S. screws as they came from the screw machine with a female thread gage. The screws fitted with a good "gage fit." I tried one with a thread micrometer and it measured 0.444 inch, or 0.006 inch too small. The operator explained that he thought the "mike" was out of whack. Taking the screw to a "lead tester," it developed that the die was cutting a long lead—about 0.005 inch over size. Now perhaps an experienced inspector would know that a variation in lead on an undersize screw would compensate for the undersize in diameter and (apparently) equalize the fit; but hardly any machine operator realizes it, or ever stops to puzzle out the reason why. Hence, there are places and conditions where a female thread gage is apt to contribute to defective work rather than to avoid it.

In perhaps the majority of cases where constant testing of a machine product is needed, gages of the fork or crescent type for screw threads are far better than female thread gages. But it must be borne in mind that such gages only test the pitch diameter of the thread. They do not take account of variations in lead any more than a thread micrometer does. But, given a die that cuts close to the normal lead, the fork or crescent gage enables an inexperienced "hand" to test the threads (every one) in a mere fraction of the time required for testing in a female thread gage. The care of gages and frequent comparison with standards (which are used for no other purpose) is given scant attention and yet both are of vital importance. Where a working gage is in more or less constant use every day, better results will ensue if at least two are provided, giving out to the workman a new gage each morning, and keeping the one used the day before in the inspection department for comparison with the standard and adjustment if any is needed, having it ready for use again the next day. The chief inspector should also be provided with setting plugs for every size and gage in use. It would be advisable to have these setting plugs certified by the Bureau of Standards at Washington.

It is really astonishing to find how little attention is paid, in this country, to our fundamental unit of length. A factory

* Advertising Manager, Wells Bros. Co., Greenfield, Mass.

wants some gages; they are bought from some gage manufacturer and purport to be a certain fraction or decimal of an inch. The factory accepts the gages, takes it for granted that the gage maker is working to the right standard (or else they give it no thought whatever) and proceeds to work up their material to fit those gages. But the whole scheme depends upon how long an inch is. The inch is a legal dimension in the United States, legally established and legally maintained with extreme care, and at great expense, by the Bureau of Standards. I care not how painstakingly a manufacturer preserves his primary standard (so-called), if it does not agree with the Bureau of Standards, he's wrong—just as wrong as the farmer who measures with a bushel basket containing only 2135 cubic inches. And yet, in the face of this undeniable fact, it is unusual to find even a gage manufacturer equipped with certified standards. The day is coming when it will be expected and required of gage manufacturers to supply comparison standards bearing the certification of the Bureau of Standards to their accuracy. The gage maker who realizes this and equips for it now will be strictly in line and find a widening demand for his product. The gage maker who sneers at the legal standard and prides himself on his own carefully maintained dimensions will find himself left alone with them. The inch is $\frac{1}{39.37}$ of the international meter, and that meter is officially maintained at Washington, where, for moderate fees, gages of almost every type can be sent and compared, receiving in return a certificate as to just how much variation there is—carried down to 0.00001 inch if desired. Equipped with certified standards, any chief inspector is in position to adjust the working gages of the shop and keep them in good condition. Without those certified standards, he is at the mercy of every toolsmith and gage maker and will find himself in doubt and perplexity all the time.

The first cost of equipment often deters a manufacturing executive from ordering gages, even after he is convinced that he would get more uniform results by adopting the use of such gages. He has lived along, permitting and expecting his workmen to measure his product with their own tools, and he hates to spend the money. The answer to this attitude comes almost automatically: his competitors will produce so much more uniform work at a lower price that he will soon have no work to measure, and so will have need for neither gages nor workmen. I can point to one shop that used to test their screw machine products by micrometers, both cylindrical and thread work. It was one never-ending squabble between the inspection department and the operators. The lost time and defective work sometimes swallowed all the profit on a job. Limit gages of the fork type were installed. The limits were all carefully worked out in advance, allowance being made for the cutting action of taps, hobs, etc.; as many working gages were ordered as needed and enough more to provide one working set in reserve for unusual cases or accidents. No gage was allowed to remain out of the inspecting department over night. Setting plugs were supplied to the chief inspector, and every gage was tested for wear once a day (if used). The general reputation of that shop for precision work has improved wonderfully in two years. Over 90 per cent of former defective work has been made impossible now, and annoying disputes have ended—a most important factor in the smooth operation of the plant. The inspection cost is less than 25 per cent of its former cost and the whole outfit of gages, standards, etc., has been paid for many times by increased profits. Their precision product today costs less than their mediocre stuff of two years ago. It is all due to gages, planned right, made right, used right, and maintained right.

* * *

As another step in the development of wireless telephony should be noted the fact that messages have been transmitted by wireless telephone between the Nauen wireless station at Berlin, Germany, and Vienna, Austria, a distance of over three hundred miles. Special apparatus of new design was employed and it was possible to hear in Vienna a newspaper article read at Nauen.

TYPES OF ROTARY MAGNETIC CHUCKS*

BY O. S. WALKER†

During an experience in the manufacture of magnetic chucks, extending over a dozen or more years, our firm has constructed a wide variety of styles of chucks, especially of the rotary type where much variation in the contour of the magnetic face has been in demand. The object of this article is to illustrate and describe some of the more common forms that we have constructed to meet different conditions. The detachable magnetic face feature, which is a well-known characteristic of the Walker magnetic chucks, has enabled us to easily meet these conditions. The electrical features of these chucks are now so well known that it is only necessary for the purposes of this article to discuss the magnetic faces of the chucks and the arrangement of the magnetizing coils. In all the illustrations referred to, the positive and negative poles are indicated by the letters *P* and *N*, these poles always being separated by a narrow ribbon-like space called the magnetic gap, which is filled with non-magnetic metal.

Referring to Fig. 1, it will be seen that a circular path has been provided for the magnetic gap. This form is not only the simplest, but also the strongest possible to construct, inasmuch as the magnetic gap is the shortest length obtainable, thus concentrating the energy produced by the magnet. This style of chuck face, however, is suited for but an extremely small range of work, and while it may be extended by the construction of additional circular poles separated by similar magnetic gaps, it is impossible to locate the poles close enough together to avoid wide dead spaces for work such as rings, which would not cross over the gap from a positive to a negative pole; hence the chuck would have no holding power whatever. The evolution from the circular style of magnetic gap, therefore, has been in the direction of extending the gap radially in order that it might cover an increased range of diameters and have no circular dead spaces.

To this end the style of chuck shown in Fig. 2 was introduced, in which the magnetic gap takes a zigzag course. The fault of this construction lies in the fact that the outer points of the poles are too widely separated, forming wide areas of dead space between them. To remedy this objection, the style of chuck shown in Fig. 3, which is called the radial pole type, was introduced, this style having the sides of the polar branches approximately radial and dividing the circumferential dead spaces evenly. This style of chuck is found to be well suited for holding disks or rings of a considerable thickness, though it is somewhat unsuited for very thin work or for packing on a load of small parts on account of the outer ends of the poles being still considerably separated. To overcome this objection a six-branch radial pole type, shown in Fig. 4, was introduced, this bringing the outer ends of the poles closer together. The style of chuck face shown in Fig. 5 is a further elaboration of the radial pole type, in this case carried to an extreme in order to hold a multiplicity of small parts (especially small washers) in a circular row. Bringing the pole branches so closely together, however, has reduced the range of the chuck for holding single pieces of small diameter concentrically.

The chuck faces described in the preceding paragraphs all pertain to single coil chucks and in the following are described chuck faces which we have constructed suitable for both single and multiple coil chucks, the latter being generally used for chucks of larger diameters where it is desirable to sub-divide the magnetizing power to more thoroughly distribute it over the chuck face. It will be well at this point to call attention to the fact that excessive multiplication of the magnetizing coils in the chuck is detrimental to the action of the chuck in holding a multiplicity of small pieces, inasmuch as the intensity of the holding force of one of the small magnets of the combination is less than that of a like portion of the magnetic circuit of a large magnet of the single coil chuck. The advantage of the multiple coil

* For additional information on this subject see "The [illegible] of the Magnetic Chuck," by H. L. Thompson, published in the April and May, 1914, numbers of MACHINERY.

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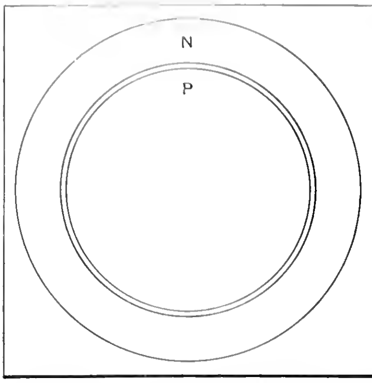

Fig. 1. Chuck with Circular Magnetic Gap

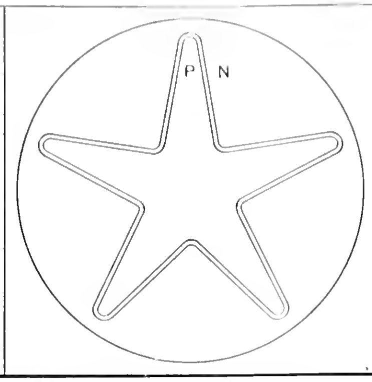

Fig. 2. Chuck with Zig-Zag Magnetic Gap

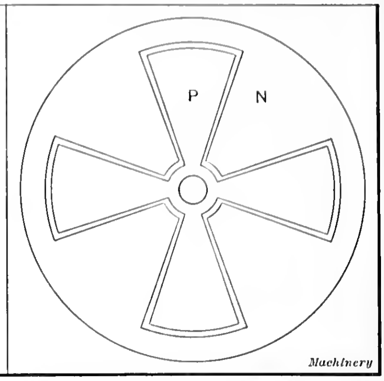

Fig. 3. Radial Pole Type of Magnetic Chuck

chuck lies in the aggregate power of the whole combination and in the somewhat shortened magnetic circuit.

Users of magnetic chucks, as a rule, desire them for a special purpose, and hence the demand for a wide diversity of styles, each of which has its particular merit. In Fig. 6 is shown a separate segment four-pole magnetic face which can be used either with single or with multiple coils, as previously mentioned. Fig. 7 shows a further elaboration of the separate segment type shown in Fig. 6. In this chuck face, the central portion, as well as the separate segments, is of positive polarity. In Fig. 8 is shown a multi-pole type of magnetic face, in which each of the positive pole segments is bifurcated at its outer and wider ends and into these separations are inserted interlocking radial teeth from the outer part of the chuck face, the magnetic gap, of course, separating the two. This construction is valuable for holding a multiplicity of small parts, as many sub-divisions are formed, with close spacing, so that the whole outer face can be utilized. This chuck face is made in the single or multiple coil styles, depending on the diameter of the chuck.

Another style of chuck face is shown in Fig. 9, this being similar to the one shown in Fig. 7, except that the central positive pole has been eliminated and in this case the inner ends of the separate positive polar segments have been brought quite near to the center of the chuck to assist in holding single pieces of small diameters. It will be seen from the preceding that still further changes in the style of magnetic faces can be made, but those shown are the ones we have found to be practicable. A very important feature in connection with the design of magnetic chucks should not be lost sight of and that is the feature of concentration of the lines of force to obtain the maximum power. The above holds true for work of considerable thickness, but for thin work the rule is often reversed as, on account of the slight cross-sectional area, only a certain amount of magnetization of the work can be effected, and it is better in such cases to extend the poles and to provide a more diffused magnetic power under the work, even though it be of less intensity.

Whatever may be the shape or extent of the magnetic gap of a chuck, its power as a unit can only be determined by mounting on it a piece of work that completely covers all parts of the magnetic gap.

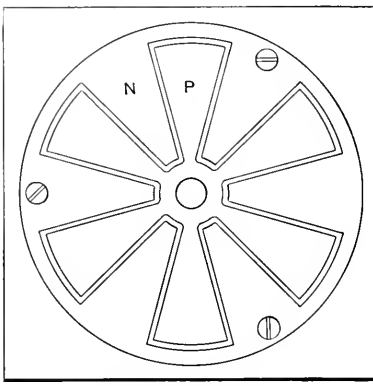

Fig. 4. Six-branch Radial Pole Magnetic Chuck

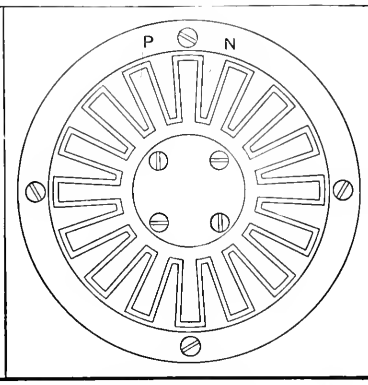

Fig. 5. Radial Pole Chuck for holding Small Parts

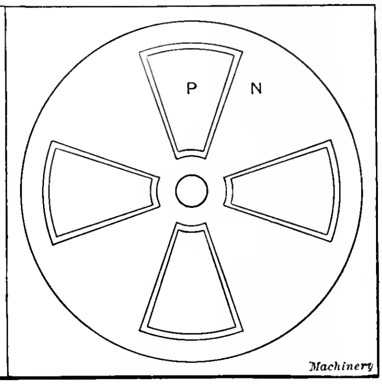

Fig. 6. Separate Segment Four Pole Magnetic Chuck

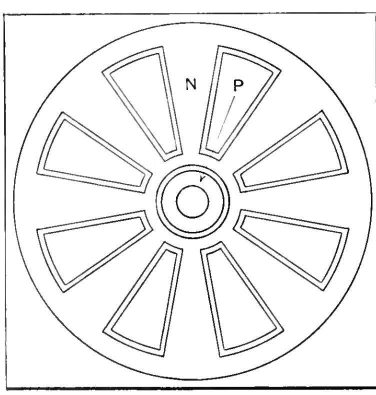

Fig. 7. Separate Segment Chuck with Center of Positive Polarity

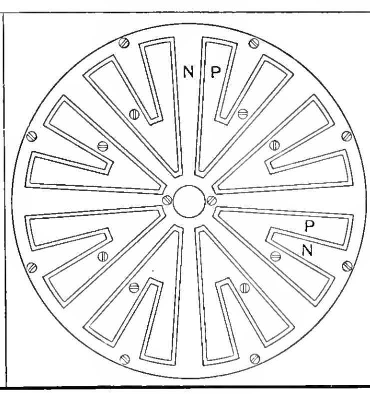

Fig. 8. Multi-pole Type of Magnetic Face Chuck

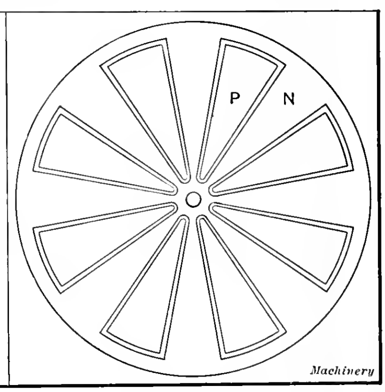

Fig. 9. Separate Segment Chuck without Positive Center

TABLES OF SPIRAL GEARS HAVING A RATIO OF TWO TO ONE

BY E. S. WIKOFF*

The accompanying table gives the pitch diameter, outside diameter and center distance for spiral gears having a ratio of 2 to 1, with shafts at an angle of 90 degrees; the angle of the driving gear is 47 degrees 34½ minutes and the angle of the driven gear is 42 degrees 25½ minutes. These tables will be found convenient by those who have to do with the computing of spiral gears of this class. A great many gas and gasoline engine timing gears are of this special form, and several automobile builders are contemplating using this system. The writer has computed these tables for this special purpose and knows from his own experience with spiral and helical gear-

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TABLE I. TWO TO ONE SPIRAL GEARS—SHAFTS AT 90-DEGREE ANGLE

Angle of driver D is 47 degrees 34½ minutes; angle of driven gear d is 42 degrees 25½ minutes.
P. D. = pitch diameter; O. D. = outside diameter; C = center distance.

Gear	Number of Teeth	14 Diametral Pitch			12 Diametral Pitch			10 Diametral Pitch			8 Diametral Pitch		
		P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C
D	6	0.6352	0.7780	0.8982	0.7411	0.9077	1.0479	0.8893	1.0893	1.2575	1.1117	1.3617	1.5718
d	12	1.1611	1.3039		1.3547	1.5213		1.6256	1.8256		2.0320	2.2820	
D	7	0.7411	0.8839	1.0479	0.8646	1.0312	1.2225	1.0376	1.2376	1.4671	1.2970	1.5470	1.8338
d	14	1.3547	1.4975		1.5804	1.7470		1.8965	2.0965		2.3707	2.6207	
D	8	0.8470	0.9898	1.1976	0.9882	1.1548	1.3972	1.1858	1.3858	1.6766	1.4823	1.7323	2.0958
d	16	1.5482	1.6910		1.8062	1.9728		2.1675	2.3675		2.7094	2.9594	
D	9	0.9529	1.0957	1.3473	1.1117	1.2783	1.5718	1.3340	1.5340	1.8862	1.6675	1.9175	2.3578
d	18	1.7417	1.8845		2.0320	2.1986		2.4384	2.6384		3.0481	3.2981	
D	10	1.0587	1.2015	1.4970	1.2352	1.4018	1.7465	1.4823	1.6823	2.0958	1.8528	2.1028	2.6198
d	20	1.9353	2.0781		2.2578	2.4244		2.7094	2.9094		3.3867	3.6367	
D	11	1.1646	1.3074	1.6467	1.3587	1.5253	1.9211	1.6305	1.8305	2.3054	2.0381	2.2881	2.8817
d	22	2.1288	2.2716		2.4836	2.6502		2.9803	3.1803		3.7254	3.9754	
D	12	1.2705	1.4133	1.7961	1.4823	1.6489	2.0958	1.7787	1.9787	2.5150	2.2234	2.4734	3.1437
d	24	2.3223	2.4651		2.7094	2.8760		3.2513	3.4513		4.0641	4.3141	
D	13	1.3764	1.5192	1.9461	1.6058	1.7724	2.2704	1.9269	2.1269	2.7246	2.4087	2.6587	3.4057
d	26	2.5158	2.6586		2.9351	3.1017		3.5222	3.7222		4.4028	4.6528	
D	14	1.4823	1.6251	2.0958	1.7293	1.8959	2.4451	2.0752	2.2752	2.9342	2.5940	2.8440	3.6677
d	28	2.7094	2.8522		3.1609	3.3275		3.7931	3.9931		4.7414	4.9914	
D	15	1.5881	1.7309	2.2455	1.8528	2.0194	2.6197	2.2234	2.4234	3.1438	2.7793	3.0293	3.9297
d	30	2.9029	3.0457		3.3867	3.5533		4.0641	4.2641		5.0801	5.3301	
D	16	1.6940	1.8368	2.3952	1.9764	2.1430	2.7944	2.3716	2.5716	3.3534	2.9646	3.2146	4.1916
d	32	3.0964	3.2392		3.6125	3.7791		4.3350	4.5350		5.4188	5.6688	
D	17	1.7999	1.9427	2.5449	2.0999	2.2665	2.9690	2.5199	2.7199	3.5630	3.1498	3.3998	4.4536
d	34	3.2900	3.4328		3.8383	4.0049		4.6060	4.8060		5.7575	6.0075	
D	18	1.9058	2.0486	2.6946	2.2234	2.3900	3.1437	2.6681	2.8681	3.7725	3.3351	3.5851	4.7156
d	36	3.4835	3.6263		4.0641	4.2307		4.8769	5.0769		6.0962	6.3462	
D	19	2.0117	2.1545	2.8443	2.3469	2.5135	3.3183	2.8163	3.0163	3.9821	3.5204	3.7704	4.9776
d	38	3.6770	3.8198		4.2898	4.4564		5.1478	5.3478		6.4348	6.6848	
D	20	2.1175	2.2603	2.9940	2.4705	2.6371	3.4930	2.9646	3.1646	4.1917	3.7057	3.9557	5.2396
d	40	3.8706	4.0134		4.5156	4.6822		5.4188	5.6188		6.7735	7.0235	

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TABLE II. TWO TO ONE SPIRAL GEARS—SHAFTS AT 90-DEGREE ANGLE

Angle of driver D is 47 degrees 34½ minutes; angle of driven gear d is 42 degrees 25½ minutes.
P. D. = pitch diameter; O. D. = outside diameter; C = center distance.

Gear	Number of Teeth	7 Diametral Pitch			6 Diametral Pitch			5 Diametral Pitch			4 Diametral Pitch		
		P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C
D	6	1.2705	1.5563	1.7964	1.4823	1.8156	2.0958	1.7787	2.1787	2.5150	2.2234	2.7234	3.1437
d	12	2.3223	2.6081		2.7094	3.0427		3.2513	3.6513		4.0641	4.5641	
D	7	1.4823	1.7681	2.0958	1.7293	2.0626	2.4451	2.0752	2.4752	2.9342	2.5940	3.0940	3.6677
d	14	2.7094	2.9952		3.1609	3.4942		3.7931	4.1931		4.7414	5.2414	
D	8	1.6940	1.9798	2.3952	1.9764	2.3097	2.7944	2.3716	2.7716	3.3533	2.9646	3.4646	4.1917
d	16	3.0964	3.3822		3.6125	3.9458		4.3350	4.7350		5.4188	5.9188	
D	9	1.9058	2.1916	2.6946	2.2234	2.5567	3.1437	2.6681	3.0681	3.7725	3.3351	3.8351	4.7156
d	18	3.4835	3.7693		4.0641	4.3974		4.8769	5.2769		6.0961	6.5961	
D	10	2.1175	2.4033	2.9940	2.4705	2.8038	3.4931	2.9646	3.3646	4.1917	3.7057	4.2057	5.2396
d	20	3.8706	4.1564		4.5157	4.8490		5.4188	5.8188		6.7735	7.2735	
D	11	2.3293	2.6151	3.2935	2.7175	3.0508	3.8424	3.2610	3.6610	4.6109	4.0763	4.5763	5.7636
d	22	4.2576	4.5434		4.9672	5.3005		5.9607	6.3607		7.4508	7.9508	
D	12	2.5410	2.8268	3.5929	2.9646	3.2979	4.1917	3.5575	3.9575	5.0300	4.4469	4.9469	6.2875
d	24	4.6447	4.9305		5.4188	5.7521		6.5026	6.9026		8.1282	8.6282	
D	13	2.7528	3.0386	3.8923	3.2116	3.5449	4.5410	3.8540	4.2540	5.4492	4.8175	5.3175	6.8115
d	26	5.0317	5.3175		5.8704	6.2037		7.0444	7.4444		8.8056	9.3056	
D	14	2.9646	3.2504	4.1917	3.4587	3.7920	4.8903	4.1504	4.5504	5.8684	5.1880	5.6880	7.3355
d	28	5.4188	5.7046		6.3219	6.6552		7.5863	7.9863		9.4829	9.9829	
D	15	3.1763	3.4621	4.4911	3.7057	4.0390	5.2396	4.4469	4.8469	6.2875	5.5586	6.0586	7.8594
d	30	5.8059	6.0917		6.7735	7.1068		8.1282	8.5282		10.1603	10.6603	
D	16	3.3881	3.6739	4.7905	3.9528	4.2861	5.5889	4.7433	5.1433	6.7067	5.9292	6.4292	8.3834
d	32	6.1929	6.4787		7.2251	7.5584		8.6701	9.0701		10.8376	11.3376	
D	17	3.5998	3.8856	5.0899	4.1998	4.5331	5.9382	5.0398	5.4398	7.1259	6.2998	6.7998	8.9074
d	34	6.5800	6.8658		7.6766	8.0099		9.2120	9.6120		11.5150	12.0150	
D	18	3.8116	4.0974	5.3893	4.4469	4.7802	6.2875	5.3363	5.7363	7.5451	6.6703	7.1703	9.4313
d	36	6.9670	7.2528		8.1282	8.4615		9.7539	10.1539		12.1923	12.6923	
D	19	4.0234	4.3092	5.6887	4.6939	5.0272	6.6368	5.6327	6.0327	7.9642	7.0409	7.5409	9.9553
d	38	7.3541	7.6399		8.5798	8.9131		10.2957	10.6957		12.8697	13.3697	
D	20	4.2351	4.5209	5.9881	4.9410	5.2748	6.9862	5.9292	6.3292	8.3834	7.4115	7.9115	10.4793
d	40	7.7412	8.0270		9.0314	9.3647		10.8376	11.2376		13.5170	14.0470	

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ing, as employed in engine and motor timing gears, that they will prove of real value to the designer. Should a greater number of teeth or a larger pitch be required than given in the tables, multiples may be used.

Example: It is required to find the dimensions for two spiral gears having a ratio of 2 to 1, and provided with 26 and 52 teeth, 6 diametral pitch. Take the pitch diameters for 13 and 26 teeth, as given in the table, and multiply by 2, thus obtaining the pitch diameters for 26 and 52 teeth. Thus:

$$3.2116 \times 2 = 6.4232, \text{ and } 5.8704 \times 2 = 11.7408.$$

To find the outside diameter for 26 and 52 teeth, add twice the addendum to the pitch diameters just found.

Dimensions for diametral pitches not given in the table may likewise be found by proportion. For example, the dimensions for 3 diametral pitch may be found by multiplying the pitch diameters found in the 6-diametral pitch column by 2.

* * *

TWO INTERESTING PAINTS

BY J. P. S.

As the result of work accomplished by members of the chemical profession, two interesting paints have recently been placed upon the market. The first of these, known as "efkalin," is a light red paint which is applied to any machine members which are likely to run hot and result in damage to the machine. This paint shows immediately if the part is beginning to heat, by a change of color. As previously mentioned, the normal color of the paint is light red, but at a temperature of 50 degrees C. (122 degrees F.) it will become a dark red, and at 70 degrees C. (158 degrees F.) the color changes to a brown-red, while at temperatures exceeding 85 degrees C. (185 degrees F.) the color becomes nearly black. Through the use of this paint, the engineer or foreman is able to tell immediately if any of the bearings are becoming heated, without having to feel them with his hands. An important feature of the paint is that it returns to its normal light red color when the temperature of the part has dropped back to the normal point. Thus the paint will last practically indefinitely, which is an important item because the cost is rather high owing to the expensive ingredients from which it is compounded. "Efkalin" is manufactured by Franz Korn, Halle a/d S., Germany.

"Acalorin" is another interesting paint which has recently been developed by a German chemist. This paint is also used to afford protection against heat but in an entirely different way. Its purpose is to intercept heat rays given off by the sun, thus rendering rooms of a building protected by this paint from 15 to 35 degrees F. cooler than they would otherwise be. It will be obvious that this paint is especially suitable for use on roofs, windows and walls which are exposed to the sun. The paint is a light blue in color and does not have any appreciable effect on the amount of light which enters a room through windows covered with it. This paint is especially suitable for application on glass, slate, corrugated iron and other roofing materials, and also for use on large factory windows. The reduction of temperature in hot weather is the means of increasing the efficiency of employes. The workmen will be more comfortable if the rooms in which they work are not too hot, and as a result their daily output will be more nearly normal than would otherwise be the case in extremely hot weather. The paint may either be applied with a calcimine brush or sprayed onto the roof, walls or windows. The use of this paint may possibly permit the establishment of industries in semi-tropical or tropical countries where it has formerly been out of the question to employ white labor. "Acalorin" is manufactured by Koch & Gruen, Offenbach, A. M., Germany.

* * *

BENCH LEG PATENTED

The bench leg illustrated with the article "Modern Equipment for Industrial Plants" in the May number of MACHINERY, page 731, engineering edition, is covered in several important features by Patent No. 803,873, owned by the New Britain Machine Co., New Britain, Conn. This notice is published for the benefit of those readers who might infer from reading the article that the design is open to the public.

TAP FLUTES—FORGED VS. MILLED

BY HARRY E. HARRIS*

Should tap flutes be forged or milled? That is a question often asked but I do not recall having seen any answer to it in print. In a paragraph in MACHINERY for March, 1914, it was remarked that a maker of taps having forged flutes imitated the shape of milled flutes in order that the purchaser should not be adversely influenced by the fact that the flutes were forged and that, as a matter of fact, forged flute taps should be better than when the flutes are cut from the solid. The time was when high carbon steel ("cast steel") was supplied by the steel mills in such condition that hammer forging and its attendant heats and workings was practically necessary to make the steel uniform, increase its elasticity and refine it generally. This was properly done by several heats of moderate temperature and light blows well distributed and balanced. Whether done by hand or power hammer, it required a conscientious and skillful man. High heats being positively detrimental to high carbon steel, and heavy squashing blows or cold hammering being equally, if not more detrimental, the results of forging were widely divergent and varied directly with the care and skill of the operator, how long he had been standing on his feet, how late he went to bed the night before and various other things.

With the present high state of development of steel manufacture and specialization in different products for different purposes, the high-grade steel company specializing in steel for taps can today produce a material which has passed through heats, forgings, rollings, annealings and drawings that leave little, if any, room for improvement which might be secured by further forging by the tap maker. In fact, the higher the grade and carbon content of the steel, the greater would be the risk to the quality of the tap produced by any such process. The object, then, in forging flutes would be to decrease the cost of manufacturing by getting away from the high cost of milling the material away and the waste of the expensive material itself. To do this the forging must be done quickly with heavy blows and as few heats as possible (this would be a drop-forging operation in one heat) which necessitates a high temperature. High-grade steel with a carbon content great enough to produce taps of proper temper and enduring qualities is very susceptible to overheating and would cause many failures under such treatment. The alternative would be to use a lower grade steel, and in either case the gain to the user would be doubtful when compared with milled taps made from steel of proper analysis and mill treatment. In other words, the ultimate result is better and more uniform if the tap maker selects the best special steel for the purpose (testing it for vital qualities, examining its structure microscopically, and cooperating with the steel mill for improvement wherever possible) and then conserves and enhances its value by careful machining, annealing and scientific heat-treatments, than if he, in order to improve a poorer steel or cheapen his manufacturing costs, changes its form by forging.

The other half of the question is, why should the milled shape of flute be imitated if the flutes are forged? Obviously the milled form should be "imitated," no matter how they are shaped, if a milled flute of proper form is taken as an example. A large proportion of commercial taps have improperly shaped flutes, but more of that later. Forging does not produce the same accuracy as milling. More or less scale and decarbonized surface is present and a keen cutting edge is practically impossible. We forge a lathe or planer tool, but grind both the top rake and the clearance to get a tool having the proper angles to cut efficiently. We would get poor work, if any, and the tool would not last long, if we tried to use it *as forged* or if we ground but one of the two surfaces that meet at its cutting edge. But we might file or machine the tool to the proper shape, and harden it, and we would then get a tool that would work well and stand up. Then why isn't it much more important to machine the front face of the cutting edges of a tap, where each tooth has so much harder service, than to leave them rough-forged? It is. A test with a tap wrench of a tap of each kind in a

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piece of cast or wrought iron will convince anyone. Try it; or if you can, put the two kinds of taps into service in a tapping machine of some sort, get production speeded up to where it ought to be and see which will give the better threads and last longer. Or you probably know without trying it.

In regard to what milled tap to imitate, one should be taken that has the combination of the greatest strength compatible with the necessary chip room, a shape or profile that in the hardening process will not tend to raise the "heel" higher than the cutting edge (thus causing "back clearance" and making the tap bind) and one which has that part of the flute forming the "rake" of the cutting edge so formed as to easily separate the chip from the metal and break it up into sections small enough to readily work out through the flute and not cause the tap to clog. I have never yet seen a truly correct form of flute described or illustrated in technical journals or books. I have tested many different kinds that have come under my observation, both in laboratory on testing machines and in commercial work under practical conditions, and while they varied greatly in efficiency, the best gave results considerably below those obtained with the ideal form. A tap having a "hooked" or curved front face on the cutting teeth such as that produced by a radius mill, or modifications of the same, produces curling chips which roll up within themselves, forming tight spirals that tend to tear the thread and jam or wedge the tap fast; the deeper the hole and the more tenacious the material the worse this action becomes. On the other hand, a tap with a straight front face to the teeth and with a small corner or radius at the bottom of the flute, will turn off a straight chip which will slide down this front face to the corner at the bottom of the flute. When the end of the chip strikes this obstruction the tendency is to resist further action, compelling metal subsequently removed to wedge into it and over it, and the metal removed will become a compressed lump, clogging and tearing the threads, and generally breaking the tap at an early stage in its use.

The proper form of flute has a front face (or "rake") to the teeth which is flat or straight for a short distance, joining a curve in the bottom of the flute which has sufficient magnitude to bend the straight chip and break it into such lengths as will prevent wedging and allow the pieces to be readily washed out with the lubricant. Greatest effective strength is not indicated by large dimensions from bottom to bottom of the flutes; that is, by shallowest milling. Too shallow milling of the flutes is cheap, making less metal for the tap maker to remove, and thus allowing him to do it at higher speed; but that is the only advantage. It has been found by numerous tests that these heavy taps, while having approximately 1½ times the torsional strength of properly milled taps, have a varying factor of safety from 0 to 2, while the properly milled tap averages over 9 as a factor of safety. To be plain, and taking ½-inch taps to illustrate: In tests on a Riehle testing machine, the heavy taps showed a maximum torsional strength of 1500 inch-pounds, and in threading a test piece they either broke under the strain or else took power of from 750 inch-pounds upward to thread the test piece; the deeper milled taps showing a minimum torsional strength of 1000 inch-pounds (due to their lighter section) averaged but 110 inch-pounds to thread the test piece.

The angle that the front face of the cutting teeth forms with a tangent drawn to the outside diameter circle of the tap is a feature of vital importance in its cutting action and should vary somewhat for different metals. These points are apparently not considered by tap makers generally, commercial taps being largely the same. However, at least one of the more progressive makers has experimented largely on different materials and has produced a standard form that will give excellent results on the most common machine shop materials. This firm also holds itself in readiness to make special taps suited to any peculiar materials or uses, and to give expert, practical advice on the subject. The angle of the back face of the land is also important, in that it is a factor in controlling any distortion of the tap in hardening and also in cleaning out chips in "backing out," although the latter function is not so important where chips are broken up instead of curled or wedged.

The writer has not attempted in this article to give rules, formulas or diagrams for producing properly shaped flutes in taps, as the matter is an exhaustive one and would require a treatise by itself, which would embrace all kinds, diameters and pitches of taps, including special gages, cutters, cutter grinders, flute grinders, etc., that are necessary. In fact, this matter of flutes parallels in importance any other step in the process of tap making, including the selection of steel and heat-treatment. It might even be said to exceed them, as a properly constructed tap of inferior steel might produce good results for a time, but a badly fluted tap of most excellent steel and temper would never be a success. A word about finish. The only excuses for fine polish on the shank of taps, aside from the fact that customers prefer it, is that it rusts less easily; the maker's trademark is stamped on the shank, the quality of the tap can be more readily seen, and the final inspector can see and throw out taps showing any defects such as slight checks or cracks. In regard to the finish of flutes: the flutes, particularly on the smaller taps, should be ground as smooth as possible, as the rougher the surface the coarser the cutting edge, and also the more surface friction resulting from the action of the chips.

* * *

PRESENTATION OF THE SEAMAN MEDAL TO GENERAL GORGAS

The Louis Livingston Seaman medal was presented to Surgeon General William C. Gorgas, U. S. A., under the auspices of the American Museum of Safety, Tuesday evening, April 28. The medal was presented to General Gorgas for his work in making the Panama Canal Zone habitable and sanitary for the workers on the canal. The presentation was made in the rooms of the American Society of Mechanical Engineers, New York City, and President Arthur Williams, of the American Museum of Safety, presided. Prof. F. R. Hutton made the presentation speech, and Dr. Norman E. Ditman and Dr. Louis Livingston Seaman recounted the work of General Gorgas as a great sanitarian. In accepting the honor conferred upon him, General Gorgas expressed the thought that the great value of the sanitary work done on the Panama Canal Zone was in showing that the tropics are inhabitable by white men. He predicted that these regions would eventually be great centers of population. Food is produced there with a minimum of effort and the labor of man is rewarded as nowhere else. With the banishment of disease these regions, which are largely uninhabitable now, would become the most important, fruitful and productive sections of the globe. General Gorgas modestly disclaimed credit for the discoveries in sanitation attributed to him. He spoke of his work as that of application of discoveries made by other eminent sanitarians and asked recognition for the four or five hundred young Americans who were his able assistants in the Panama Canal sanitation work and who in the beginning risked their lives and health in promoting the sanitary work.

* * *

NEW LIFE-SAVING RAFT

A novel life-saving raft is described in the *Scientific American*. A material known as Java kapok, a fibrous, silky material, the product of a tropical tree found in the East Indies and Java, is said to be very suitable as a filling for mattresses, cushions, etc. The best quality of kapok has wonderfully buoyant properties. The fiber is very fine and will support twenty times its own weight in water, and if enclosed in a leather or artificial leather casing, it will continuously support this weight for two months, before the water finally penetrates the mass sufficiently to make it sink. Ocean liners equipped with mattresses of this kind would be provided with what would virtually be a great number of small sized rafts. An ordinary mattress filled with kapok will easily support a man lying on it. In tests made, it has been found that a mattress covered with ordinary ticking would support a load of two hundred pounds for eight hours. It is stated that the Navy is beginning to use this material for mattress filling, but the merchant marine will not be interested until cushions and mattresses filled with kapok are acceptable instead of cork life-preservers to steamboat inspectors.

WATCH PENDANT DRILLING AND BOW-BENDING MACHINES*

AUTOMATIC MACHINES FOR DRILLING, COUNTERBORING AND TAPPING PENDANTS AND FORMING BOWS

BY CHESTER L. LUCAS†

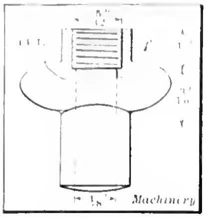

Fig. 1. Operations performed on the Watch Pendant

THE designing and building of automatic machines for making watch parts presents difficulties not found in other lines of automatic machinery construction. In addition to the automatic features to be provided for, the fact that the work is very small and must be handled carefully to avoid abrasion or distortion greatly adds to the designer's problems. In this article will be described two machines which were designed and manufactured by the Sloan & Chace Mfg. Co. of Newark, N. J. The first of these machines is for drilling, counterboring and tapping watch pendants. One of these pendants is shown in section on an enlarged scale in Fig. 1. In Fig. 2 samples of the pendants are shown before machining at *A* and after machining at *B;* at *C* is shown a different style of pendant handled on the same machine. The machine itself is shown in Fig. 4. One of the watch bows is shown before bending at *D* in Fig. 2 and after bending at *E*. The machine for bending these bows is shown in Fig. 5 and the details of the machine appear in Fig. 7. Both of these machines are extremely small, being less than two feet long in their greatest dimensions, and either one of them may be picked up bodily without much exertion.

Taking, first, the watch pendant machine and referring to Fig. 1, it will be seen that the work to be accomplished is the drilling of a hole 5/16 inch deep, the counterboring of the outside and the tapping of the larger portion of the hole as marked in the illustration. The blank watch pendants are made by hydraulically pressing a rolled-gold covered composition piece of metal. While the machine is shown as a whole in Fig. 4, it will be best to refer to Fig. 6 in order to understand its design and operation. Referring to the latter illustration, then, it will be seen that the machine is of the multiple spindle type, having three spindles for drilling, counterboring and tapping. The work is held in a turret and revolves to the different spindles. In this illustration, the turret is shown between indexings in order that none of the important parts may be hidden. Power is received at the driving wheel, a part of which is shown at *A*. At the end of this driving shaft is the miter gear *B*, that, in connection with the mating gear *C* carries rotation to the second or counterboring spindle *D*. Rotation is carried from the counterboring spindle *D* to the tapping spindle *E* through pinion *F* on the counterboring spindle that meshes with an idler *G*, and thence to the gear *H* on the tapping spindle. The reversing gear for the tapping spindle is also carried from the counterboring spindle by means of pinion *I* meshing with gear *J*. Rotation is carried to the drilling spindle *K* by means of a belt *L* directly on the tapping spindle.

The watch pendants are held in the four stations in the turret and the turret is rotated by the indexing shaft *M*. Midway between driving wheel *A* and miter gear *B* on the driving shaft is a worm that meshes with a worm-wheel *N* on the indexing shaft *M*. At the lower end of the indexing shaft is the segment gear *O*. The teeth on segment *O* mesh with those in the turret gear *P*. By means of the worm and worm-wheel, indexing shaft *M* is slowly and continuously rotated. As, however, the movement of the turret can only take place when the teeth in the segment are in mesh with gear *P*, the indexing takes place but once during each revolution of the indexing shaft. During the time that the segment is running idle, the turret is locked in position by a locking bolt that engages one of the four tapered slots cut in the disk *Q* that is integral with the turret gear *P*. The locking mechanism

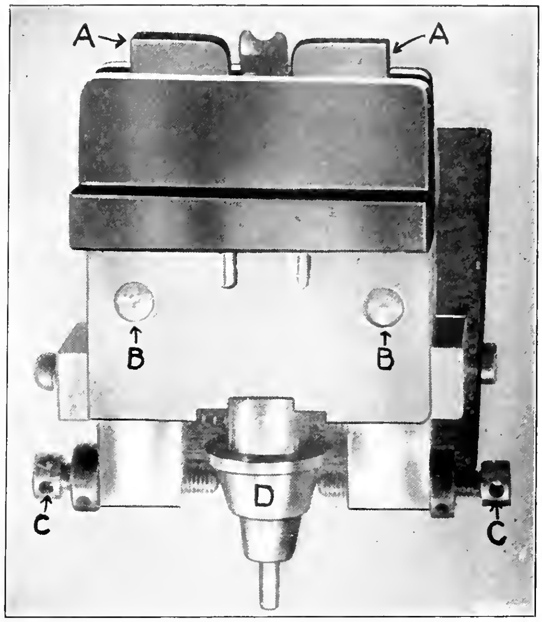

Fig. 3. One of the Turret Chucks

is concealed beneath the indexing segment but its manipulation is very simple, being operated from a cam on the lower part of the indexing shaft.

The turret rotates upon a stud mounted on the base of the machine. Each of the four stations on the turret is provided with a chucking fixture *R* in which the pendant is held and a chute *S* that serves to conduct the finished piece away when at the ejection point. One of the chucking fixtures is shown separately on a larger scale in Fig. 3. This type of fixture provides for an automatic chucking of the pendant as well as for the automatic loosening of the jaws from the work and the ejection of the piece. These movements are accomplished by having the two gripping jaws *A* of the fixture, as shown in Fig. 3, pivoted upon studs *B* that pass through the body of the fixture. The bottom ends of the jaw levers are fitted with adjustable screws *C*. The points of these screws project inward and are acted upon by the tapered plunger *D*. Any upward movement of the taper plunger allows the jaws to open and continued upward movement causes a rod to rise and eject the piece from the jaws. Referring again to Fig. 6, the method of operating the chuck will be seen. The fourth

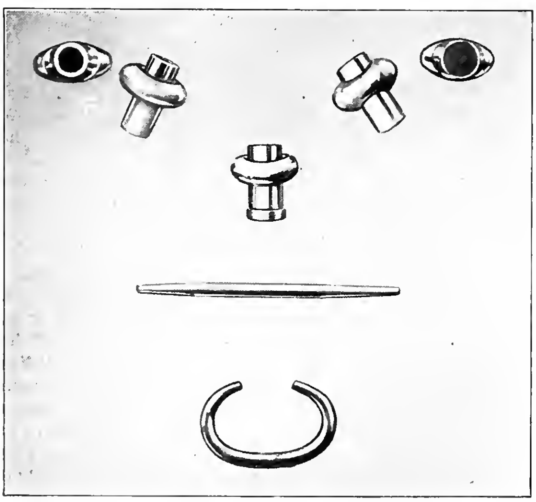

Fig. 2. Samples of Watch Pendants, a Bow Blank and Bow

* For other articles on watch-case making see "Method of Making Watch Case Pendants," October, 1912, and "Watch Case Manufacture" 1 and 2, July and August, 1912.
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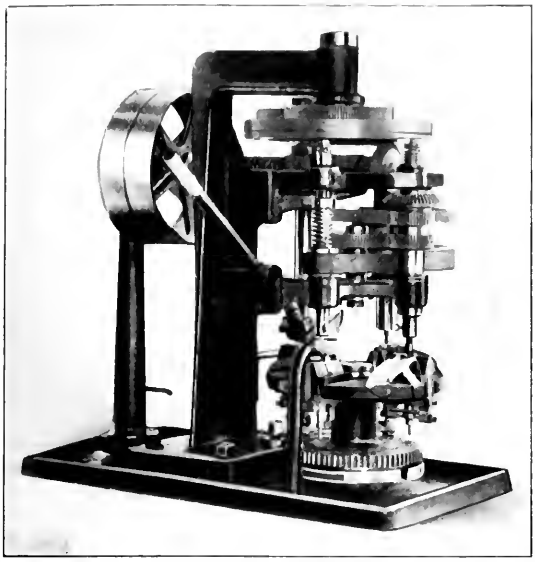

Fig. 4. The Pendant Drilling, Counterboring and Tapping Machine

station of the turret, at the rear, is for the purpose of ejecting the machined pendant and taking on the new blank pendant. At the time of indexing, when the turret is turning and the completed piece is approaching the fourth station, the lower end of the chuck plunger comes into contact with a gradually ascending grooved track *T*. As the piece approaches the ejecting point, the plunger is, of course, rising and allowing the jaws to open; at the same time the plunger raises the pendant in the chuck so that all that is necessary is for it to be swept out of the way. Ejecting lever *U* is operated upon by cam *V*. When the pendant has been raised in the chuck and is ready for ejecting, a sharp drop in cam *V* allows the ejecting lever to be pulled against the pendant by spring pressure, thus knocking it out of the chuck and down chute *S* into a receptacle placed there for the purpose of catching the finished work. The gradual ascent in cam *V* brings the lever back into position for ejecting the next piece that will be finished. The pendants are fed to the machine through a tube *W* which is of the right section to admit the pendant blanks but will not allow them to turn in the tube. At the bottom of tube *W* is the latch *X*. This latch is for the purpose of allowing but one of the pendants to drop from the tube and into the chuck at each loading time. This latch is operated by a cam lever *Y* that is located on the indexing shaft.

The method of feeding the spindles downward for the cutting action is interesting and the three spindles are all operated from the cam plate *Z*. The cam plate is turned by means of spur gearing from the top of the indexing shaft. The ends of the three operating spindles are rounded over and bear against separate cam sections upon the under side of this cam plate. By means of spring pressure the ends of the spindles are kept normally in contact with the cam surfaces. As cam *Z* turns, the inclined faces of the cam paths cause the spindles to descend in their brackets, thus advancing the tools in the work. At the end of each cut an abrupt drop in the cam paths allows the tools to jump back out of the work and leave the field clear for indexing. The changing of the tapping spindle direction from forward to reverse is accomplished by means of a friction within the spindle. This friction is operated from the cam plate and when the spindle has reached the limit of the tapping operation, the engagement of the friction clutch causes the reversing gears to act on the spindle and back the tap out of the work.

The operation of the machine is as follows: Loading cam *Y* operates the latch on the feed tube and allows one pendant to drop into the open chuck. Indexing now takes place, the chuck jaws grip the work and it is carried to the drilling station. The drilling takes place while the counterboring and tapping operations are proceeding on other pieces and then the turret indexes, bringing the drilled pendant to the counterboring position. At this point the outside of the pendant is counterbored as shown in Fig. 1 and a subsequent indexing brings it into the tapping position while another pendant blank is chucked and goes to the drilling position. Here a 5/32-inch tap, 64 threads to the inch, taps out the upper

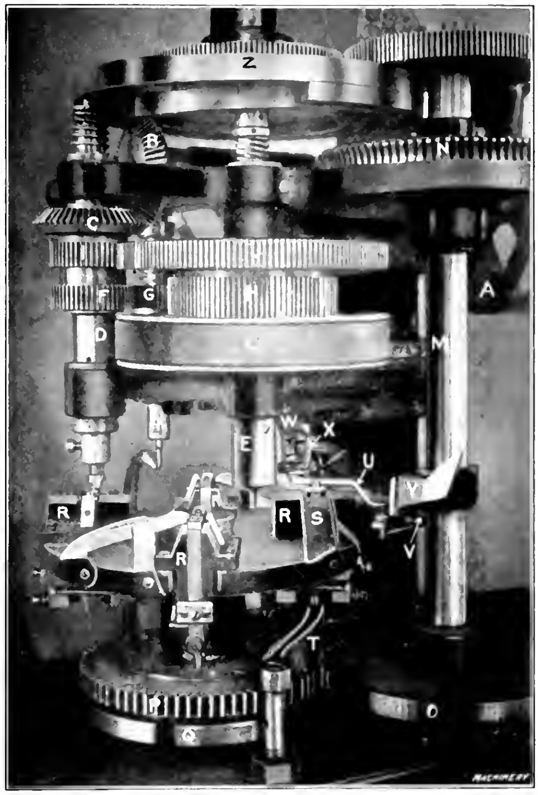

Fig. 6. Details of the Pendant Machine

section of the hole, after which the last indexing brings it into the ejecting position. At this point the ejecting lever comes into action and sweeps the piece from the chuck into the chute and out of the machine. Just after the ejecting operation takes place, the loading cam operates the latch on the tube and allows a new piece to drop into the chuck. Thus one piece is finished at each indexing.

The operation of the machine is entirely automatic after the pendants have been placed in the feed tube. The machine can be used for different types of pendants and, in fact, by proper tooling, for any work requiring similar drilling and tapping operations.

A Machine for Bending Watch Bows

In the lower part of Fig. 2 at *D* is shown the blank for a watch bow. This, it will be noticed, is thinned down at the

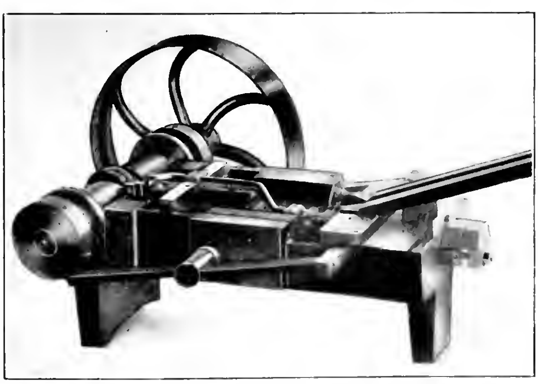

Fig. 5. The Watch Bow Forming Machine

ends so as to leave the central portion of the link of the correct thickness. The wire stock used is rolled gold and the ends are thinned down by swaging. At E in the same illustration is the bent watch bow, and it is for the purpose of performing this bending operation that the machine illustrated in Fig. 5 was designed and built.

The details of this machine may best be seen by referring to the enlarged illustration, Fig. 7. This shows the machine as viewed from above, and those familiar with wire working machinery will recognize that it works on the same principle as the four-slide wire forming machine. The straight blanks for the bows are fed down the inclined chute A. Directly under this chute is a semicircular stationary forming tool. This is not shown in the photograph. The principal forming tool or arbor B is located on the ram C of the machine. This ram has, at its extreme rear end, a roll D that is acted upon by contact from a cam E on the crankshaft of the machine. The function of this cam is to advance the ram and the forming tool on it. The ram is re-

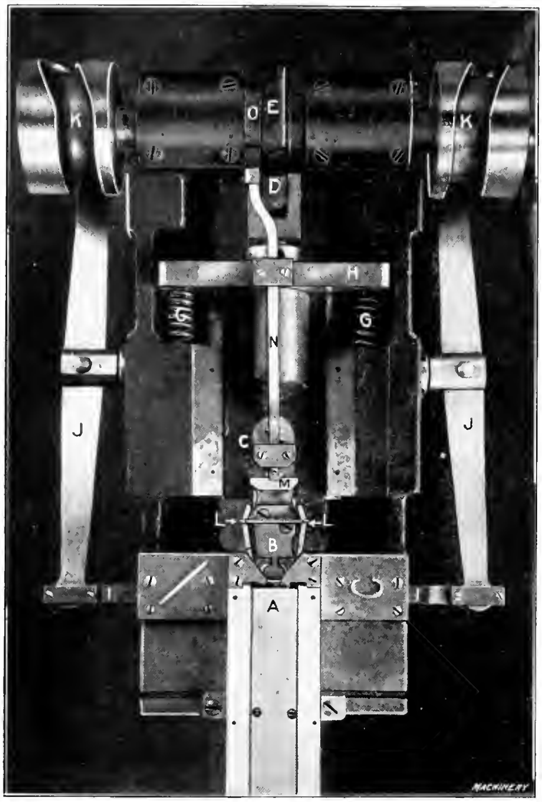

Fig. 7. Plan View of the Watch Bow Machine

turned by springs G that bear against a plate H, keeping roll D always in contact with the cam on the driving shaft. There is a dwell on cam E that serves to keep the forming tool B and the bow that it has pushed into the semicircular stationary forming tool in its innermost position, while the side arms I, actuated by the long operating levers J, come in from the sides and force the ends of the wire around forming tool B. These levers are operated from cams K on the driving shaft. As soon as tool B is withdrawn by the spring action of the ram, the formed bow drops from the forming tool B to a box beneath the machine. The slight spring of the wire is sufficient to loosen it from the arbor, and as the entire lower half of this arbor tapers sharply, the bow drops off by gravity.

An interesting feature of this machine is the method by means of which the blank is centered in relation to the forming tools. As soon as the blank drops down into the bending position its ends are caught between spring fingers L. These spring fingers are evenly brought together when the ram advances, just before the bending takes place, by means of a wedge shaped block M. This wedge shaped block is, in turn, pushed forward by lever N that is operated by a cam O on the crankshaft. This centering action takes place just before the bending tools start to act upon the wire and insure that the ends of the link are bent, leaving them the same length. Like the watch pendant turning drilling machine, this machine is entirely automatic after the blanks have been placed in the chute.

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APPROXIMATE RULES FOR STEEL BEAMS

Some useful approximate formulas are to be found in a paper on "Calculations and Details for Steel-frame Buildings from the Draftsman's Standpoint," recently read before the Concrete Institute (Great Britain) by W. C. Cocking. The author states that the section modulus of an I-beam is given approximately by the expression:

$$M = \frac{W_s\, d}{10}$$

where W_s denotes the weight of the section in pounds per foot run, and d its depth over flanges in inches. The safe load on a 1-foot span for I-sections is approximately

$$\frac{W_s\, d}{2},$$

the corresponding stress being 7½ to 8 tons per square inch.

For I-beams used as pillars, the safe load is approximately equal to the safe load per foot run on a span, which measured in feet is equal to twice the width of the flange in inches, the load being taken as applied laterally, and the column considered as fixed at both ends. For a stress of 7½ tons per square inch the section modulus required is $M = 0.2\, w L^2$, where w denotes the load in tons per foot run, and L the span of the beam in feet. The approximate weight of a beam to carry a given load is:

$$W_b = \frac{W L^2}{1000\, d},$$

where W_b denotes the weight of the beam in tons, W the total equivalent uniform load in tons per foot run, L the span in feet, and d the depth of the beam in inches. The weight of a column is approximately:

$$W_p = \frac{W L}{C},$$

where C is 2500 for both ends fixed, and 2000 for one hinged and the other fixed. In this case W denotes the total central load on the column, and L its laterally unsupported length in feet. The weight of a beam-casing is approximately:

$$W_c = 0.00035\, b\, d\, L,$$

where W_c = total weight of the casing in tons, b the breadth, and d the depth, both in inches, while L is the length in feet. The same formula applies to columns. For calculating the effect of eccentric loads on columns, Mr. Cocking recommends the following factors: For I-sections the equivalent central load

= 1½ times eccentric load if latter is connected to the web of the I-beam,

= 2½ times eccentric load if the connection is to a flange.

The corresponding factors for an I-beam column with plates over each flange are 1¼ and 2½, respectively. For a double I-section, with plates riveted to each flange, the factor is greatest when the connection is made to the web of one of the I's and may be taken as 2¾ times the eccentric load.

* * *

The Detroit Executives Club was recently organized in Detroit for the purpose of determining how the efficiency of local organizations can be increased. E. St. Elmo Lewis of the Burroughs Adding Machine Co., Detroit, is the chief promoter of the idea. The club is at present in a formative stage. Primarily it will be composed of fifty members of as many different organizations in Detroit, and only those who are invited to join will be made members. The object of the club is to study efficiency, scientific management, welfare work, methods of employment, etc. One subject will be taken at a time, and exhaustive researches will be made in factories all over the country.

A GAGE LIMIT SYSTEM FOR GENERAL WORK

BY FRED W. MC ARDLE*

The system of gage limits here described was devised for use in an engineering office which specializes on general machine design. The various machines designed are built in different factories, depending on the client for whom the work is done, and often without supervision by the engineer; so it is evident that any system of limits used must be simple and readily understood. When a new machine is designed it is almost impossible to make a set of drawings so complete in detail as not to require more or less explanation, and one of the most important items is that of fits. It is not sufficient to give nominal sizes on a detail, as it then leaves the matter to the judgment of the individual machinist as to whether a stud, shaft or other part shall be up to size, over or under. If the man is a careful workman, he either refers it to his foreman, who as likely as not knows little more than

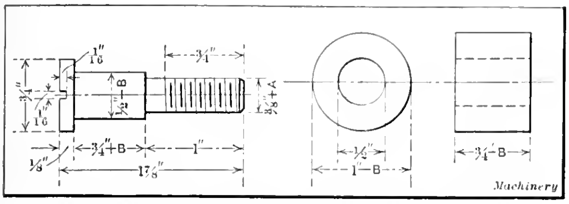

Fig. 1. Examples of Details showing Use of Gage Limit System

GAGE LIMITS.

All holes are standard reamer size unless noted.
+A indicates from plug size to .001 over,—A same under,
+B indicates from .001 to .002 over size,—B same under,
+C indicates from .003 to .005 over size, —C same under,
Finish dimensions unmarked, from .005 under to .005 over.

Machinery

Fig. 2. Form of Gage Limit System for General Work

he does about the matter, or he makes it "full" to allow for final fitting.

In either case there is a loss of time and added expense. This is equally true if parts are designated as "running" or "driving" fits, for still the machinist must use his judgment, which is apt to be such as to leave him on the safe side. If instead of following this practice, the sizes are given in thousandths, with or without limits of variation, it often occurs that the work will be built in a small factory unaccustomed to such specifications, and the cost will be increased by the extra care that is taken with parts that do not require particularly close work, solely because the job bears the hall mark of accuracy on some of the parts. The latter method has the additional disadvantage of causing extra work in placing the limit sizes on the drawing. This, of itself, is something of an item on any design requiring a considerable number of details.

Experience with these and kindred difficulties led to a tentative method that has been developed into a system, in no sense perfect, but one which can be readily used in general work, and which insures good work without fitting or questions as to fits; these are decided by the designer and indicated in a way that is easily understood by the workman. This result is accomplished by affixing to all dimensions which require limiting, a plus or minus sign and a letter, *A*, *B*, or *C*, which indicates the amount of variation; plus indicating over nominal size and minus indicating under size. A rubber stamp giving the data presented in Fig. 2 is used on each detail sheet and the various details are marked accordingly, with the result that the machinist makes a part regardless of fits, and each individual part is made without the disturbing element of thousandths on some other part.

The gist of the method is this: If a dimension has a plus letter after it, it must be up to size or over, within the limits called for by the letter. Similarly, if a dimension is followed by a minus sign, it cannot be over size and may be under, according to the letter. A finish dimension without plus or minus letter indicates that the size is nominal, and ordinarily careful work is all that is required. Slots and depressions that would be measured by a plug gage may be considered as holes, and come under the heading "all holes are standard reamer size unless noted." Working on this basis, studs, shafts, slides, etc., are marked minus if a running fit, plus if a driving or press fit, and the limiting letter according to the judgment of the designer. Both the plus *A* and the minus *A* dimension may ordinarily be considered as plug size, with this difference that the plus sign would be used where it was essential that the part be absolutely rigid, as in the neck of a stud where it fastens or is screwed in to another part, making it integral; the minus sign would be used where a part is subject to frequent removal, as in a stop plug or other part where ease in removing is essential. If preferred, however, plug sizes may be specified in thousandths, which of course would admit of no variation. Drilled holes are so marked, and cored holes should be specified. Fig. 1 will illustrate the application of this method to detail work. The roll shown is a running fit on the stud, and it is evident that the two details may be made independently and yet work together without subsequent fitting. It will be noticed that limits are given, both on the length of the shoulder on the stud, and on the width of the roll, and this apparently departs from the general method described. It seems advisable, however, to allow variation when possible, rather than absolute sizes, and in such cases as this, side clearance may be split up between the two details with satisfactory results.

Since the adoption of this method, two machines radically different in class have been designed, and the form shown in Fig. 2 could not be used without modification. One of these machines was of a character that forbade a maximum variation of more than 0.002 inch; the other was of an exactly opposite character, being used on heavy work, subjected to the action of water, and lubricated with heavy grease. In the latter machine a maximum variation of 0.015 inch or even more was allowable, without affecting the action. To meet these conditions, the same rubber stamp was used and the values of the limiting letters changed, as shown in Fig. 3.

After a year or more, it has been found that little or no explanation is required when a drawing marked as described

GAGE LIMITS.

All holes are standard reamer size unless noted.
+A indicates from plug size to .0005 over,—A same under,
+B indicates from .0005 to .001 over size,—B same under,
+C indicates from .001 to .002 over size, —C same under,
Finish dimensions unmarked, from .003 under to .003 over.

GAGE LIMITS.

All holes are standard reamer size unless noted.
+A indicates from plug size to .005 over,—A same under,
+B indicates from .005 to .010 over size, —B same under,
+C indicates from .010 to .015 over size, —C same under,
Finish dimensions unmarked, from .015 under to .015 over.

Machinery

Fig. 3. Special Forms of Gage Limit System for Fine and Rough Work

is put into the shop; moreover, the men seem to take kindly to it. In estimating costs, it is found valuable as an aid to the contractor in getting a closer figure than would be obtainable where nicety of finish would be a matter of guess work. Finally, one additional safeguard is given both to the designer and to the machinist. Errors are almost certain to occur either in the shop or drafting-room, or in both. The writer has a case in mind where cumulative errors in finish, any one or two of which would have had no effect, resulted in apparent discrepancy which affected to a considerable extent the working of the parts. In going over the work it was found that fits were made according to the judgment of

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the man making the piece; in making fits he kept on the side of safety, and no blame could be attached to him for his work. In several parts all fitting on the safe side the net result was over size. Apparently it was a mistake of the draftsman, until the drawings were shown to check up correctly. The only thing that could be done was to alter the parts affected in order to make the machine operative, and there remained a lurking impression in the minds of both the builder and the man who paid the bills that somehow it was the fault of the draftsman, but that he had got out of it on a Scotch verdict, "not proven." The method described may be improved and amplified, but the results obtained from the present form are such that it has been thought inadvisable to introduce additional complication.

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PROFIT-SHARING AND CO-PARTNERSHIP

An interesting report on profit-sharing and labor co-partnerships has been issued by the British Labor Department of the Board of Trade and is reviewed in a recent number of the *Mechanical Engineer*. This report indicates that under present industrial conditions, co-partnerships and profit-sharing are successful only in exceptional instances. It shows that, as far as the engineering and allied industries are concerned, the present outlook is discouraging. Out of six mining and quarrying companies that started on a profit-sharing basis, the co-partnership scheme has been abandoned. In the metal trades, out of nine firms that started profit-sharing arrangements only one still employs the method, and out of twenty-one engineering and shipbuilding firms, only four still maintain the system. The only trade or industries in which schemes of this kind seem to be successful are those in which the company has more or less of a monopoly and in which the profits are almost assured from the beginning. As an example of this may be mentioned gas works, where out of thirty-four cases reported, in only one instance has the profit-sharing been abandoned. France is the country in which methods of this kind have been longest in existence; in fact, its oldest profit-sharing undertaking dates from 1820. In Germany, profit-sharing has made little progress and many of the arrangements introduced have been comparatively short-lived. Thus, out of fifty-four profit-sharing instances recorded in 1878, only nine were in existence in 1901. At the present time, there are only thirty profit-sharing institutions known to be in existence in that country; twenty-one of these undertakings for which particulars are available employ about 15,000 people. In the United States there are about twenty-five or thirty firms that have introduced profit-sharing schemes, and some of those that have done so are very large. A general survey would therefore indicate that at the present time there is little hope of relieving industries from labor difficulties by arrangements of this kind. A much better method would seem to be the Canadian provision for public investigation and publication of all the facts when differences arise between employers and employes.

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Every new movement is attended by quackery, and no matter how meritorious it may be, the effect of the fakers engaged in promoting it for large personal gains is to discourage and retard its legitimate development. Scientific management of manufacturing plants is no exception. In fact, it has suffered severely from the absurd methods and claims made by "efficiency engineers" who have exploited it to their own profit and the loss of concerns who have engaged their services. The possibilities of scientific management properly worked out are almost unlimited, but they will be realized in the greatest measure when it is developed by practical men who are able personally to do the work they aim to direct. The result of malpractice in efficiency betterment is reflected in the fact that some concerns actively engaged in the study of production methods will not admit that such work is being done for fear of being discredited in the eyes of their workmen. The study is carried on unobtrusively by men who do not pose as "efficiency experts." No radical changes are made, but when the weak places are found changes of method are made gradually.

REDUCING LABOR COSTS BY BROACHING*

BY A. B. CORMIER†

The rough forging for a bearing ring and one of the finished rings are illustrated in Fig. 1. In machining these forgings, a prominent automobile parts manufacturer has reduced the labor cost materially by the application of broaching in machining the inside surfaces and the four holes through the ring. In this article a description will first be given of the methods now employed in machining these forgings, after which a comparison will be drawn between the present method and that formerly employed, with the object of showing how the saving of time was made possible by the change.

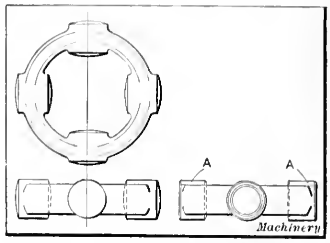

Fig. 1. One of the Rough Forgings and a Finished Ring

The rough forgings are made from 0.25 to 0.30 per cent carbon open-hearth steel. The first operation consists of machining the surfaces *A* which come in contact with the fixture used in broaching the inside of the ring in the second operation. The broaching fixture consists of a faceplate which holds the hardened steel block *B*. This block guides the broach, and the finished surfaces *A* on the forging are also held in contact with the block to locate the work properly. A set of three broaches is used; the first broach takes a coarse chip because the cut is relatively narrow; the second broach takes a finer chip; and the third broach, which has the maximum width of cut to deal with, removes but 0.001 inch of metal. The last seven teeth of this broach are straight while only the last three teeth of the first two broaches are straight. Accuracy in this operation is particularly important because it is not only employed to finish the forging, but the four surfaces finished by broaching are used in locating the work for all subsequent operations.

The duplex milling fixture on which the third operation is performed is illustrated in Fig. 3. The forgings are

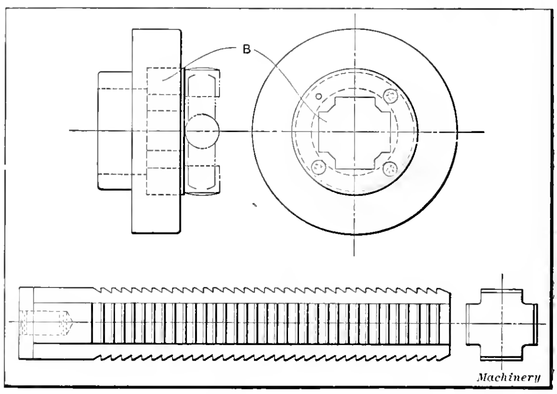

Fig. 2. Broaching Fixture and One of the Broaches used for finishing the Inside of the Forgings

located on hardened plugs *C* and clamped down against the surfaces *A* which were machined in the first operation. The two work-holding plugs of this fixture are indexed simultaneously by means of spur gears *D*, and the blocks are located in position by means of tapered plungers *E* controlled by operating screws. The milling cutters are employed to finish the outside faces of the forging corresponding to the

* For additional information on broaching previously published in MACHINERY, see "Broaching a Dovetail Key-seat in a Taper Hole," February, 1909; "Broaching Automobile Parts," April, 1909; "Broaching a Connecting-rod End," June, 1912; "Broaching the Square Holes in Vise Bodies," February, 1913; "Broaching Automobile Parts," June, 1913; "Broaching Vs. Milling," June, 1913; "Broaching Pivot Holes in Scale Parts," July, 1913; "Broaching a Vacuum Cleaner Part," July, 1913; "Broaching a Long Keyway," August, 1913; "Points on Broach Making," October, 1913; "Drilling Machine Fixture for Broaching Push-rod Guide Holes," December, 1913; "Broaching Vs. Reaming," by F. J. Lapointe, February, 1914; "Broaching vs. Reaming," February, 1914; and "Broaching Round Holes," March, 1914.

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four inside faces which were finished by broaching in the second operation.

After completing the milling operation, the forgings are taken to a four-spindle semi-automatic horizontal drilling machine of special design where four 31/32-inch holes are drilled in each piece. The work is held on a hardened plug *F* of the fixture shown in Fig. 4. The plug has holes in it to admit the drills when they pass through the work. After the holes have been drilled on this machine, the forgings are transferred to another broaching machine where the four holes are broached to 0.999 inch in diameter. In performing this operation, the work is held on a hardened plug *G* of the fixture shown in Fig. 5. This plug also has holes in it to allow the broach to pass through in finishing the holes on opposite sides of the forging. Nothing in the way of an indexing mechanism is attempted on this fixture, the work being lifted off the plug and replaced in position for broaching the other two holes.

After the broaching has been completed, the forgings are burred by the tool shown in Fig. 6. The lower burring cutter is made with a square hole in it. This cutter is placed in position and the arbor with the fixed cutter mounted on it is entered through the upper hole in the work and moved down until it enters the hole in the lower cutter. After the operation has been performed in this position, the work is moved three times in order to burr the other three holes. One operator is employed for each of the operations except those of milling the outside of the forgings and drilling the holes, these two operations being performed by one man.

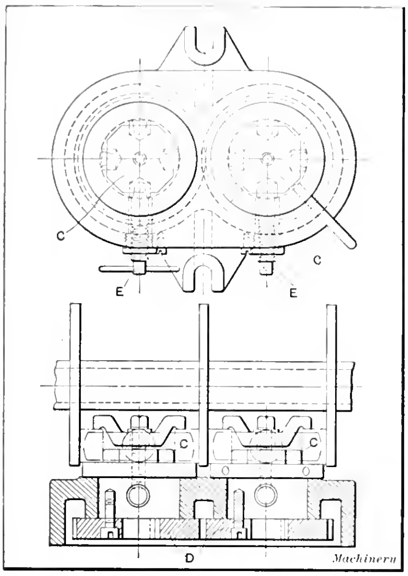

Fig. 3. Duplex Fixture for use in milling the Outside Faces of the Forgings

The original method of machining these pieces was to first drill and ream the holes on a four-spindle drill press provided with two drills and two reamers. Four box jigs were used in a row on this machine. The second operation consisted of profiling the inside of the forging, a fixture being used for this purpose which had four locating pins. In the third operation, the square hole was broached to the required size, the work being located by a fixture with four pins as in the preceding case. The fourth operation consisted of rough- and finish-milling the outside faces of the forgings on a hand miller, which milled one face at a time.

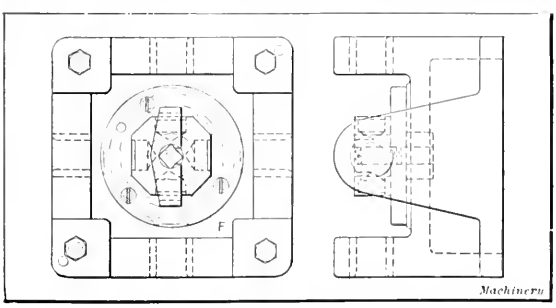

Fig. 4. Jig used for drilling the Four Holes in the Forgings

In the fifth operation the holes were broached to the required diameter of 0.999 inch, and after this had been done the final operation was performed, which consisted of burring the holes by hand.

A great saving of time has been effected by adopting the new method. Through the use of special four-spindle semi-automatic drilling machines, one man is able to finish eight holes in the time formerly required to drill and ream two holes. The substitution of broaching for profiling in finishing the inside of the forgings has not only effected a saving of time, but it requires less manual labor and produces more satisfactory work. There was a tendency to chatter in finishing the inside of the forgings on the profiler. The new milling operation has also been the means of effecting a great saving of time. We were at first under the impression that the length of cut was too short to allow the work to be handled efficiently with power feed, but it was found that when hand feed was used the operator pushed the work across the cutter at a greater speed than was necessary, the result being poorly finished work. As previously mentioned, only one roughing cut is now taken which gives a very nice finish.

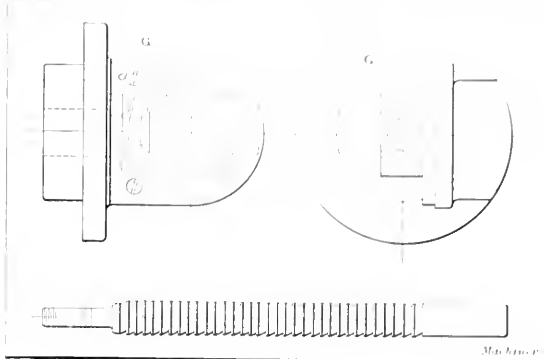

Fig. 5. Broach and Fixture used for broaching the Four Holes in the Forgings

In order to obtain the most efficient results, particular attention has been paid to the grouping of the machines in order to allow the work to be transferred from one machine to the other as rapidly as possible. The arrangement is such that when the work is finished on one machine it is laid down within easy reach of the operator of the next machine and so on until the last operation has been performed. This method of grouping is, of course, only possible in factories which specialize on standard products.

* * *

It is interesting to note that in the battleship machinery of today there is not found the great amount of copper, brass and gun-metal that was common in ships built twenty years ago. In the propelling machinery of the modern battleship, the weight of non-ferrous metals today equals about 17 per cent of the steel and iron, whereas twenty years ago the non-ferrous metals in the propelling machinery amounted to about 34 per cent of the weight of the steel and iron parts. Except for the very smallest pipes, for example, copper steam pipes are not used in the most modern types of battleships. Gun-metal ends for condensers have also disappeared and the condenser shell is made from sheet steel, which is lighter, although not so durable as gun-metal. It has, however, sufficient life as compared with the probable life of the battleship. In the whole structure of the vessel, however, the proportionate amount of the non-ferrous metals has not been reduced as compared with twenty years ago, on account of the increase in gun turrets, fire control appliances, electric lighting, telephones, etc., where non-ferrous metals are advantageous or necessary.

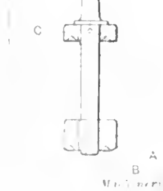

Fig. 6. Tool used for the Burring Operation

ON INDUCING OURSELVES AND OUR MEN TO EARN MORE MONEY*

SOME POINTS ON SECURING EFFICIENCY THROUGH COOPERATION OF EMPLOYER AND EMPLOYE

BY J. C. SPENCE†

THE record of the recent past and the evidence as to the immediate future point to the fact that if the American machine tool industry is to compete for the best workmen, there must be a change in our methods. Competition with Europe and within the trade precludes the possibility of any great increase in the selling prices of our products. The changes, then, must take place within our organization; we must get more salable goods per dollar of investment, and this result must be attained, not by a decrease in the earnings of all concerned, but by an increase, else we will gradually lose the best of our men to such other industries as have, at present, a larger margin of profit. This movement has already made inroads into the field of good machinists, and everyone is familiar with the statement that "we can't get the kind of man that we could some years ago." This lack of good men is, of course, not due entirely to the fact that other industries are offering better opportunities, but is more or less influenced by the growth of industry in general being faster than the supply of trained men can keep pace with. Nevertheless, one industry in particular is taking from us many of our brightest young men, and is taking them almost entirely because of wages. Granting, then, that conditions will remain practically as they are, the only method by which we will keep the personnel of our particular industry in the highest class is by the offering of greater wages. The mere act of holding a job has ceased to be the all-important inducement.

Inefficiency of Workmen

Whenever the word "efficient" or "inefficient" has been used as applying to our line of work, the natural tendency has been for all minds to turn to the shop end of the business, especially to the man who runs a machine. Practically all of the illustrations by means of which our eminent experts have arrested the attention and gained a permanent lease of the ears of managers and board of directors have had to do with such perfectly awful incidents as a shaper tool taking a 5-inch stroke when a 3⅝-inch stroke would have been sufficient. I hold no brief for the man who cuts air when he should cut metal, but to my mind it is no more than right that we should first look to ourselves to see wherein we fall short of the mark of 100 per cent. If the workman is not efficient, just what is our share of the cause of his inefficiency?

First, let me say, that it is my firm belief that the large majority (if I were to state a percentage I would say 90 per cent) of all machinists employed by the National Machine Tool Builders' Association, are endeavoring to give an honest day's work. That they do not produce more work than at present is largely the employer's fault—so much so that it is going to take the whole of his attention to certain details before he can induce his men, and hence himself, to earn more money. I am saying this from a mind that only a comparatively few years ago looked at the workman's side only of this question. I am not so far away from the operation of a machine that my memory has become dulled to what went on when I was trying to produce against obstructions allowed to stand in my way by my foreman and his superiors.

The metal cutters, or chip makers, on the simpler class of work, may be assumed to be fairly efficient in most of our shops. It has been a comparatively easy matter to set standard times or prices on these operations. There is still a good field for improvement in the making of drawings, especially for the workman's use. I'll venture to say that in every one of our shops today there are blueprints that the "old man" himself would not recognize as showing a part of his own inventions, if someone should cut the title corner off, and as for settling where the machining should begin he would have to lose a good many minutes in study. Even the simpler drawings are a puzzle to the beginner and the foreman cannot be in all places at once. We should point out, on our drawings, by the copious use of English and by means of routing sheets, just what the workman is expected to do. Most of the shops that I have seen are open to this criticism: We are all drifting along, to some extent at least, in the old way of leaving a workman to his own initiative to find ways and means of doing a great share of the operations. The draftsman who learns to make drawings with the idea of saving time in the shop gradually makes of himself an engineer in the true sense of the word, because in order to tell how a piece should be made, he first has to learn by consulting with those who do know. He is inducing himself to earn more money. The foreman who is fortunate enough to have his blueprints come to him in such form that the more intelligent of his men need little personal instruction and supervision has more time to devote to the weaker members of his gang and his department output is higher—consequently, his own value increases.

Putting the Workman in Business for Himself

Right in line with this plan I recently tried an experiment that is interesting because it is illustrative of exactly what is going on in many shops, and is causing the loss of a lot of money. A quantity of a certain small piece was sent to us by another firm to be ground. We had quoted on the work and there was a price we had to meet. As usual, in such cases, before letting the work start in the shop we sent along with the pieces a routing sheet, which told how many pieces per hour we had estimated to be a fair production. The pieces were produced inside of the time limit and the net cost per piece was 1½ cent. Several months later a lot of the same pieces came in, and these were put into the shop and ground by the same man, but without anything to tell him what was expected of him. The second lot cost 2 cents each. Now the operator was not dishonest. I do not believe that he intentionally held back. He simply wasn't in business for himself. He would have produced those pieces for 1½ cent if there had been any means supplied for concentrating his mind on the job. Even if he had run into an obstacle that he couldn't overcome, he would have called for help quickly, in order to protect his own record. As it was, the time drifted by without his having a very clear idea of anything in particular. You have to get the man interested, and there's only one way—put him into business for himself. How this is to be done, whether by premium or by piece-work, matters little, provided you see to it that more product means more wages. There is just this much about it—those who stick to a straight-day work system, unless ways are devised for periodically rewarding increased efficiency, will lose their men to the shops that succeed in putting every man into business for himself.

I know of a shop that has reduced the cost of erecting its machines as shown by the following table, by doing two things: first, by giving up the old, slipshod method of starting to erect before everything was ready, and second by putting the assemblers into business by giving them a generous bonus for speed.

Machine	Old Cost, Average	New Cost, Average	Machine	Old Cost, Average	New Cost, Average
No. 1	$43.73	$22.62	No. 4	$36.78	$18.25
No. 2	45.01	19.78	No. 5	41.26	18.84
No. 3	45.21	18.26	No. 6	32.35	18.97

The bulk of this reduction was due to the fact that all the parts were ready before the erecting was started, but a lot of the saving came from putting the men into business. Where they were formerly paid $3 a day, at day rates, they now earn about $4.50 per day, and it would be a difficult task to try to hire one of those men to go back to the old $3 job, even if he were guaranteed less exertion per ten hours.

An incident reported to me by the foreman of that job shows how it works out. He overheard one of the assemblers

* Paper read before the National Machine Tool Builders' Association convention, Worcester, Mass., April 23, 1914.
† Superintendent, Norton Grinding Co., Worcester, Mass.

using rather forceful language to a truckman. It seems that the truckman had been sent to the stores to get a certain mechanism that was to be the next one to go onto the machine. He arrived there at about six o'clock, and, as the mechanism was covered with an anti-rest compound, the stores boy, not wishing to have to wash his hands again, put him off with some excuse. The truckman went back with an empty truck and the conversation overheard by the foreman was the result. I cannot, for obvious reasons, quote verbatim what he told the truckman, but the gist of it was to get back to the stores with word that the mechanism had to be at the machine ready to be used at seven o'clock the next day or something unpleasant would happen. That assembler was in business for himself.

Another incident: A lot of gears were being machined at the turret lathe. The operator could, ordinarily, make good pay at ten cents each. The foundry had evidently made the gears of iron that was intended for larger work. They were hard. Under the old methods it would be only by accident that this fact would be discovered before the job was completed. In this particular case the workman appealed to his foreman who took the matter up with the superintendent. The result was that the foundry acknowledged its error, paid for the amount the operator ran behind, and the expense was put where it belonged.

An operator noticed that some bars in a lot of tool steel machined much more rapidly than others. His insistence on having all the bars good ones led to a thorough investigation and the formulation of specifications for tool steel that now enable that firm to form three-inch diameter tool steel bars with tools three inches wide at a surface speed of over 100 feet per minute.

The firm from whose experience these incidents have been cited believes that the best way to put a man into business so that he can share profits on each job he does is to have a rate setting department that is made up of good operators, under the leadership of a man who is himself capable of taking hold of any productive job in the works. It is almost always found to be a fact that a careful study of a job, not by the stop watch, but by actually doing it, leads to improvement. Sometimes there is only a slight gain. In other cases the time has been reduced to one-third of what it formerly was. The rates are set on the principle that since it has been found possible to reduce the cost and the concern was satisfied with that cost, before this discovery, then the new rate can be placed well above what it actually can be done for. This is contrary to the old spirit of management, but is right in line with what most machine tool men at least believe, and is the only way you can get your men into business for themselves.

Efficiency Movement on a Common Sense Basis

In this connection I do not wish to be understood when I mention the stop watch as not agreeing that oftentimes facts can be learned and gains made through the medium of so-called "efficiency" workers, who are themselves perhaps incapable of performing the operations, but who are intelligent observers. What I do mean is that I personally believe that greater savings are to be made by having a skilled man study the job from an inventor's standpoint rather than from that of a recorder or historian. All interferences with production are not evident to a mere observer. Most of them hark back to the design or to conditions imposed by the relations of a given piece to others in the same machine. The "efficiency" movement, like many other great movements, has its quacks who seize the time of unrest to play upon the credulous ignorant. But every one of us should be thankful for the impetus given to our minds by the crusade definitely started by F. W. Taylor. The obtaining of the benefits of this common sense scheme need not cost anything. In fact, it can be made to pay almost from the beginning. One good man can do enough for a group of men in so short a time that the extra production of the group will pay not only for the money spent on them, but also for further work with other groups. The scheme, properly conducted on a common sense basis, without frills, soon is compounding its gains. Such a movement, to be successful, requires the hearty backing of the management, for there will always be men in every organization, perfectly honest in their view, who are unable to see beyond the tips of their own noses when it comes to making a change from the established order of things. A management that will accept, without considering it a personal affront, the statement that it is not as efficient as it could easily be made, and at the same time is so constituted mentally that it is eager to share with the producer in any saving that may be made, will easily find ways to reduce cost, and need have no fear of being unable to get good men or to keep them loyal.

Educating Men in the Value of Materials

Men are more often careless through ignorance than by nature or intent. The man who spoils a piece of work knows that he has destroyed value, but to him the time lost is usually the item that appears to be the most important. Men should be educated in the total value of the goods they handle. They should know the cost of materials and approximately the shop burden. I know one superintendent who has adopted the system of having all spoiled work reported to him on a card that states the fault and the number of pieces spoiled. Whenever the case is of enough importance to attract his attention, he makes it the excuse for a friendly talk with the man who did the job. He talks the affair over in a way that brings out both sides of the case. Before he lets go of that incident he has taught that man a whole lot about what it costs to carry the burden of a business. He has done more good than any "call down" would do, and he has strengthened the workman's loyalty to the firm, and this, without saying, includes a determination to spoil no more if he can help it.

Discharge should be the last resort, and a frequent use, under ordinary conditions, of the power of discharge, for any reason other than the lack of work, is the sign of poor shop management. Under the management that finds its main corrective in discharge, the new man will be at a still further disadvantage because he will not have had the experience that caused the downfall of his predecessor.

The Foreman as an Executive

Now and then you will find a foreman who is a natural born business man, but this kind is rare, as foremen are usually promoted to their positions because they are good workmen, and not because of the other qualities that a foreman should have. There is a lot of difference between being a good workman and being a good executive. Most foremen have no definite idea of the cost of anything, except net labor, and it is not their fault either. Management rarely interests itself in a foreman to the extent of trying to make a real business man out of him. Yet the returns are well worth the effort. Just start a scheme whereby your foreman really runs his own department, and knows exactly where every cent was spent for which he was responsible, and you will find a most interested and watchful lot of men. You will find that having the entire list of officers on the alert for economy is way ahead of trying to do all the worrying yourself, about the time the cost department reports the facts, which is several weeks after the damage is done.

At the Norton Grinding Co. we keep an account against each foreman and gang boss, of all of the expenses for which he is directly responsible, that is, repairs and replacements, supplies, non-productive labor, spoiled work, etc. Such items as taxes, rent, power, etc., are, of course, not considered, as he has no direct control over them. The total of his expenses divided by the total of his productive labor gives what we, for the sake of comparison, call the overhead of his department. At the end of the month he is given by the cost department all of his supply requisitions with the costs marked in, and all through the month, if another foreman does for him any non-productive job, such as repairing a machine or grinding a cutter, a duplicate of the time card is sent to him with the total money cost showing. This system has aroused more interest among the foremen than any scheme we have yet found.

One foreman found that he was being charged \$10 per week for trucking, the truckmen, up to that time, being responsible

to the head inspector, and responding to calls much the same as the bell boy plan in a hotel. The foreman kept careful record for a few weeks, and then made the announcement to me that his trucking was worth only $6 per week, and that he didn't want to pay $10 for it. The result was that we took one truckman away from the inspector and put him at productive work in the casting department, and the foreman hired a cheaper man to do simple productive work some of the time and trucking when it was needed.

Another foreman came to me with a milling cutter and said, "We make cutter grinders for sale. How much time would you tell a customer that it would take to grind this?" I knew something was up, so I was conservative. My estimate was that it ought not to take over two hours. He thereupon produced a charge by another foreman of sixteen hours for the job. We both made a trip to see the other foreman with the result that the charge was reduced to two hours, which all agreed was ample. The foreman who had done the job was charged with fourteen hours of spoiled work, and the grinder operator was given his notice because his foreman said this was simply the climax of several such incidents, and he had failed to show any interest.

Even second-hand belting suddenly assumed great importance. I did not, at first, foresee that hairs would be split so fine, but it did not take long before a foreman wanted to know what became of a certain belt that was taken out of his department and replaced by a new one. I told him the good part of it would be spliced to another piece and used again. He wanted to know if I didn't think he ought to have credit. So now, when we take an old belt out, if the man in charge of belting says the bulk of it can be used again, after cleaning and repairing, we credit the department with one-half the price of a new belt. When we use that belt again, we charge the department getting it with one half the price of a new belt. Cotton waste is down to one-quarter pound per week per man using waste, and belting is down to $18 per month, average, for the whole shop, where there are 1160 belts in almost constant use every working day.

The foremen are enthusiastic over the scheme. One foreman said, "Sure, I like it. It teaches me so much about my job that if you don't treat me right I can go to someone else and tell him just how much I can run a department for, including my own wages." That is just the position we want him to be in, because we, being on the inside, know all about him, and ought to be able to keep him, if we consider him worth keeping. If, by poor judgment, on our part, he leaves and is really worth more, then we can rejoice with him.

Duties of the Superintendent

The superintendent should never be too busy to take care of any matter that the foremen or workmen think is important, whether or not it is firm's business or personal, and he should be a man in whose word the men have confidence. His training and his actions should be such that the men will know that he is not asking anything unreasonable or that he would not do himself. He must be an enthusiast in his business. He must be a boy with the boys, in fact, he must never forget to be a boy at heart. All first-class enthusiasts are. He must always be on the lookout for good qualities in men. He must campaign for loyalty, a shop's best asset, just as the nation, through the public schools, campaigns for patriotism, for both are the result of plan and not of accident. Loyalty, like patriotism, is spontaneous only in times of intense emotion. It has to be created and fostered by well laid plans that have for their fundamental principle the giving of value for value received.

The superintendent must have the cooperation of the management in teaching the so-called "non-producer" that the business of capital is to make dividends, and that the only excuse for his particular "non-productive" existence is to help "productive" labor to make more chips or to get something assembled faster or better, and that the closing of his day's duties at a certain hour is merely an unimportant incident instead of being the great event that tradition has made it.

Misunderstanding between Employer and Employes

Before we leave this subject of loyalty, it seems necessary to me that I should broach a topic that is usually tabooed in open meeting, but it is one which, to my mind, should be discussed openly, as it has to do directly with the earning power of all workmen who become infected. I refer to unionism as it is now conducted. What are we doing to combat or counteract it? Practically nothing that will have a permanent effect. The opposing of strikes by means of strike breakers and by any other combative means within our power is simply the expedient of necessity and is costly to both sides. We must get at the question through the education of the individual. Practically nothing is being done in this line. The machinist who knows absolutely that there is nothing for him in unionism, as it is today conducted, learned it only by costly experience. It is going to take too long for all men to be educated by that method.

The manufacturer has thus far stood between the union and the public, and has been discredited by the public because the public has been left practically ignorant of the employer's side of the question. The other side of the question sells more newspapers, the people hear all about that side and many untruths about the other.

If all workmen could know, today, the burden that shop owners have been carrying and are carrying in the problem of how to keep their men at work during this period of depressed business, there would be a great many men who would not stop to listen to the agitator when he starts in again. That these men do not know such facts as this is our misfortune, and it is my belief that we have every right to uncover such facts and especially to educate our men to such an understanding of business conditions that they will cease to listen seriously to many of the wild statements made on the street. For instance, in Fitchburg, during the machinists' strike, the daily papers quoted a union leader as saying something like this: "You fellows average to get $2.50 a day. You average to produce $10.00 a day. The man in the automobile gets $7.50 a day out of each of you." Now that statement was allowed to stand, and I believe that many of that man's hearers accepted it as being practically true.

Those who can remember back, if they were so fortunate as to have the privilege of learning a trade, can also recall a time when that man would have arrested their attention, and if they had not followed him, it would simply have been because they had other ideas about what they were after, and not because his statement appeared to be so very far wrong.

The employer has not taken the trouble, through well planned intelligent means to teach the workman that net labor is not the great item in an industry. He thinks it is a serious sin to mention the word "overhead" outside of the office. He has not actually proved to anybody, but himself, that if a machinist gets $2.50 a day and only produces $10 worth of salable goods in the heavy lines of machinery, such as are made in Fitchburg, the "man in the automobile," in a good many cases, would lose money. This kind of education should be spread broadcast. It is not a dream to think that it would be good for a high school boy to know something of the "overhead" of education and of business, just as the engineering schools, notably the Worcester Polytechnic Institute, are teaching it. Trained men should address workmen, in front of the shops, if you like, and the public at every possible opportunity, in an endeavor to clear the workman's mind of the ignorance that continually works against his own advancement. Employers already issue several very good papers for this purpose, but those papers are confined, in their circulation, almost entirely to men who already believe in that side of the question. These papers should be put into the hands of every man in the shops, and would do a whole lot of good in the hands of men outside of the machine tool trade. The printed matter should be followed up by intelligent, enthusiastic effort to convert men to the right way of thinking. Men must be taught that although they have rights every right entails a duty to the community, and the service must be rendered before the right can be justly claimed. It is about time that the sane men of this country who hire labor take hold of this question in an honest endeavor to get together with the sane men of this country who have labor for sale, instead of leaving this important duty to labor leaders who would lose their jobs if they ever really did succeed in doing what they claim to be trying to do—that is, get us together.

NORTON SAFETY FIRST ASSOCIATION

In view of the fact that the question of safety is becoming more vital and more widely recognized the world over, it may be of interest to note the steps that have been taken by the Norton Co. and the Norton Grinding Co. to further this movement in their plants.

A "Safety First" association was formally organized among the officials and workmen of the Norton Co. and the Norton Grinding Co., March 20. At the organization meeting there were present all the foremen and assistant foremen of both companies, as well as one workman from each department. The first safety work in the factory of the Norton Co. began in March, 1909, when a safety committee was organized. This committee was composed of five members, four being heads of departments, and one a member of the engineering department, who made monthly inspections of the plant and subsequent recommendations. The result of their work has been that practically all dangerous places in the plant have been guarded and a great many accidents have been prevented. That the work of the safety committee has been thorough is proved by the fact that on investigation of the causes of all accidents reported to the Norton hospital it has been found that very few can be attributed to the lack of mechanical safeguards. The safety committees of the Norton Co. and the Norton Grinding Co. will continue this work as they have in the years past, and will enter into the "Safety First" association, being designated by the constitution as the permanent executive committee.

A study of the accidents that happened in the plants of both companies showed that they were almost always due either to inevitable risks or to carelessness. Further study showed that if the accidents caused by carelessness could be eliminated those remaining would be almost insignificant in number. With this in mind the safety committees of the Norton Co. and the Norton Grinding Co. were called together for the purpose of organizing a safety educational campaign. After several meetings the following plan of procedure was recommended and has been carried out.

First, to establish a standard for all mechanical safeguards, a book of standard safety specifications was given to all foremen, draftsmen, inspectors and others who have occasion to order machinery of any kind. Second, a book of safety rules for workmen was drawn up, and each man who learns the rules to the satisfaction of the committee is made a member of the Norton "Safety First" association, and is given a button. This society holds social meetings at which discussion of safety topics forms part of the program. Only members wearing buttons are admitted. Third, a set of safety rules for foremen was adopted, which was issued to each foreman and assistants. Fourth, to assist the foremen in enforcing the safety rules, a safety inspector was appointed in each department, whose duty it is to report any one whom he sees violating the safety rules or any dangerous conditions which he observes in his department. These inspectors wear a special button as a badge of authority and an official notice of their appointment is posted in each department. To introduce the subject to the men, the words, "Safety First" were printed in large letters on the pay envelopes. This prompted the men to ask what these words meant. After two issues of such pay envelopes, large placards printed in English, Swedish and Italian, as shown in the accompanying illustration, were posted in various parts of the works, which gave a short explanation of "Safety First." An announcement of the proposed organization was also published in the monthly *Health and Safety* bulletin, issued by the health and sanitation department. No attempt has been made to coerce the men into joining, but the response of the workmen to the invitation has been prompt and many from all departments have already qualified as members. Following are the safety rules issued for the foremen:

Safety Rules for Foremen

Learn all safety rules for workmen. You will be held responsible for the enforcement of all these rules in your department.

When you hire a new man, you must explain to him all safety rules in connection with his work.

When you put a man onto a new class of work, explain to him all safety rules in connection with his new work.

Watch all new men carefully and see that they take no unnecessary risks.

You are responsible for keeping in place all safeguards in your department.

If a new machine is set up in your department, do not allow same to be started until you make sure that all gears and other dangerous parts are protected.

If a machine has been repaired, do not allow same to be started until guards have been replaced.

If a guard or safety device is out of order, do not use machine until it has been repaired.

Keep all passages in your department clear at all times.

Examine frequently all belts in your department and see to it that they are under the proper tension, also that lacings are in good condition.

See to it that all overhead work, shaft-hangers, etc., in your department are kept rigidly secured.

* * *

The complexity of modern manufacturing conditions has led to the use of a variety of methods of transmitting power, each of which has its advantages for different installations. One advantage of rope drives is that this transmission is practically independent of the relative positions of the driving and driven shafts. Where shafts are at an angle to each other, the application of a rope drive does away with the necessity of using a quarter turn belt which is regarded as a troublesome problem in mill-wrighting. Regardless of the type of drive that is used, it is essential for the design to be worked out by an experienced engineer who is able to advise the most suitable method for the case in hand.

SAFETY FIRST

What does this mean?

It means that SAFETY should be your FIRST thought always.

Never take any chances with your own or others' safety, for the sake of getting a little more work done, or saving a little time.

It NEVER pays in the end to TAKE CHANCES; You and your family are the ones who suffer.

It is ALWAYS best to think of SAFETY FIRST.

Försiktighet Först

Hvad betyder detta?

Det betyder att FÖRSIKTIGHET bör alltid vara Eder FÖRSTA tanke och sträfvan.

Gör ingenting, som kan sätta Eder egen eller andras säkerhet på spel, i afsikt att få litet mera arbete gjordt eller vinna litet tid.

VÅGSAMHET i detta afseende BETALAR SIG ICKE, ty Ni sjelf och Eder familj äro de som bli lidande.

Det är därför alltid bäst att tänka: FÖRSIKTIGHET FÖRST!

La Salvezza Prima

Che cosa significa cio?

Significa che la salvezza deve essere sempre il vostro primo pensiero. Non cercate mai di azzardare la vostra o l'altrui salvezza, con la speranza di fare un poco di lavoro di piu, o per risparmiare un poco di tempo.

Infine non paga azzardare, giacche voi e la vostra famiglia siete i soli a soffrire.

E'sempre buono pensare prima alla salvezza.

Norton Company

MAKING WING NUTS IN A PUNCH PRESS

DIES, TOOLS AND METHODS USED IN MAKING A PATENTED TYPE OF WING NUT IN THE PUNCH PRESS

BY DOUGLAS T. HAMILTON*

The utilization of a punch press for producing wing nuts may seem to be rather unusual—as it is—but as the following description shows, the operations are handled in a perfectly practical manner. The wing nut to be described is used largely on knock-down furniture and articles of a similar kind. The methods of manufacture are patented, the patent being held by R. Smith, general superintendent of the National Screw & Tack Co., Cleveland, Ohio, at whose plant this information was obtained. The wing nut is made from a cold-rolled coil of wire 0.248 inch in diameter, and is completed in seven operations, the first two being accomplished by one blow in a cold heading machine.

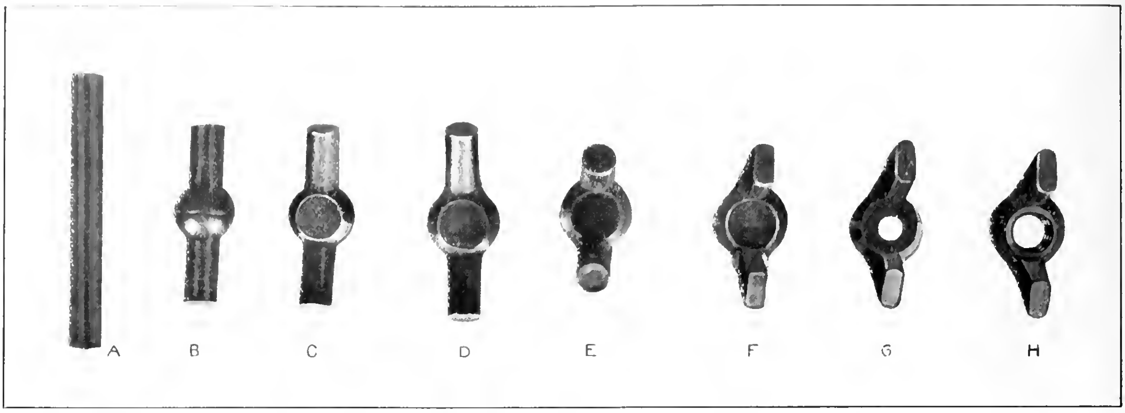

Fig. 1. Development of a Wing Nut in a Punch Press

Cutting Off and Upsetting the Stock for the Wing Nut

The first operation on the wing nut is to cut off a piece of wire 2 3/32 inches long. This is accomplished in the Waterbury Farrel cold header illustrated in Fig. 2. The wire *A* is held on a reel and is drawn in to the cutting-off tool by means of rolls, cut off and then gripped and upset in the center, as indicated at *B* in Fig. 1. The method of operating a machine of this type was described in the article entitled "Cold Heading—2" which appeared in the July, 1913, number of MACHINERY. This upsetting operation reduces the length of the cut-off stock from 2 3/32 to 1 3/8 inch, and at the same time increases the central portion or bulge on the stock to 0.460 inch diameter.

Fig. 2. Cutting and upsetting the Blank—First Operation on the Wing Nut

Shaping the Body and Bending the Ends to Form the Wings

The next three operations on the wing nut, illustrated from *C* to *E* in Fig. 1, are accomplished in the punch press shown in Fig. 3. This machine has been arranged with a special dial and work-carrying mechanism similar in operation to the multiple plunger press described in the August, 1911, number of MACHINERY. The dial *A* located to the right of the machine has sixteen elongated slots which conform in shape to the upset stock. This dial is filled by the operator, and as it is indexed, one blank at a time drops out and is located in fingers in the carrier *B*. The carrier moves the blank to a position over the first die and as the punch *C* descends, the blank is flattened in the center and slightly bent at the ends as shown at *C* in Fig. 1. The carrier *B* then picks up the blank and carries it to the next position. Here the blank is located over another flattening die and the punch *D* performs the final flattening operation on the center of the blank and at the same time bends up the ends a little further. This punch is provided with a conical impression in its lower face, which forms the sides or beveled portion on the center of the nut; it also has semicircular grooves in its sides corresponding to the shape of the wire so that the wings can pass up by the punch. The result of this operation is shown at *D* in Fig. 1. The slide *B* which carries the blanks from one position to the next is operated by a crank motion that transmits a movement to the slide through arm *F*. The sequence of operations is progressive until the blank reaches the last position where it is forced through the die and drops into a box under the machine. Seventeen thousand of these wing nuts are turned out from this machine in ten hours.

Flattening the Wings

Following the flattening of the body and the bending up of the wings, comes the flattening of the wings. This is accomplished in the punch press shown in Fig. 4. The operator lays the blank in a slide, operated by means of a crank motion, that carries the work to the flattening die. The work is carried forward with the two prongs or wings facing in toward the machine. This slide places the wings over the die and holds the blank in position until the punch descends and flattens the wings. Upon the return stroke, the flattened wing nut is ejected from the carrier and dropped into a box. Seventeen thousand blanks are turned out from this machine in ten hours.

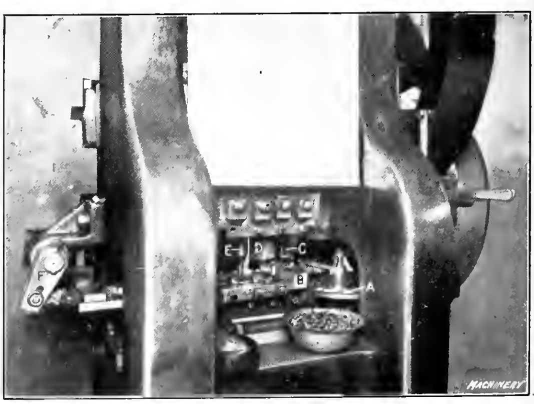

Fig. 3. A Progressive Punch Press Operation—Flattening and Bending the Wing Nut

* Associate Editor of MACHINERY.

Punching the Hole and Tapping

The hole is punched in the wing nut in the machine shown in Fig. 5; this is provided with a special work-holding device consisting of a stationary and a movable slide. The movable slide *A* is controlled by the lever *B*, and to insert the work this slide is drawn back, the nut placed in the cage and the slide returned to its clamped position. The press is then operated, and as the punch *C* descends it punches the hole in the nut. When the ram of the punch ascends, the operator again moves lever *B* outward, pulling back the slide, removes the punched wing nut and inserts an unpunched one in its place. The rated capacity of this machine is from 16,000 to 18,000 in ten hours.

The tapping of the wing nut is accomplished in the tapping machine shown in Fig. 6. This machine is provided with four spindles and carries long shank taps held in quick-

Fig. 4. Flattening the Wings of the Nuts

removing sockets. The operator places the wing nuts in cages and as the taps descend, they pass through the nuts, the latter traveling up on the shanks of the taps. When the shanks of the taps are filled they are removed, inverted so that the nuts drop out into a box, and then replaced in the collet.

* * *

A public hearing was held by the United States Commission on Industrial Relations, in Washington, during the three days beginning April 13, for the consideration of efficiency systems and their effect on industrial relations. Witnesses were called by the commission to testify with special regard to the status of workmen under scientific management. Consulting engineers and employers who have led in the introduction of efficiency systems alternated with trade union officials in giving testimony. Among others who were re-

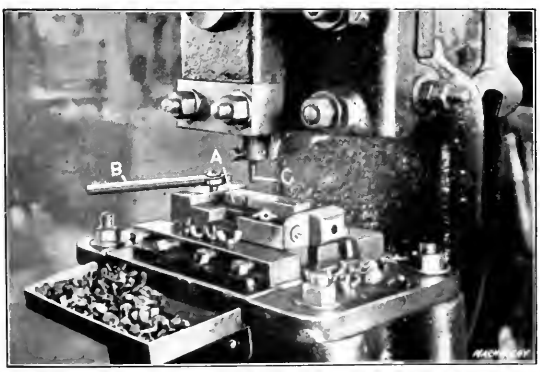

Fig. 5. Punching the Hole in the Wing Nut

quested to give their opinions were F. W. Taylor, who originated and developed the Taylor system of scientific management; James Duncan, first vice-president of the American Federation of Labor; Louis D. Brandeis, H. L. Gantt, Harrington Emerson and Carl G. Barth, consulting engineers; J. M. Dodge, president of the Link-Belt Co.; William H. Johnston, president of the International Association of Machinists; and A. L. Berres, secretary of the Metal Trades Department of the American Federation of Labor.

APPLICATION OF A PROTECTIVE METAL SURFACE BY SPRAYING

BY J. OSBORNE*

In many industries it is necessary to coat one metal with another. Hitherto such a coating has been applied by electrical deposition, but a process is now available by which one metal can be deposited upon another by mechanical means. It is claimed that the new method offers many advantages. The invention has been worked out by a Japanese metallurgist, and is especially designed for the coating of iron or steel with aluminum to prevent rusting. The process is a simple one. The metal surface to be protected is, in the first instance, galvanized or tinned; it is then immersed in molten aluminum under the surface of which it is scrubbed with steel wire brushes to remove the zinc or tin coating, which is replaced by the aluminum. The metal with its new coating is then ready for any processes through which it may have to pass, such as rolling, pressing, polishing.

Large castings or built-up iron or steel members cannot be subjected to the process just described. As it is often desirable to render structural steel work rustproof by means of a coating that is not easily corrodible, an alternative system has been worked out for this class of work, which may be briefly described as follows: The protective metal is, in the first instance, pulverized and is then forced by mechanical means into intimate contact with the surfaces which it is desired to protect. Molten lead can be readily pulverized by methods which have been known for three decades and have been very extensively used in the manufacture of electrical apparatus; the finely divided metal is applied in the form of a paste and pressed into grids to form the active material in accumulators. The stream of pulverized metal could also be directed onto plates made of some such material as asbestos,

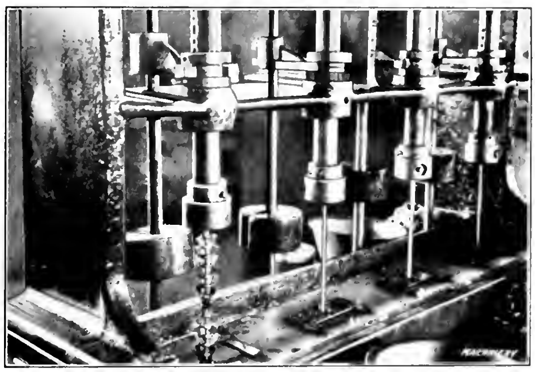

Fig. 6. Tapping the Hole in the Wing Nut

which is not sensitive to the action of sulphuric acid, so that these plates with their porous film of lead could be used without further preparation as accumulator plates.

This was the first step in the development of a process for the pulverization and spraying of metals. A steam boiler was first used for pulverizing and spraying the lead, high-pressure steam being delivered through a conveniently situated pipe and caused to impinge on the surface to be protected. Melted lead was injected into the path of this jet of steam from a suitable container, with the result that the lead became completely pulverized and was carried forward in that form by the steam and thrown against the surface to be coated with sufficient force to make it adhere. The process was then carried a step further. An apparatus was designed to enable jets of oxygen and hydrogen to be obtained at a high speed and ignited at the point of emergence, in that way forming practically an oxy-hydrogen blowpipe, capable of melting a portion of the metal held in the flame and at the same time pulverizing it and throwing forward the pulverized particles under pressure. The pulverized metal was directed against the surface to be coated. Now if means can be provided by which the pulverized metal will be fed at the desired rate, a spraying apparatus will be ob-

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tained by means of which even substances fusible with difficulty can be worked easily and continuously.

There is the alternative of using an electric arc, should the heat of the oxy-hydrogen blowpipe be insufficient. The electrodes are made in the form of hollow carbon rods; they melt off the metal used for the protective coating and this melted metal is carried forward by a highly heated or burning stream of gas passing through the hollow electrodes. In practice, the idea just outlined is carried out by means of an extremely compact little apparatus in which the compressed gas, before it is used for pulverizing the metal, first operates a miniature air turbine, the rotation of which determines the rate of feed of the metal in exact accordance with its consumption. The thickness of the deposit may be anywhere from a few thousandths inch up to half an inch or more, according to the duration of the period of treatment, while the density of the deposit can be varied. Thus a lead covering which was sprayed with superheated steam had a specific gravity of 9.5, while another lead coating sprayed under similar conditions by means of hydrogen had a specific gravity of 11 to 11.3.

It has been ascertained that, for a given pressure, hydrogen possesses a much higher velocity of flow than superheated steam, and so the pulverized metal is projected by it with proportionately greater energy. This increase of energy is proportional to the square of the velocity and, knowing this, it is possible to vary the velocity to obtain a density of the coating suitable for any particular purpose. The hardness of the sprayed coating is usually considerably more than that of the cast metal and, indeed, in many cases which have come under observation, it is even equal to that of a rolled sheet. The manufacture of metal coatings by this process should be found useful in the electrical industry. To give an instance, very thin sprayed strips should come into use as electrical resistances for all classes of electrical heating apparatus, and, as a matter of fact, the heating element in such apparatus has already been made in extremely thin layers of the more costly metals, which are painted on in the form of salts that are subsequently reduced to metals. Such strips offer a very high resistance to the passage of the current and therefore become incandescent very rapidly.

The process described is available for coppering carbon brushes and the ends of electrodes, and for the production of contacts. The spraying of two adjacent surfaces at the interstice formed at the point of contact causes this to be entirely filled up, thus providing a perfect union of the two bodies. It also facilitates mending a cracked or broken surface, so that a simple substitute for soldering and welding processes is provided. Another important application is that of galvanizing iron of irregular section used for structural work. Aluminum—the single metal that so far has not been available for treatment by electric deposition—can now be utilized by means of the spraying process. It has been suggested that sprayed aluminum could be used for coating aeronautical fabrics to render them air-tight, also for the coating of the wooden frames and fabrics of aeroplanes for the purpose of protecting them against the weather; it would, in addition, increase their stability. The coating of wood with metal is a novel idea and its application has many possibilities. Wooden parts protected in this way would be insured against dampness and rotting, or in the tropics, against damage done by insects. Packing cases could easily be strengthened by spraying the edges, or the boxes could be sprayed all over to exclude dampness.

* * *

An electrical instrument has been developed that promises to be of considerable value to electric light and power companies, inasmuch as it will enable them to sell current at two rates and to measure it at the rush and slack hours with the same meter. The device responds to a momentary slightly higher current wave than normal and it shifts the meter from one rate of register to the other. Thus, when the lighting load is heaviest in the early evening, the meter is set to register at the high rate but when the demand falls off after midnight, the wave impressed on the circuit shifts the meter to register at the lower rate.

IMPORTANCE OF PURITY OF OXYGEN USED IN CUTTING STEEL

BY J. F. SPRINGER*

The cutting of steel by means of the torches employed in autogeneous welding may be divided into two rival procedures. These differ principally in respect to the generation of the heating flame, one employing the oxy-hydrogen and the other the oxy-acetylene flame. In some respects, cutting with the hydrogen flame is to be preferred. In most cases, however, either will accomplish the desired result with economy and despatch.

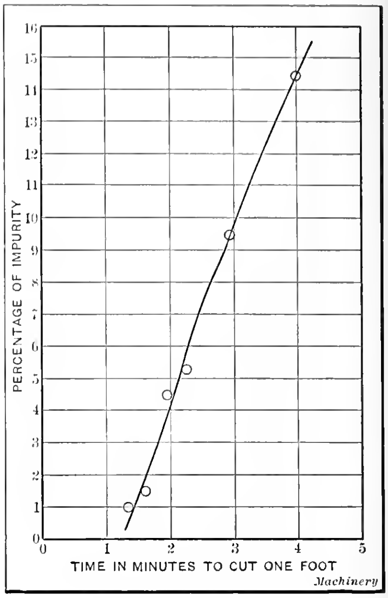

Fig. 1. Showing the Effect of Impure Oxygen on Oxy-Hydrogen Cutting

Impurity of Oxygen

It is of considerable importance to understand the effect of impure oxygen. The impurities which have any especial claim to attention are those which arise through the presence of nitrogen or hydrogen. If the oxygen is prepared by the liquefaction of air, some percentage of nitrogen will be very sure to be present. Nitrogen itself seems to be harmless, in so far as any ill effect on the metal is concerned. It is, however, practically unburnable, and so clogs the action of the oxygen. It probably also tends to cool the heating flame and thus retard the work. In the manufacture of oxygen by the electrolytic process, the principal impurity will probably be hydrogen. As hydrogen is a gas that is readily combustible it has but little effect on the heating flame, but in the cutting stream of oxygen its presence doubtless gives rise to a clogging effect similar to that of nitrogen. At all events, whether we account for the result in one way or another, the presence of nitrogen or other impurities in the oxygen supply has the effect of retarding the cutting operation. This retardation means a labor loss in addition to a gas loss, besides hindering output. Certain experiments carried out abroad will assist us in seeing just how serious the retardation is. Table I gives the results of twenty-six experiments, all tried on sheets of the same kind, of the same thickness, and with the same style of torch.

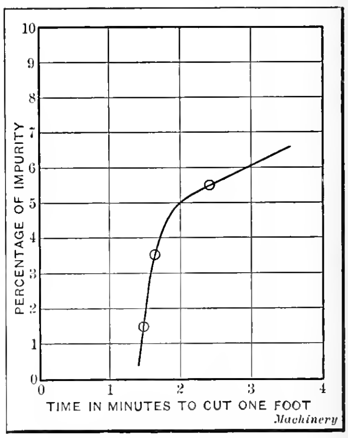

Fig. 2. Showing the Effect of Impure Oxygen on Oxy-acetylene Cutting

It will be seen at once that the purity of the oxygen plays a most important part in the efficiency with which cutting

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TABLE I. TIME REQUIRED FOR OXY-HYDROGEN CUTTING OF METALS

Siemens-Martin sheet steel, 1.18 inch thick. Oxy-hydrogen procedure. Gas consumption per minute: Hydrogen, 1.06 cubic foot; oxygen, 0.28 cubic foot. Oxygen pressure = 1.5 atmosphere = 22 pounds per square inch.

Purity of Oxygen, expressed as Percentage	Length of Cut, in Inches	Time required in Making Cut, in Seconds	Time required to Cut One Foot, in Minutes	Average Time required to Cut One Foot, in Minutes
99.00	28.0	182	1.30	
99.00	21.3	140	1.31	
99.00	18.9	120	1.27	1.30
99.00	34.3	228	1.33	
99.00	29.9	196	1.31	
98.50	31.5	210	1.33	
98.50	41.7	330	1.58	
98.50	41.7	320	1.53	1.52
98.50	39.4	310	1.53	
98.50	27.6	225	1.63	
98.50	18.9	150	1.53	
95.50	44.5	426	1.91	1.91
95.50	32.3	295	1.91	
94.75	25.2	270	2.14	
94.75	21.7	240	2.21	
94.75	33.9	364	2.15	2.21
94.75	23.6	270	2.29	
94.75	41.6	475	2.28	
90.50	34.3	480	2.80	
90.50	36.6	500	2.73	
90.50	32.7	480	2.94	2.88
90.50	35.4	495	2.80	
90.50	29.9	470	3.14	
85.50	43.3	870	4.02	
85.50	21.7	420	3.87	3.99
85.50	23.6	480	4.07	

Machinery

may be accomplished. With oxygen 85.5 per cent pure, it requires three times as long to cut the 1.18-inch plate as with oxygen 99 per cent pure. This means that the cost is three times as much. Even the one-half of one per cent drop from the 99.0 per cent oxygen to the 98.5 per cent quality means an increase in the expense amounting to 16 per cent. So even if the better grade of oxygen should cost more, we see from the foregoing that it would have to cost a great deal more to make it a matter of no importance which grade of oxygen were used.

In Table II the same kind of steel and the same thickness of sheets are to be understood as in Table I. The pressure of the oxygen is increased, however. Note especially that here we have the alternative procedure with acetylene gas.

It will be noted that we do not have any experiments here

TABLE II. TIME REQUIRED FOR OXY-ACETYLENE CUTTING OF METALS

Siemens-Martin sheet steel, 1.18 inch thick. Oxy-acetylene procedure. Acetylene consumption per minute: 0.153 cubic foot. Oxygen pressure: 2 atmospheres = 29.4 pounds per square inch.

Purity of Oxygen, expressed as Percentage	Length of Cut in Inches	Time required in Making Cut, in Seconds	Time required to Cut One Foot, in Minutes	Average Time required to Cut One Foot, in Minutes
98.50	17.3	123	1.42	
98.50	28.3	192	1.36	
98.50	32.3	228	1.41	1.40
98.50	33.9	230	1.36	
98.50	28.3	200	1.41	
98.50	28.3	202	1.43	
96.50	33.9	255	1.50	
96.50	45.3	360	1.59	
96.50	47.2	380	1.61	
96.50	37.8	320	1.69	
96.50	58.3	480	1.65	1.63
96.50	44.1	370	1.68	
96.50	41.7	340	1.63	
96.50	30.7	245	1.60	
96.50	41.9	380	1.69	
94.50	34.6	400	2.31	
94.50	43.3	510	2.36	2.33
94.50	43.3	520	2.40	
94.50	35.4	400	2.26	

Machinery

with 99 per cent oxygen. Comparing the 98.5 per cent purities in Tables I and II, we see that the acetylene cutting has the advantage. The result with 94.75 per cent oxygen, hydrogen cutting, when compared with the work done with 94.50 per cent, acetylene cutting, indicates that the efficiencies at this degree of impurity are about the same. This would become clearer by drawing curves illustrative of the last columns in Tables I and II. It must be borne in mind, however, that the oxygen pressure is distinctly higher with the acetylene experiments.

* * *

HIGH PRESSURES

Cold iron can be made to flow like molasses, providing the pressure on it be great enough. Many may not have seen it do so, but it is stated in the *English Mechanic and World of Science* that the late Sir William Roberts Austen, who was then Master of the Mint in London, once made a public exhibition of this phenomenon before an audience at the Royal Institution. He subjected iron to great hydraulic pressure and by an optical device he threw the image of the iron, at the point where the pressure was applied, on the screen, and the solid iron was seen to flow slowly, it being extruded through a small aperture. Investigations with very high pressures have lately been made by Dr. Bridgeman of the physical laboratory at Harvard University, and he has probably been experimenting with higher pressures than have ever before been reached. In some of his experiments he obtained a pressure of something like 300,000 pounds per square inch, and succeeded in measuring the pressure with reasonable accuracy up to 175,000 pounds per square inch. What these pressures mean will be understood when we consider that the highest pressures commonly produced are those exerted by the explosions in modern arms with smokeless powder, where a pressure up to 30,000 pounds or more per square inch is developed when the gun is fired. Pressures of 200,000 pounds per square inch have been produced by exploding nitro-glycerine in a closed vessel.

* * *

Not all improvements in working conditions are appreciated by men who have become accustomed to those that appear to others as being intolerable. An example showing the effect of imagination is of interest in this connection. A basement lighted artificially had been used as a casting cleaning and snagging room. The working conditions were abnormally bad. The floor was damp, no windows permitted daylight to enter and dust removal apparatus had not been provided. Consequently, the air was filled with dust and grit but the workmen could not *see* the dust. The superintendent fitted up a floor in a new building above ground with exhausters and removed part of the cleaning force to it, but the men soon became dissatisfied and clamored to go back to the basement. They said that the dust in the new place would soon kill them. The fact, of course, was that the dust was much worse in the basement but being more visible in the new place because of being lighted by the sun, they imagined that they were being choked and injured by it. The superintendent was able to make use of the new department only by placing men in it hired to take the places of the old ones as they left. These, being unaccustomed to the former conditions, had no fault to find.

* * *

No other feat in the history of the oil industry has equalled the killing of the wild gas well near Oil City, La., that has been wasting from 10,000,000 to 20,000,000 cubic feet of gas a day for the last six years. This great loss was stopped by the boring of a relief well close to the old one. When this well reached the same depth, water and then mud was forced into the relief well under heavy air pressure. This soon choked the gas stratum and shut off the flow. The work was done under the direction of the Louisiana State Conservation Commission which furnished a portion of the funds for the work. The remainder was furnished by gas and oil companies operating in the district. As soon as the flow of gas had been stopped, the well was cemented. The well had made a crater 225 feet in diameter and 50 feet deep. *Compressed Air*

WHY CENTER THE HOB?*

CAUSES OF THE PRODUCTION OF FLATS AND METHODS OF PREVENTION

BY JOHN EDGAR†

Whether or not it is necessary to center the hob in order to get satisfactory results, is a question that is not so readily answered as it might appear. For the sake of making the matter clear to those who have not the time to make a study of the subject, the results of an investigation conducted by the writer will no doubt be of interest. Theoretically speaking, these results should show no difference whether the hob is centered or not. However, practical modifications enter into the actual conditions and

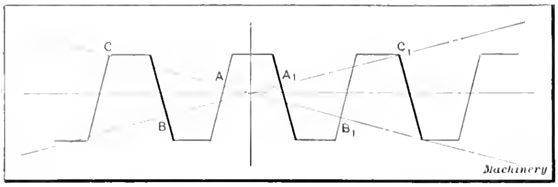


Fig. 1. Diagram showing Points of Intersection of the Pressure Lines with the Hob Teeth equally spaced at each Side of the Pitch Point

exert peculiar effects upon results produced. To briefly explain the action of the hob, we may say that the generating operation consists of a successive trimming of the teeth of the gear by those cutting edges of the hob located in the generating path. The portion of the cutting edge that forms the tooth of the gear lies on the pressure line of the hob, intersecting the pitch point, and the maximum length of the hob in this generating space is $2s \div \tan \phi$, where $s =$ addendum or reciprocal of diametral pitch and $\phi =$ pressure angle; in the cases of the small pinions this length may be as short as the circular pitch of the teeth.

The point where the two opposite pressure lines cross the pitch line is the center of the hob, and the object of centering is to get corresponding portions of the generating edges at equal distances on each side of the center, so that the sides of the teeth generated will be symmetrical. Thus in Fig. 1, the points where the pressure lines intersect the teeth of the hob at A, A_1, B, B_1, and C, C_1, are at an equal distance on each side of the center or pitch point, and at a like distance from the axis of the hob when the pitch point lies in the center of a tooth or space as shown. If the pitch point is shifted out of the center of the tooth or space, the radial distances of the respective points of intersection are not equal, the points A, B and C being a greater or less distance from the axis than the points A_1, B_1 and C_1.

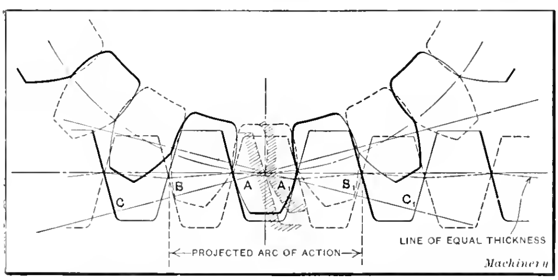


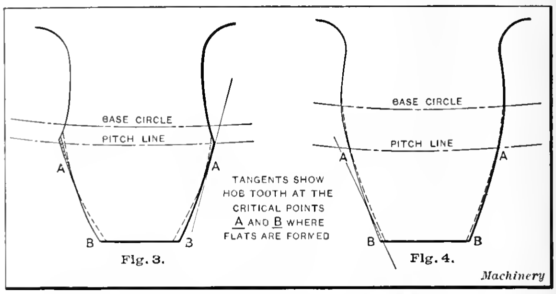
Fig. 2. Case I. Hob with Low Tooth and High Space centered. Full Lines show High Side and Dotted Lines show Low Side

There are defects in the hob that no amount of centering will compensate for and insure symmetrical teeth being generated. Among these we may cite the defects due to distortion in hardening, unequal tooth thickness due to springing of the tool in forming, and errors in size resulting from careless workmanship. The defect that can be favored in the setting of the hob is that in which the eccentricity of the form and axis causes the teeth to run out. This eccentricity may be caused by the use of an inaccurate mandrel in the backing-off operation or in not truing up the hob properly in grinding the hole; and may also be caused by an untrue hob arbor on the hobbing machine itself. These defects can be determined and proper allowance made to counteract the natural results by a careful setting of the hob. By knowing what result will be obtained with these eccentric hob conditions the defect can be diagnosed and a remedy applied or the setting can be made to favor the defective conditions.

Let us take the most common condition—the case where the axis of the form and that of rotation are eccentric and parallel—and treat it as follows: Case I. Hob with low tooth and high space centered. Case II. Hob with high tooth or low space centered. Case III. Hob not centered, but half way between the conditions of the two preceding cases.

Case I for Fourteen and One-half Degree Teeth

The method of treatment is to take a normal gear and show it in mesh with the eccentric hob in the desired position: in this case, with the "high" space centered. This setting brings the tooth on the opposite side of the hob in the center if the number of gashes are even, and this opposite side is the "low" side of the hob. This is shown in Fig. 2. In each case, the high side is shown in full lines and the low or opposite side in dotted lines. The intermediate teeth which range from high to low are not shown except in the central



Figs. 3 and 4. Tooth Outlines showing how Flats are formed at the Pitch Line and at the Point in Case I

position in Figs. 2 and 5, and in the extreme positions in Fig. 8. An inspection of Fig. 2 will show that the pitch line of the hob, considered in its relation to the tooth itself, does not lie along a straight line parallel to the axis of the hob, but on a zigzag line that is shown broken. This line represents the pitch location of the right side of the hob tooth, and may be termed the "line of equal tooth thickness." It will have a drop for each pitch length of the hob for every convolution of the thread. In reality, the line instead of being zigzag should be a reverse curve.

In the central position indicated by the full lines, the contact between the teeth of the hob and gear is normal and correct. If the hob be given one-half revolution, the position taken is indicated by the dotted lines and it will be noticed that the gear and hob do not come into contact as they should at the points B and B_1, the space widening from the points of contact A and A_1 to the points B and B_1. From this we may rightly assume that the hob would form the teeth of the gear with a fullness at the point, as indicated by the full line from A to B in Fig. 3. The dotted line shows the normal curve of the tooth. If the hob is given a quarter turn from the full line position, the relative position of the teeth of both the gear and hob is at the dotted line position shown in the center of Fig. 2, midway between the teeth instead of giving the normal contact at the pitch point on the pitch line of both gear and hob. This should develop a fullness of the gear tooth at the pitch line diminishing again to normal at the point A. But the normal position of the hob tooth at the point A brings the edge of the hob tooth inside of this bulge, so that it would remove the greater

* For other articles on the subject of hobs and hobbing which have appeared in MACHINERY see "Special Hob Tooth Shapes," by John Edgar, published in May, 1914, and other articles there referred to.

† Address: 61 Bruce Ave., Windsor, Ontario, Canada.

portion of it shown in cross-section in Fig. 3, leaving a flat from the point A extending to the pitch line. In exaggerated cases, in cutting large numbers of teeth, the flat will extend past the pitch line to the base of the involute.

When the projected arc of action shown in Fig. 2 is greater than twice the pitch of the teeth, which is the case when cutting gears with a greater number of teeth than 36, the trimming of the involute portion of the teeth takes place through two or more turns of the hob instead of one. This brings the tooth of the hob more nearly into the normal position at the end of the gear tooth, tending to make the point of the tooth nearer to the proper thickness; but the correct thickness is never reached as it would be necessary for the contact to continue to the position C, which is the case of a gear of infinite diameter. This develops a flat at the point of the tooth for the same reason as that given for the flat produced at the pitch line. The result of this action on gears with teeth greater in number than 36 is illustrated in Fig. 4, where the cross-sectioning shows the excess metal removed, resulting in the production of the flat. The effect on the flank of the tooth need not be taken into consideration; as the hob leaves it, there is ample clearance for the gear tooth of the mating gear, it being only in the case of a gear meshing with a rack that the flank would be apt to give trouble.

Case II for Fourteen and One-half Degree Teeth

The high tooth centered, as illustrated in Fig. 5, shows the normal contact between the teeth at the points B and B_1. With the hob revolved one-half turn, the low space comes into the central position, but there is no contact between the teeth at the points A and A_1. In the central position where the pitch lines of the gear and hob are tangent, instead of the normal contact we have a space between the teeth. A

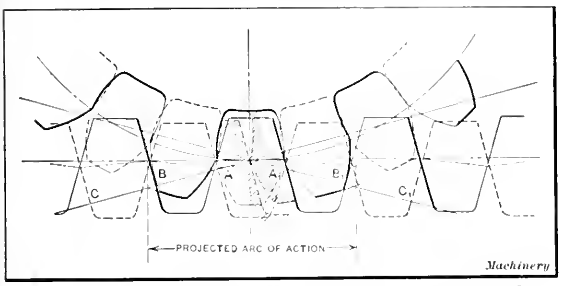


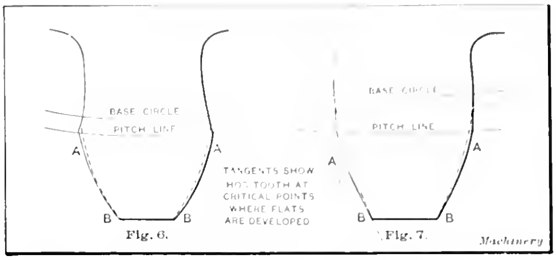
Fig. 5. Case II. Hob with High Tooth and Low Space centered. Full Lines show High Side and Dotted Lines show Low Side

gear generated with the hob set in this position would have teeth of the form illustrated in Fig. 6, with fullness at the points A and a perceptible flat below the pitch line, which extends to the base circle in gears with a large number of teeth. In the case of gears with more than 36 teeth, the normal contact at the points B and B_1 develops into a space and results in a flat at the point of the teeth, as shown in Fig. 7.

The two preceding cases give the two extremes in setting the hob central and show the results of eccentricity of the axis of form and the axis of rotation. Of the two methods, the latter is the more practical. By centering the high tooth the depth is easily obtained, whereas in the first case with the high space centered, the depth is not so easily obtained because the centered tooth is the low tooth and if the hob is fed to depth after bringing it so as to mark the blank, the depth will be deeper than that shown in Fig. 2 and the tooth thickness will be under size. The reverse is the case with the second method of setting, but to obtain the proper tooth thickness the hob will have to be fed in deeper than the standard amount. The pointing of the tooth at B in Case II will give better running gears than the fullness at the point as in Case I.

Case III for a Fourteen and One-half Degree Tooth

By moving the hob along so that the pitch point lies on the edge of the high tooth, as in Fig. 8, we have a case which gives results similar to those obtained by setting the hob at random, and we will get results more or less unsymmetrical. The full lines in Fig. 8 show the high side of the hob in normal contact with the gear teeth, with contacts at the pitch point and at the point A_1. On bringing the hob into the opposite position with the low side, or to the location shown by dotted lines, we find no contact at the pitch point nor at point A. Rolling the gear until the teeth come to the end of the normal point of contact on the pressure line at B and B_1 on each side of the pitch point, we will find a space at B_1 instead of the contact as at A_1, and a lessened space at B. Had this rolling brought the gear tooth to the low hob tooth position, as at C_1, the space at B_1 would have been maximum and the position at B would come into con-



Figs. 6 and 7. Tooth Outlines showing Points at which Flats are produced in Case II

tact with the high tooth at C. Further rolling of the gear away from these positions would tend to reduce the space to the right and to develop a space to the left.

A hob in this condition and so set would generate a tooth with the left side normal at the pitch line, with a bulging face; and with the right side full at the pitch line and nearly normal at the point of the tooth, with a flat near the point when the hob is cutting to depth. The case of a twelve-tooth pinion is shown in Fig. 9; and the case of a larger gear in which the contact between the teeth of gear and hob continues to the point C of Fig. 8 is illustrated in Fig. 10. In both cases, the last "swipe" of the hob tooth will cover a broader length of the tooth than it ought to, and will leave a flat at the point on the left side of the tooth. Similarly, in the case of both Figs. 9 and 10, the hob tooth in the position A_1 of Fig. 8 will leave a flat at this point covering considerable of the right side of the tooth face. The cross-sectioned areas show portions of the bulges cut away, leaving flats.

The method outlined in Case III has the same effect as centering any of the teeth of the hob except the high or low tooth, so that the usual procedure of shifting the hob to bring new cutting points into position will result in unsymmetrical teeth being developed in the gear if the hob runs out of true with the axis of rotation. The actual amount of the distortion in the teeth generated will depend upon the amount of eccentricity of the hob form and is approximately one-fourth of the eccentricity on each side of the

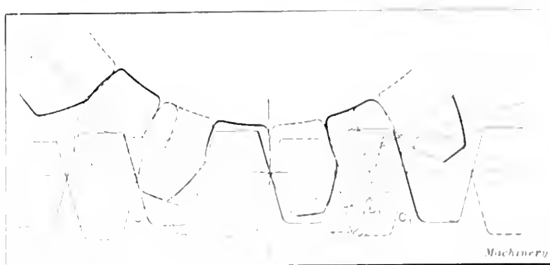
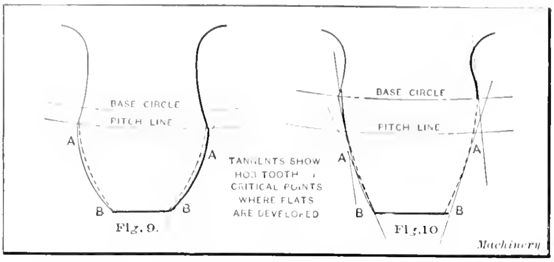


Fig. 8. Case III. Hob centered midway between Positions in Case I and Case II

tooth. In Fig. 3, for example, the amount that the tooth is thick at the point B, for a hob 0.002 inch eccentric, will be 0.0005 inch on each side or 0.001 inch altogether. The amount of the space at the pitch line would be the result of only one-half the eccentricity, as the tooth is in the mean position at this point.

Several cases could be treated in this way, as for instance, the case where the axis of form is not parallel with the axis of rotation but where these axes intersect. The only remedy that would make it possible to obtain symmetrical teeth

would be to find the point of intersection of the axes and set the hob central with that point. But instead of setting the high tooth central, as in Fig. 5, the hob should be set in such a position that the axis of the form lies in the same plane as the spindle on which the gear is placed, and the hob should be set central irrespective of the location of the teeth of the hob. That is, the hob should be set so that the point of intersection of the two axes will lie directly in line with the axis of the work spindle of the machine, whether or



Figs. 9 and 10. Tooth Outlines showing Flats produced by Hob set according to Conditions of Case III

not the tooth of the hob comes central. Of course if a tooth comes into this position, so much the better for the symmetry of the teeth of the gear. This setting is illustrated in Fig 11. The unsymmetrical results sure to be developed by any other setting are quite obvious without further exposition.

The preceding treatment of three typical cases gives some light on the cause of the poor shape of the teeth so often complained of in the results obtained from the hobbing machine, and while this discussion does not include all of the defects that will produce similar results, it does emphasize the fact that more care will be necessary in the preparation of the hobs than has formerly been the practice. Eventually we shall have the ground hob, with the defects of hardening and careless forming eliminated by grinding the hardened hobs on precision machines in which the human element will be reduced to a minimum, so far as its effect on the accuracy of the hob is concerned. When such hobs are available, the hobbing process will meet with little or no opposition based on the unreliable results obtained by it. However, until the ground hob is perfected, flats and unsymmetrical tooth outlines will be a source of worry to the user of the hobbing machine and he will meet the results already pointed out in my article "Hobs for Spur and Spiral Gears," published in the July, 1912, number of MACHINERY. In that article, a remedy was given to reduce the effects of the careless workmanship, and a further means of correcting such defects and distortions of the hob teeth is outlined in the following paragraph.

This consists of the more direct process of grinding out the distortion of the teeth from the narrow helical path, and of bringing their cutting edges back into the proper helical relation with each other. All that is necessary for the operation is a toolpost grinder—preferably an electric machine. Of course it goes without saying that the more carefully the performance is carried on, the more satisfactory will be the results obtained.

The procedure is simply this: Set the lathe to the proper lead of the hob, with the toolpost grinder on the slide-rest, and with a clean cutting wheel grind the edge of the side of the teeth into the proper helical relation. It is necessary to be careful not to grind too much from the side of the teeth; just let the wheel touch the teeth all the way around, and if the mandrel on which the hob is held is running true, the hob thread will be straightened up. It will be noticed that the land left by the wheel is not uniform and the amount that the teeth are out of true is directly proportional to the width of this land. It will also be noticed that some rows of teeth will have wide lands while those of the opposite side of the hob will have narrow lands; this is the result of the eccentricity of the axis of form with the axis of rotation and should be corrected by grinding the teeth back until the lands are of uniform width. This is the same treatment that was given for the correction of careless spacing and improper sharpening in the previous article referred to. Besides this regular variation in the width of the ground lands, other irregular lands will be noticed which are the result of singly distorted teeth, due to careless forming or to distortion in hardening. If the land left by the wheel is not so wide as to cause the teeth to drag on account of the relief being ground away, they may be allowed to remain in the condition as left by the wheel, or they may be treated singly by grinding back as in sharpening.

The results obtained by this treatment more than pay for the time and expense, and where a hob is giving trouble this remedy is recommended. A hob thus treated need not be centered, as the teeth generated by it will be symmetrical by the most rigid test usually applied to commercial work. The treatment will have to be repeated at each sharpening, however, to insure the continuance of the good results. In choosing the change gears for the lathe, the axial lead corresponding to the normal pitch of the teeth must be used; and as a difference of 0.0005 inch is noticeable in the angle of the teeth, the lead must be closely followed. Some such treatment as this is necessary with the irregular hobs now obtainable.

In conclusion, it may be well to apologize for the title. The answer is that with the unground hob in which the eccentricity is an unknown quantity, but may be taken as sure to be existent, it is well to center the high tooth as in Case II; and with the accurate hob, that will be available when the methods of grinding the teeth are perfected, it will be unnecessary to center the hob *if* the hob has been carefully sharpened and the hob arbor runs true on its axis. While the results revealed by the treatment of the three cases seem to be unfavorable to the hobbing process, it is such studies as these that bring the truth to light and lead the way to the remedy which, when applied, brings to the hobbing process the share of consideration it deserves as one of the simplest and most efficient methods for the production of the teeth of gears.

* * *

Engineers, designers and others who have studied foundry practice, know that it is bad practice to make patterns with sharp corners. The sharp corner in a casting is the seat of weakness and possible failure. But notwithstanding this common knowledge, we go on committing the error every day. Prof. John E. Sweet has preached the gospel of liberal fillets

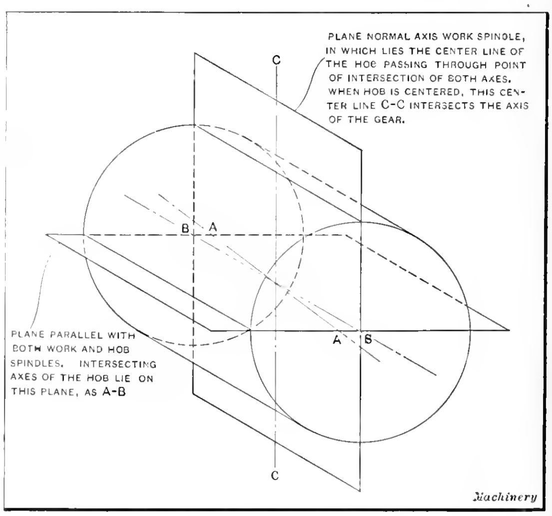


Fig. 11. Method of setting Hob when Axes of Form and Rotation intersect

and points out that in many places their use means an appreciable saving of iron. In the case of large cast-iron pipe tees, a fillet with a radius of three inches at the junction of the tee saves ten pounds of iron as compared with the not uncommon pattern having a very small fillet radius, and a better and lighter casting is the result.

REPLACING PINS IN THE WILLIAMSBURG BRIDGE

AN EXCEPTIONAL BORING OPERATION PERFORMED UNDER UNUSUAL DIFFICULTIES

THE structure of the Williamsburg Bridge, New York City, is at present being strengthened to sustain the increased load to which it is being subjected by additional traffic. This is done by building four additional towers under the approach spans between the main towers and the anchorages, and by strengthening the trusses. In connection with this work it became necessary to replace four hinge pins which connect the approach span trusses with those of the main span just outside of the main towers on the land sides. The original hinge pins had a diameter of ten inches, whereas the new pins are thirteen inches in diameter. One of these pins is located at the point indicated by the arrow in Fig. 1, and the other pin for this tower occupies a corresponding position on the opposite side of the tower. There are also corresponding pins for connecting the approach span to the tower on the other side of the river. These pins are about two feet below the level of the roadway and twenty inches from the tower leg. Fig. 2 shows the opening made through the floor of the south roadway preparatory to removing and replacing the pin on this side.

Heretofore, each of these pins was subjected to a load of 800,000 pounds from the approach span. In order to replace the ten-inch pin with the thirteen-inch size, this load was transferred to a new girder erected transversely above the ends of the main span trusses close to the tower. From this girder the approach spans were suspended, the load being transferred to them by means of wedges to relieve the pins. In order to rebore the pin holes from ten to thirteen inches in diameter, the truss members surrounding the hole had to be held perfectly rigid during the boring operation. This rigidity could not be obtained while the traffic on the bridge was in operation and even without the traffic the wind pressure and temperature stresses were likely to interfere with the boring; moreover, as the bridge is a main artery of traffic, only one night could be spared for the operations of removing one of the old ten-inch pins, enlarging the pin hole to thirteen inches in diameter, placing the new pin in the hole and erecting the new wind member on this pin.

Fig. 1. Williamsburg Suspension Bridge across East River, New York City—Arrow indicates One Point where 10-inch Pin was replaced by a 13-inch Size, necessitating an Unusual Boring Operation

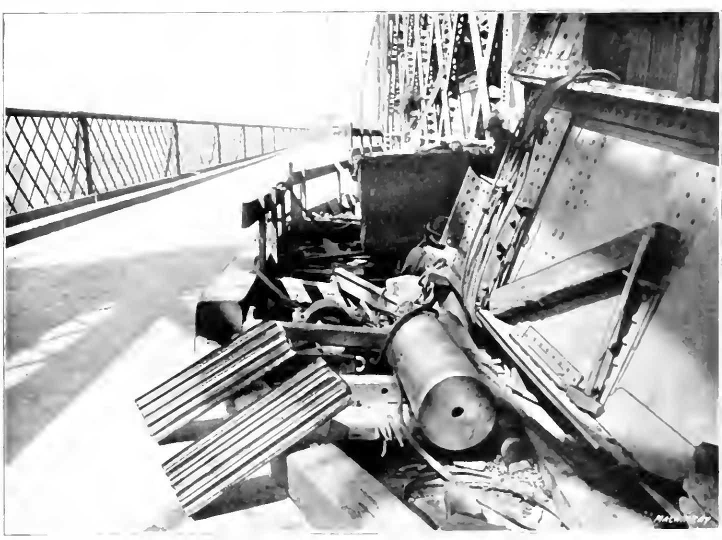


Fig. 2. Hole made in Roadway to make Room for Boring Machine—Collapsed 10-inch Pin and New 13-inch Pin in Foreground

To obtain the necessary rigidity between the different members while boring, steel plates, tie rods and special castings were fastened to the truss members and joined by bolts and wedges just before the boring operation was started. All traffic on the bridge but that of pedestrians, was stopped at 1 A. M., and the task of removing one of the pins, rebor-

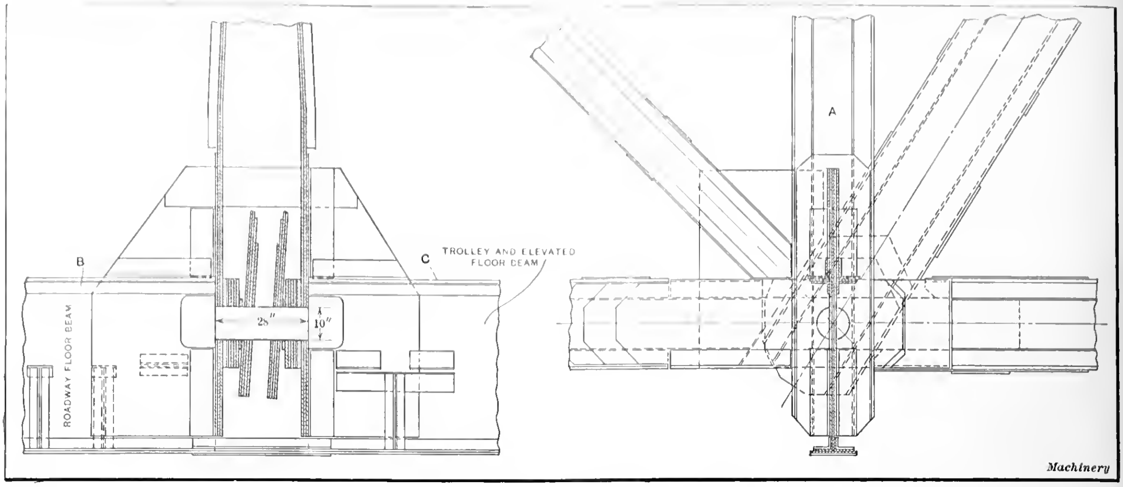


Fig. 3. Section and Elevation showing Pin Connection between Approach and Main Span Trusses

ing the hole and inserting the larger pin was begun. At 5:50 A. M. of the same day the new pin had been put into place and the bridge was open to traffic. It is evident that every step connected with this work had to be carefully planned beforehand. First, it was necessary to design and build a special machine for reboring the pin holes. The total length of the hole is twenty-eight inches, twenty-four inches of which is formed in solid steel plates. Some of these plates occupy oblique positions, as shown by the sectional view to

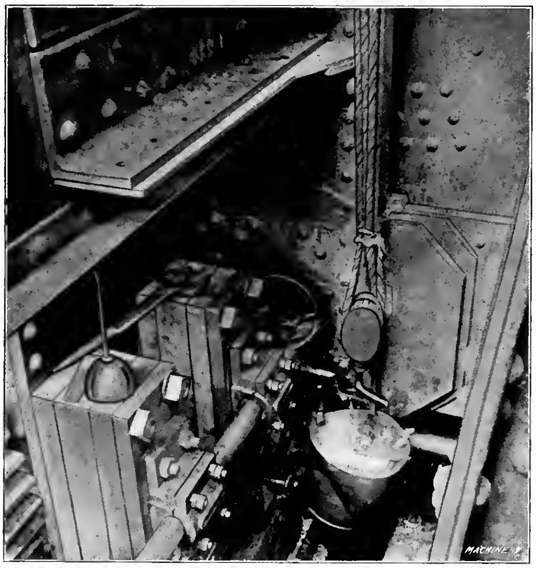


Fig. 4. Drilling Series of Axial Holes through Old 10-inch Pin to collapse it

the left, in Fig. 3, which further complicated the boring operation. The total amount of steel which had to be removed was 1300 cubic inches. The time limit for the boring operation was two hours.

The design of the boring machine was limited in several ways, but principally by the small space available between the axis of the pin hole and the leg of the main tower of the bridge, this distance being only about twenty inches in a horizontal direction. The problem was made more complex by the fact that the truss and roadway of the bridge connected thereto, are constantly moving either toward or away from the tower, which prohibited the use of the latter as a support for the boring machine. To the post *A* of the bridge (Fig. 3) which holds the pin, floor beams *B* and *C* are fastened on both sides at the vertical center line so that their webs cover the pin hole, as shown by the elevation at the right. While it was possible to remove a part of the floor beam on the roadway side of the post, the beam on the rear side, which supports the trolley car tracks, had to remain in place. After considering various ways of doing this work, a design of boring machine was finally adopted by the Department of Bridges; F. J. H. Kracke, commissioner; Alexander Johnson, chief engineer; Austin Lord Bowman, consulting engineer; and Leon S. Moisseiff, engineer of design. The structural design was in charge of Isidor Delson, assistant engineer; and J. R. Geogham, assistant engineer, was in charge of construction. The design of the machine and the boring operations were in charge of Martin Joachimson, assistant engineer.

It was found impossible to remove the old ten-inch pin, which was tightly stuck into its hole, even after the load had been transferred to the overhead transverse girder previously referred to. All attempts to remove this pin failed. An idea as to how tightly it was held in place may be obtained from the following: The pin had a 1½-inch hole extending through its center and this was enlarged at the outside end to 2½ inches and tapped. A bolt was then entered into this hole and by tightening a nut against a resistance, with large wrenches, an attempt was made to pull the pin out. The result was that the bolt snapped across the body but the pin did not move. It was then decided to collapse the pin in the following manner: On a horizontal line each side of the 1½-inch central hole, two 1 15/16-inch holes were drilled through the pin from end to end, which left six walls about ⅛ inch thick across the mid-section of the pin. As soon as a hole was drilled, tapered plugs were driven into both ends to prevent any distortion of the pin that might result from the stresses to which it was still subjected. After all the holes were drilled, the walls were removed one at a time, and, finally, after removing all of the plugs, the pin was collapsed and the two halves were pulled out easily.

In the operation of boring the 1 15/16-inch holes, the frame of the boring machine was used as a support for the smaller boring-bar. This bar, which is 2½ inches in diameter, was carried in two ordinary boxes or bearings as shown in Fig. 4, and was provided with an internal Morse taper at the end toward the pin. At the outer end there was an external

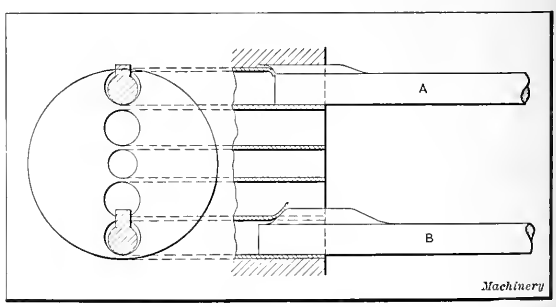


Fig. 5. Tools used to cut away Walls between Axial Holes drilled through Pin as illustrated in Fig. 4

taper where connection was made with a pneumatic drilling machine. After one hole had been bored, the bar was aligned for boring the next hole by placing packing blocks under the journals. The length of these holes was 29 inches and the drilling of each hole required three drills of different lengths, because of the limited space which made it impossible to use a longer boring-bar. These drills were of high-speed steel and had lengths of twelve inches, twenty inches, and thirty inches, respectively.

The walls between the holes were removed for collapsing the pin by means of special tools, as indicated by the diagram Fig. 5. Two types of tools were used, as indicated at

Fig. 6. Pin Hole after Removal of Pin and before reboring

A and *B*, and these were driven through the holes by means of a sledge-hammer. The slanted nose of tool *B* was used to cut away the walls between adjacent holes, whereas the walls at the outside of the pin were removed by the tool shown at *A*, which was provided with a cutting edge at the front, as the illustration shows. It required only about fifteen minutes to drive out one of these walls, where the minimum thickness was 1/8 inch, but a considerably longer time was necessary where the wall was thicker. The drilling of one of these 1 15/16-inch holes through twenty-nine inches of steel required about five hours, but the holes were drilled so accurately that not one of the walls was pierced when drilling the adjacent hole.

The two halves of the severed ten-inch pin are shown in Fig. 2, and also the new thirteen-inch pin at the right. The

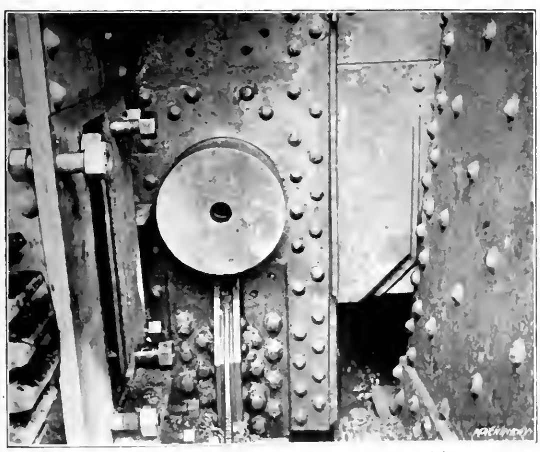


Fig. 7. View showing New 13-inch Pin in Position

ten-inch hole, after the pin was removed, is shown in Fig. 6; whereas, Fig. 7 is a view taken after the hole was bored and the new thirteen-inch pin was inserted. The special boring machine and tools used will be described in a later article.

* * *

The British Navy Department has announced that it has abandoned its own fine screw thread system in favor of the British standard fine screw threads.

ELECTRIC MOTOR STANDARDIZATION*

WHAT FEATURES OF ELECTRIC MOTORS CAN BE STANDARDIZED FOR MACHINE TOOLS

BY CHARLES FAIR†

This paper is not written so much with the idea of actually settling at this time the question of standardization of motor dimensions and speeds for machine tools as it is with the idea of pointing out a method which if followed should accomplish much toward the standardization desired. Certain of the dimensions and speeds once standardized will result beneficially not only to the machine manufacturer but to the motor manufacturer and to the machine user as well.

FACTORS TO BE CONSIDERED IN STANDARDIZING MOTORS FOR MACHINE TOOLS

SPEEDS

- Constant Variable[2]
  - A. C.
    - Full load / Synchronous
    - Cycles / Phase / Voltage
    - Squirrel cage — High torque / Normal torque
    - Slip ring[4]
    - Internal resistance
  - D. C.
    - Full load / Light load
    - Voltage
    - Shunt / Compound [3] / Series [2]
- Adj'tble[1] Variable[2]
  - D. C.
    - Voltage
    - Shunt / Compound [3] / Series [2]
  - A. C.
    - Brush Shifting — Shunt characteristics / Series characteristics
    - Multi-speed[5] — Constant horsepower / Constant torque
    - Slip ring[4] — Multi-speed [4,5]

NOTE

1. Adjustable speed motors.—Infinite number of fixed speeds within their speed range.
2. Variable speed motors—speed varies with the load { series / compound / slip ring
3. Compound wound motor—speed varies with the load and proportion of series and shunt winding.
4. Slip ring motor.—If resistance is left in circuit, speed varies with load and resistance.
5. Multi-speed motors.—A limited number of fixed speeds, seldom more than four as 600, 900, 1200, 1800.

SHAFTS

Diameter
Keyway
Length

- Gear
  - Involute — Steel / Rawhide
  - Herringbone
  - Bevel, worm — Thrust
- Chain
- Coupling
- Belt

Special extensions / Double extensions — Auxiliary drive / Handwheel

FRAME

Bottom of feet to center line of shaft
Shoulder on shaft to center of feet
Overall dimensions of feet
Drilling of feet—dimensions and sizes of holes

DRIVE

- Gears
  - Peripheral speed — Normal for constant / Maximum for adjustable — Cost / Size
  - Minimum number of teeth, pitch, face bore

Chain, coupling, belt
Reversing, non-reversing, slow down, brake { Dynamic / Solenoid / Mechanical
Range of speed required { Cost / Size of motor — Diameter vs. Length
All geared drive for constant speed { A. C. / D. C.
Balance of rotating parts
Change gears—motor speed overlapping

GENERAL

Uniformity marking motor terminals
Uniformity control diagram
Protection of live parts
Covers for end shields, etc.

The importance of motor driven tools has now reached such proportions as to warrant most serious consideration of this subject.

There will, of course, always be demands for odd combinations of speeds and requirements and these it would be useless to attempt to standardize; but by far the majority of cases could be standardized under a heading that for con-

* Paper read at the National Machine Tool Builders Association convention, held in Worcester, Mass., April 23-24, 1914.
† Power and Mining Department, General Electric Co., Schenectady, N. Y.

venience might be known as normal, and our efforts should be bent toward standardizing these speeds and dimensions.

For years and under generally adverse circumstances, much progress has been made in the standardizing of certain machine parts, with results advantageous both to the machine manufacturer and to the machine user. For a long time it has been recognized as desirable at least on the part of a number of the machine tool builders that something be done toward standardizing certain motor dimensions, speeds, etc., for machine tool drive. For the past five or six years attempts have been made to standardize certain dimensions and speeds for machine tool motors, but these attempts have failed for various reasons. It would be of little use to analyze these past failures. Unquestionably there should be first of all a better understanding on the part of the machine manufacturer and the motor manufacturer of each others difficulties; and much work is essential before material progress along the line of standardization can be accomplished. With this in mind, I have prepared an outline which I think fairly presents the situation from the viewpoint of both sides and which must be considered if real progress or results are to be obtained.

It could not be expected that the electrical manufacturers would change existing standards of motor dimensions or speeds, nor do I believe it would be either desirable or practicable to do so on account of the confusion that would result; but I see no reason, if the machine manufacturer in conjunction with the motor manufacturer will give the subject the consideration it warrants, and do his part toward bringing about a better understanding of what is really desirable in the way of speeds and dimensions, why the motor manufacturer, in turn, cannot incorporate, at least in part, some of the dimensions and the speeds when bringing out new lines of motors. Obviously it would be just as impracticable for the various motor manufacturers to design their motors to a single set of dimensions as it would be for the machine manufacturers to design their machines to a single set of dimensions. Notwithstanding this, however, much can be done to improve the situation. The American Society of Mechanical Engineers has offered to cooperate and is willing to do everything within its power to help in this question of standardization. Before going further into the subject, it might be well to look at the outline given in the accompanying table that we may have a better understanding of the subject as a whole.

For the sake of convenience, I have divided the outline into five parts, namely, speeds, shafts, frame, method of drive, and general.

Speeds.—Under the heading of speeds, there is an almost endless number of constant, adjustable, and variable speed combinations available, but from this great variety, certain speeds should become the logical ones for the majority of drives. The direct current constant speed shunt motor speed, for instance, should logically be that of the alternating current sixty-cycle motor. Alternating current and direct current motor speed should be given in terms of full load or else in terms of both no load and full load. It is, of course, understood that the cycles fix the alternating current speeds, except as modified by slip, etc. Adjustable speed motors would naturally be higher in speed on the highest speed than a constant speed motor because the adjustable speed motor would only run a certain percentage of the time at high speed. Adjustable speed motors are nearly always geared and their speeds should be governed by a proper gear speed.

There should be little difficulty in arriving at a set of suitable speeds per horsepower to be known as standards for both constant and adjustable speed motors after properly considering the items as set forth in the table.

Shafts.—Obviously there should be little difficulty in arriving at a proper shaft diameter and key for a given horsepower and speed motor. The length of shaft might offer some difficulty, but a compromise length could probably be agreed upon. Special shaft extensions and double shaft extensions, whether for handwheel or power transmission, should be considered.

Frame.—A uniformity of dimensions under this heading is obviously impossible but much can be done to reduce the large variety of dimensions to perhaps two or three sets per frame instead of the dozen now existing. There is, of course, no reason why there should not be a uniformity in the size of the holes drilled in the motor feet per frame.

Drive.—It is not only important but absolutely necessary to consider seriously the items under this head in order to arrive at some basis upon which properly to determine the best speeds, shaft dimensions, etc., to standardize. Here we should consider such subjects as diameter of motor *versus* length, minimum speed *versus* size and cost, maximum variation for adjustable speed motor and its relation to minimum speed, cost, and size of motor.

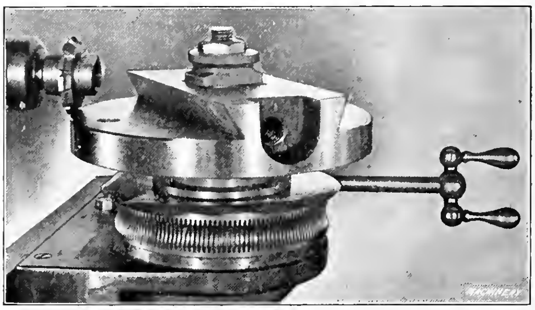
General.—Uniformity of making motor terminals, wiring diagrams, protecting live parts, etc., is of advantage to all concerned.

The machine user will derive considerable advantage from the standardization of motor speeds and dimensions as well as the machine manufacturer. The importance of the motor-driven machine tool with relation to production has become such that the method of applying the motor to the tool, in my opinion, warrants far more attention than has been given to it in the past by some of the tool manufacturers.

* * *

EDGE-ROUNDING ON A MILLING MACHINE

The simplest jobs are often the most troublesome. The Stockbridge Machine Co. of Worcester, Mass., had one of these simple jobs that caused considerable trouble for some time. It was the rounding off of sections of the edges of swivel-plates used in the heads of their shapers. The edge of the plate required rounding over for a section of about ninety degrees on each side of the swivel-plate. To round the edge over with a file, giving the same appearance to each side of the plate and stopping off at points uniformly distant from the center line, was a job that was not always correctly done. To secure uniformity on this job, the superintendent of the



Rounding the Edges of a Circular Plate

shop of the above company devised the little rig shown in the accompanying illustration. This consists of a worm-wheel mounted upon a vertical arbor, which was mounted on a milling machine at right angles to the spindle. The swivel-plate is placed above the worm-wheel, and is capable of being rotated by means of a worm turned by hand. On the spindle of the milling machine there is a quarter-round forming cutter, and by turning the work on the spindle by means of the worm and worm-wheel the edge is uniformly rounded. Lines are marked for the beginning and end of each cut so that the rounding may be started and stopped at the right places. In addition to doing the work better, it is also a much quicker method. C. L. L.

* * *

In Holland, a special branch of engineering is devoted to land reclamation, that is, reclaiming the land from the sea and protecting it by dikes. The people of Holland boast somewhat irreverently that God made the rest of the world but the Dutch made Holland. From twenty to twenty-five thousand acres of land are thus "made" every year, but there are still 250,000 acres of the best land under water, susceptible to reclamation, not including the great area under the Zuider Zee, the reclamation of which is a never-ending topic of discussion. The question is simply one of engineering and the necessary capital to carry it out.

MECHANICAL PRODUCTION RECORDING

AN ELECTRICALLY-OPERATED MECHANISM FOR INDICATING AND RECORDING MACHINE OPERATIONS

BY DOUGLAS T. HAMILTON*

Of the twelve principles of efficiency classified and arranged by Harrington Emerson, the sixth, *viz.*, reliable, immediate and adequate records, is an important factor of efficient production. Information or data which has been secured from biased sources is worthless. Records which are not classified or arranged in such a manner that they can be referred to readily have little or no practical value, and records which are incomplete or inadequate are a hindrance rather than a help.

As an example, a piece-rate price which is set by stop-watch observations is not always accurate because of the human element, which complicates the problem. Records, to be reliable, must be made over a considerable period of time so as to cover all the variable conditions of material, operators, etc. Furthermore, the human element should be eliminated as far as possible and mechanical means substituted.

Fig. 1. The Production Manager or Cost Clerk has Adequate Production Figures at His Finger Tips

The electrically operated instrument to be described in the following gives this desired result. It operates, of course, independently of the operator and records accurately any movement of the machine to which it is connected. It is made by Slocum, Avram & Slocum, Inc., engineers, 30 Church St., New York City.

Operating Mechanism and Connections

The mechanism of the "Productograph" consists primarily of magnets, which, when energized, attract needles that draw lines on a revolving chart. At the same time, the magnets actuate counters which record the number of lines drawn by the needles. Every tenth line on the chart is shown by a line a little longer than the rest, which greatly facilitates counting if the production of the machine between any two limits is desired. The needle point is made of German silver, and the chart of lead paper. The line drawn is very distinct and cannot be easily erased. No ink or other recording devices usually incorporated in instruments of this kind are necessary.

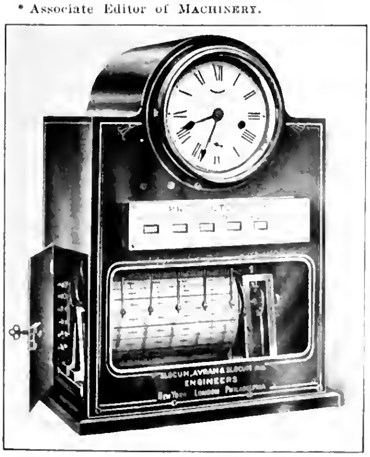


Fig. 2. The "Productograph"—a Machinery Efficiency Recorder

The movements of the machine under test are transmitted to the recording instrument of the "Productograph" by means of the switch shown in Fig. 3, which is attached to that portion of the machine on which a record is to be made. It consists of a small cast-iron box 3 by 4 by 1¼ inch, which is fastened close to any revolving shaft or part of which the motion is to be taken. Inside this iron case is a ratchet *A* which is held on the arm *B* and carries a cam *C* usually worked out in a ratio of 10 to 1 with the ratchet *A*, but it can be made, of course, to suit any desired speed. By a 10 to 1 reduction between the cam and the ratchet, it requires ten oscillations of the switch arm *B* to make one contact; hence one line is drawn on the chart every ten oscillations of the switch arm. Cam *C*, through a lever *D*, operates a plunger *E* in an air chamber which, in turn, causes the contact of two flat springs *F*. The cam then allows the plunger to return immediately to its original position, so that no matter in what position the machine is left at night there is no danger of the switch being short-circuited.

The connections from the switches to the instrument are made by ordinary wiring, and from each of the switches fixed to the machine a single wire is run to the corresponding terminal of the magnet coil in the "Productograph"; in addition, a wire which is common to all switches is connected to the source of electric supply and thence to the common terminal in the instrument. The wire used should in no case be less than No. 16 B. & S. wire gage, but the size depends largely on the distance of the switches from the "Productograph." The conductor should be well insulated and carried in cleats and when running under or near the machine should be enclosed in circular loops. The neatest installation that could be adopted, of course, would be to enclose all wires in metal tubing.

Power for operating the "Productograph" is of three different types. Dry batteries should not be used because they become exhausted too quickly. Storage batteries may be used with good results if properly attended to, but the best and most satisfactory method is the motor generator. This can be connected to an ordinary lamp socket, and is the best means of obtaining regularity of movement of the drum and the correct action of the recording needles. This, of course, is absolutely essential if a complete and accurate record of any machine movements is to be obtained.

Samples of "Productograph" Records made on Bullard "New Era" Vertical Turret Lathes

A five-point "Productograph" installed in the plant of the Bullard Machine Tool Co., Bridgeport, Conn., was attached to one of their "New Era" vertical turret lathes. Five movements of this machine were connected to the "Productograph," *viz.*,

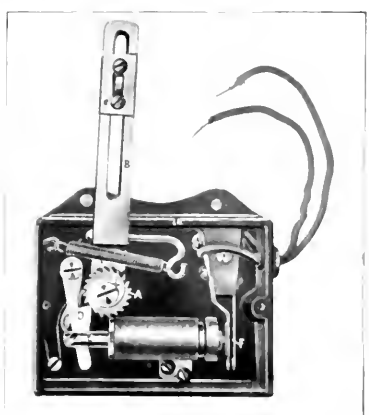


Fig. 3. Operating Mechanism of the Switch

* Associate Editor of Machinery.

the main head vertical feed, main head horizontal feed, table rotation, side head vertical feed and side head horizontal feed. By this means it is possible to make a comparison of the relative movements of the two heads vertical and horizontal in either direction and also to record the number of revolutions of the work table. Records have been made with the machine in operation on both steel and cast iron. The following gives the record that was made on a 0.40 to 0.50 per cent carbon machine steel forging.

Efficiency Record of Bullard "New Era" Vertical Turret Lathe on 0.40 to 0.50 Per Cent Carbon Machine Steel Forgings

The section of a "Productograph" chart shown in Fig. 5 shows a record of a Bullard vertical turret lathe on a run of two hours, approximately. This is part of a time study which covered a period of ten days and which was made while machining eighteen unannealed 0.40 to 0.50 per cent carbon steel forged disks, 24 inches in diameter, each weighing 405 pounds in the rough. The instrument was attached to five different motions of the vertical turret lathe, giving complete and detailed records of every operation. The first column of this chart gives the main head vertical feed; the second column, the main head horizontal feed; the third column, the work-table speed, or revolutions per minute; the fourth column, the side head vertical feed; and the fifth column, the side head horizontal feed. These various movements, except the table rotation, are recorded in thousandths of an inch.

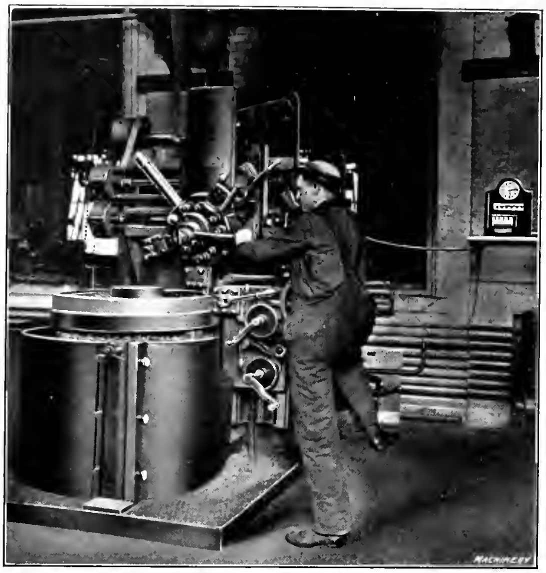


Fig. 4. "Productograph" recording Five Movements of a Bullard "New Era" Vertical Turret Lathe set up and in Operation on Large Cast-iron Flywheels

The section of the chart in Fig. 5 shows when the tools held in either head are cutting, when they are being used at the same time, the rate of feed, the cutting speed of the work and the lost time between cuts—in fact, every detail that usually requires an elaborate and expensive stop-watch test. This record also shows the use of the rapid traverse movements by the operator. The actual running time of the work chuck for the test made on March 4 is figured out as 276 minutes, and the actual running time of the tools, 230 minutes, giving a productive efficiency of the machine of 83 per cent. The time from 7 to 10 A. M. was spent waiting for tools and the machine was run from 10 to 5:30 P. M., or approximately 390 minutes. The productive machine time, therefore, is 230 minutes and the combined machine and operator efficiency figured out on this basis is 60 per cent. These records were taken during a time study period before the best tool set-up had been determined and do not show the high efficiency ultimately obtained. Only a section of this "Productograph" chart has been shown in the illustration, but it demonstrates how this instrument records every desired movement of the machine, and gives an excellent comparison of the relation of the various operations and machine movements.

The chips removed by this machine were at times 1¼ inch wide by 0.018 inch thick and the material was full of hard spots. Fig. 8 shows one of the interesting arrangements used for machining this machine steel forged disk. The flange joining the rim and hub had to be machined tapering, and to provide for this a guide strip was held in a toolpost in the main head which remained stationary. The side head was used for taking the cut, the saddle being unlocked and kept in action, while the tool was traversed horizontally by the feeding mechanism. The data for the particular set-up shown in Fig. 8 is as follows:

Operations	Start	Finish	Average
Feed of work in feet per minute starting at smallest diameter of disk	71	205	138
Feed of tool in inches	0.011	0.011	0.011
Depth of cut in inches	1	1¼	1 1/8
Pounds of stock removed per minute	2.7	9.8	6.25
Revolutions of work chuck per minute	39	39	39
Length of cut in inches	..	..	6½

Material—0.40 to 0.50 per cent carbon machine steel forging.

The weight of the solid blanks in pounds was 405; the weight of the blank roughed out by the first operation, 185 pounds; the weight of the stock removed, 220 pounds; the total roughing time on both sides of the forging, 88 minutes; and the weight of the stock removed per minute, 2½ pounds.

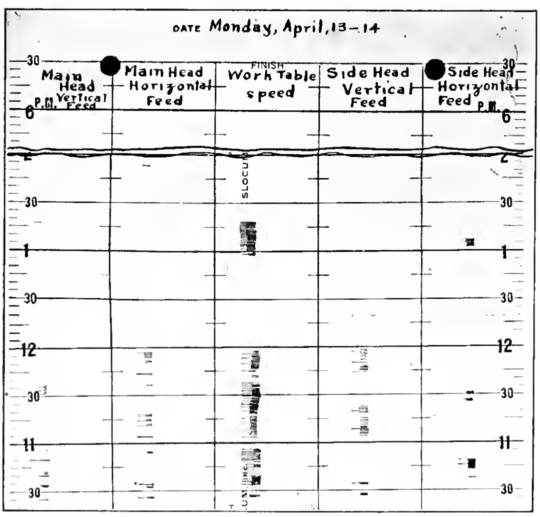


Fig. 5. "Productograph" Record of the Machining Operations of a Bullard Vertical Turret Lathe on a 0.40 to 0.50 per cent Carbon Steel Disk

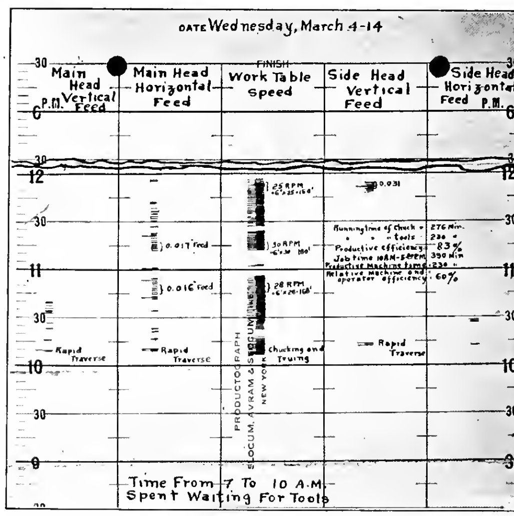


Fig. 6. "Productograph" Record of Machining Operations of a Bullard Vertical Turret Lathe set up and in Operation on a Large Cast-iron Flywheel

A "Productograph" Record made on a Bullard Vertical Turret Lathe—Machining a Cast-Iron Flywheel

Another job upon which a "Productograph" record was made in the plant of the Bullard Machine Tool Co. was a large cast-iron flywheel upon which five separate readings were made. For instance, the "Productograph" was connected by switches to the vertical shaft, rotating at an exact multiple of the table speed, to the cross-feed screw of the main head, to the down-feed screw of the main head, to the horizontal feed of the side head, and to the down feed of the side head. In this way, it was possible to secure relative

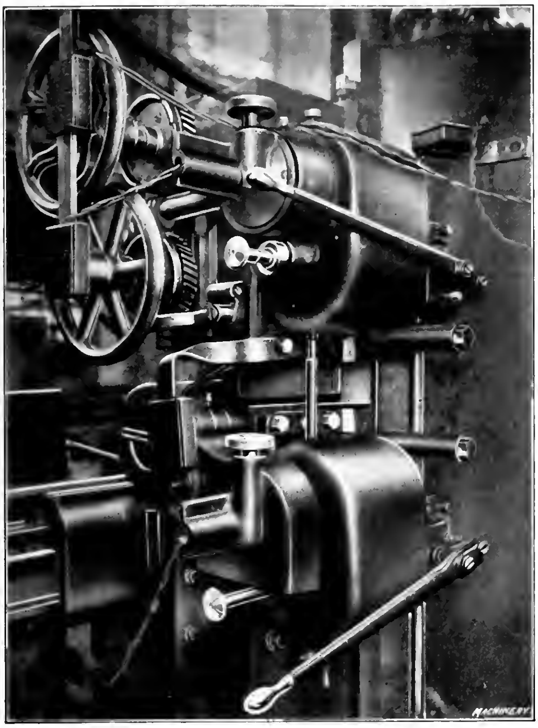


Fig. 7. The Movements of the Machine are transmitted electrically by Switches which are attached to the Operating Members

positions on the chart of these two heads and the time required for them to perform their individual operations.

On this job, a stop-watch test was also made to show how close the "Productograph" record was to the actual stop-watch test. The test started at 11 A. M. and was conducted as follows: Put wheel on table, 11:04; true up casting, 11:05; crown face with side head vertical feed of 0.131 inch per revolution, ¾ inch depth of cut and a table speed of five revolutions per minute, a forming attachment as shown in Fig. 9 being used. This enables the rough-turning and crowning operations to be accomplished without reversing the position of the work on the table. 11:07, face side of rim with main head, using a cross-feed of 0.083 inch per revolution of the work, and a cut ½ inch deep; 11:15, main head cut finished; 11:16, side head cut finished; 11:16, finish-face side of rim with main head—hand feed to just remove the sharp corners; 11:17½, set up for finish-crowning rim, five revolutions; 11:18, finish-crown rim at 0.245 inch feed per revolution; 11:19, set for boring hole with main head, feed 0.083 inch per revolution of the work; 11:22½, final cut of side head finished.

Continuing operations, bring side head for facing hub into position; 11:23, face hub, 16 revolutions of work at a feed of 0.083 inch per revolution and a depth of cut of ½ inch—horizontal feed used; 11:26, change speed to 20 revolutions per minute; 11:27, side head cut finished—stop to clear chips from beneath hub of work to allow boring tool to enter to the correct depth; 11:27½, continue boring at a feed of 0.083 inch per revolution, 29 revolutions of the work required; 11:28, change cutter in the boring tool; 11:28½, start second boring cut and finish-face hub with side head at a horizontal feed of 0.245 inch per revolution of the work; 11:30, finish-bore at 0.245 inch feed, rotating work at 48 revolutions per minute; 11:32, chamfer the hole with boring tool; 11:32½, ream hole 0.245 inch feed per revolution, work rotating at 39 revolutions per minute; 11:34, change cutters; 11:35, size hole with work rotating at 39 revolutions per minute and a down feed to the cutter head of 0.245 inch per revolution; 11:36½, chamfer hub with main head, 12 revolutions of work required using hand feed; 11:37, chamfer rim with main head—five revolutions required; 11:38½, take casting off machine; 11:40, casting off.

This casting, as tested with a scleroscope, indicated from 28 to 29 points hard. The weight of the casting before machining was 859 pounds, and after the first operation only, it weighed 722 pounds, indicating that 137 pounds of material had been removed in 40 minutes—the time required to complete the first operation.

Reference to the "Productograph" chart shown in Fig. 6 in comparison with the stop-watch test given will show that the instrument recorded not only the combination movements of the two heads, but also the revolutions of the work, indicating when the rapid power traverse was used; when analyzed it would also give the feed at which the cutting tools were operated.

The analysis of this chart, however, is not a simple matter and requires some study. The ratio of the gearing in the switches has to be taken into consideration and also any other ratios in the machine between the points where the switch is attached and where the movement that it is desired to record takes place. For instance, the vertical shaft on the Bullard vertical turret lathe does not rotate at the same speed as the table, but at an exact multiple of the table speed, so this ratio must be taken into consideration when figuring out the chart. However, as this information is all known beforehand it is simply a matter of using it as a constant when making the desired calculations.

Possibilities of the "Productograph" as an Efficiency Recorder

There are several different uses for the "Productograph" in the machine building plant or other manufacturing establishments. One very good application would be for setting piece-work rates. A test record can be taken over a long period of time so as to get both the machine and operator working at what might be called an average efficiency, which, of course, would be the only reasonable basis upon which to set a piece-rate. This record is made unconsciously by the operator so

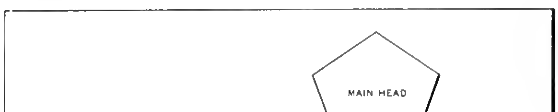


Fig. 8. Set-up on a Bullard Vertical Turret Lathe for machining a Beveled Surface on a Machine Steel Disk. For "Productograph" Record, see Fig. 5

that every move is recorded and the human element does not enter into the record at all; the result is, therefore, reliable.

From observations of this instrument on the Bullard vertical turret lathe, the following general conclusions are drawn: As a means of indicating the feed of the tools, the "Productograph" is of little value. Its application to the vertical turret lathe is satisfactory only in so far as it indicates the production in a certain specified time and the time required to turn

out each piece, also the production per day. This indicates the grade of the material, that is, whether it is hard or soft, and also whether the operator keeps the machine working to its best efficiency. By connecting various points of the "Productograph" with the different heads of the machine and its mechanical movements, it is also possible to trace whether the operator has followed the proposed layout or not. This is generally a vital point in the operation of a Bullard vertical turret lathe. There are certain combinations of tools in the main and side heads that give the best results for different jobs and this information is, as a rule, definitely obtained before the operator is set to work on the job. If he does not follow the outline suggested, he, in many cases, drops down below the estimate production. Of course, in the nature of things, he will not condemn himself and it is therefore impossible for the foreman to determine the reason for the decrease in production. The "Productograph" shows this up forcibly. It would seem that this point alone would warrant its installation in plants where large numbers of parts are to be turned out per day or year, on machines of the type where a certain specified order of operations has to be followed.

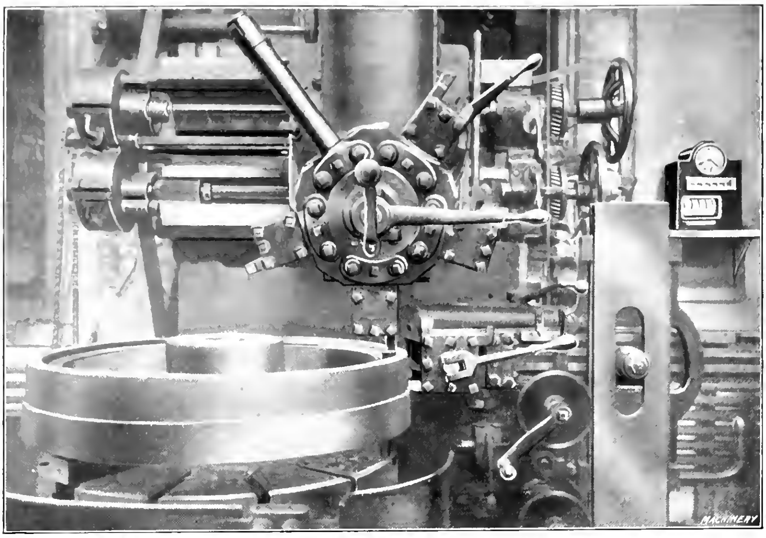


Fig. 9. Facing and Turning Operations taking place simultaneously. The Chart, Fig. 6, shows that this has been recorded

Probably the most important field of the "Productograph" is for machines which are set up and in operation on one piece of work and are run on that continually, and where the production from the machines per day is the only point on which a record is to be kept. The chart gives the information that the manager of a plant desires, and as it comes from an unprejudiced source it is of unquestionable value. Furthermore, it shows this record in such a manner that a manager can immediately find out whether a machine is working efficiently or not. For instance, as soon as a machine breaks down, the "Productograph" stops recording. A "live" manager will then call up the foreman to find out first hand what is the matter and just why the machine is not working. Suppose ten minutes or more after, the machine is still inoperative, the manager again calls up the foreman. This has the effect of making the foreman feel the responsibility of his position, and he thereafter makes it a point to see that a machine which has broken down receives immediate attention. This tends to increase the value of factory discipline and increases production and efficiency.

Of course, any mechanical instrument of this kind will not raise the production of a plant, but it forms the basis upon which scientific methods of management can be properly conducted. It shows clearly what part of the investment is idle and what part non-productive, and in reviewing the charts from day to day the average efficiency of machines and operators can easily be obtained. It also shows up many other points as regards efficiency of foremen, operators, machines, etc., which it would be impossible to obtain without its use. While in a sense it is a detector of production as much as a recorder, it discloses defects and hence, instead of being a hindrance to an operator, it is really a help. The information is taken from the "Productograph" charts and entered upon daily and monthly cards, from which a comparison of the efficiency of the various machines in the shop can be easily obtained. If these records are properly kept up, they form a basis also for piece-rate working systems and other efficiency standards, as well as exact cost systems.

* * *

It is probable that the first attempt to transmit power through any distance was by means of a rope. The first application of rope for power transmission was for hoisting and this suggested the possibility of using the same method for transmitting power from one revolving shaft to another. A single rope was originally used which was essentially a sort of round belt running in a grooved sheave. The next development consisted of the application of a flat leather belt running on cylindrical pulleys, where a greater frictional surface was required for transmitting larger amounts of power. In modern practice rope drives are used to transmit high powers by the application of a number of strands of rope. The drive may either be arranged on the English system, where the required number of separate ropes are used; or on the American system, where a single endless rope is employed, which is carried back and forth over the pulleys to provide the required amount of driving contact.

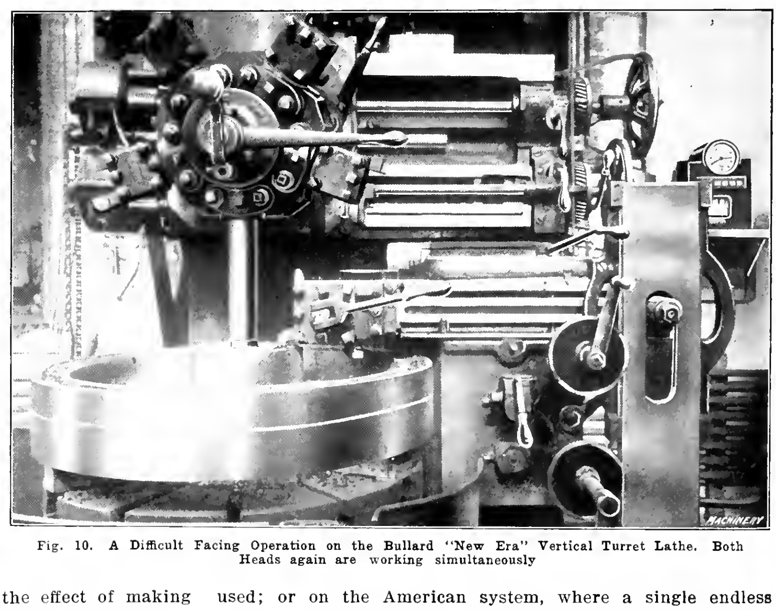


Fig. 10. A Difficult Facing Operation on the Bullard "New Era" Vertical Turret Lathe. Both Heads again are working simultaneously

LETTERS ON PRACTICAL SUBJECTS

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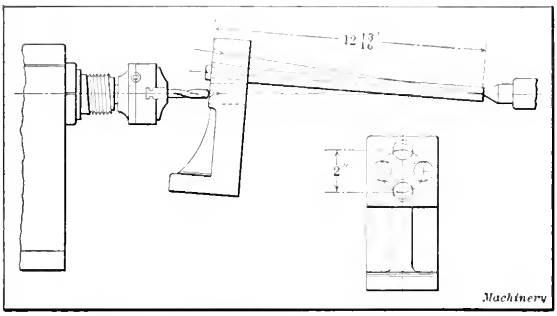
A DIFFICULT DRILLING OPERATION

A rather novel way of accomplishing a difficult operation is shown in the accompanying illustration. The work consists of a bracket, in which it was required to drill four holes equally spaced around the circumference of a 2-inch circle; the holes had to be inclined at such an angle that their center lines would come together at a point 12 13/16 inches from the front face of the bracket. This job was handled very satisfactorily by first drilling a hole at the center of the circle around which the four small holes were to be drilled; the center hole was square with the face of the bracket and was for the purpose of receiving a stud 12⅞ inches in length. The stud was centered at the further end to receive the tail center of the lathe, thus locating the face of the bracket 12 13/16 inches from the tail center.

The four small holes to be drilled around the circumference of the 2-inch circle were now laid out and center-punched, after which the work was ready for the drilling operation. The stud was located against the tail center of the lathe and the holes centered to 5/16 inch with a combination center drill. When the holes had been drilled and reamed the bracket was taken off the stud and mounted on a plug in a draw-in chuck, then counterbored a short distance to the size of the drill that was to be used. After this work had been done, the bracket was replaced on the stud and carefully drilled and reamed to the finished size. In preparing for the



Method of handling a Difficult Drilling Operation

drilling operation, the work was blocked up on the lathe bed to nearly the right height, but as the piece was of light weight it was an easy matter to hold it in line with the drill and also keep the stud against the dead center of the lathe. The work could be further supported by bringing the lathe carriage up against the back of the bracket.

Buffalo, N. Y. RICHARD WILCOX

AN UNUSUAL LATHE JOB

The machining of "outside" jobs that are beyond the capacity of the machines at hand frequently presents problems that require a different solution from those encountered in the regular shop work. A lathe job of this kind is shown in the accompanying illustrations which indicate the manner of machining this unusual piece of work at the Pond Works of the Niles-Bement-Pond Co., Plainfield, N. J. The special shaft to be machined has the following dimensions: Length over all, including square portion, 27 feet; diameter of threads, 10½ inches; lead, 3½ inches; half of cylindrical portion threaded right hand and half left hand; square part, 7 inches square.

As there was no lathe available with sufficient capacity and the necessary length of bed, two Pond 36-inch triple geared lathes that stood on adjacent foundations were selected for the job. From an inspection of the illustrations it will be seen that the headstock of one lathe and the tailstock of the other were removed and the beds were brought into proper alignment. To prevent endwise motion of the beds, straps were used to join the end legs, the front strap being shown at *A* in Fig. 2. The same illustration also shows at *B* how the two lead-screws were joined by a suitable coupling for the purpose of feeding the tail-end carriage by power.

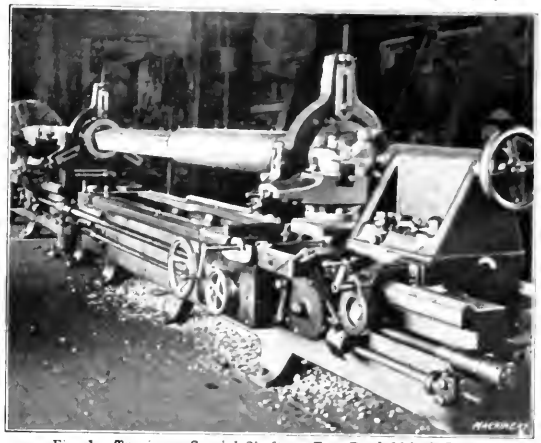


Fig. 1. Turning a Special Shaft on Two Pond 36-inch Lathes

It will be observed that bushings of ample proportions are provided for the steadyrests, which carry the principal weight of the shaft. The machining was accomplished in the usual manner, the shaft being turned end for end in order to reach the portion between the gap in the beds. The square part was machined on a planer after the shaft was rough-turned all over in the lathe.

Plainfield, N. J. ALFRED SPANGENBERG

SQUARE KEY VS. RECTANGULAR AND TAPERED KEYS

The article of this title which appeared in the March number of MACHINERY brought to mind certain experiences with keys on machine tools which may throw some further light upon the subject. It appears to the writer that a little more

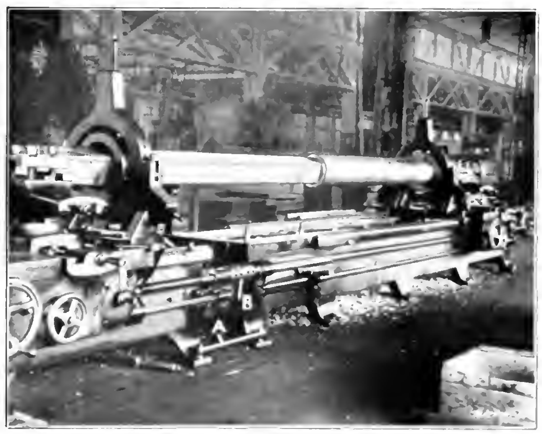


Fig. 2. Arrangement of the Leg Straps and Lead-screw Coupling

investigation of the work actually done by the keys, and not so much in the way of drafting-room calculations would result in more efficient designs, this being particularly true in the case of keys and bearings. Take, for instance, a pulley which is driven with a reversing motion, as in the case of belt-driven planers. A square key soon becomes loose both in the pulley and shaft, owing to the fact that the keyway is

too shallow to stand the strain. In repairing, it is necessary to compensate for wear in a way which makes the keyway both wider and deeper, but results in the use of a rectangular shaped key. Where this practice has been followed no further trouble was experienced and the shaft and pulley showed no signs of weakness.

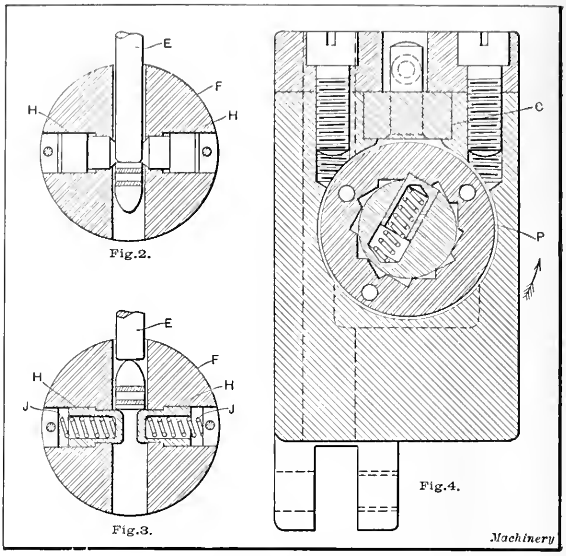
Sliding members on spline shafts should have keyways of rectangular design in order to give more wearing surface on the side of the key, and will stand the strain of the drive better. There should be a key on each side of the shaft, as sliding members are less likely to stick, and wear is more equalized, especially in the keyways. This practice will be found to give satisfactory results on the shafts used on the upright drills with four or more heads, on cold cutting-off machines and a variety of other machine tools. As Mr. Wiweke says, a square key "fills the bill" and I agree with him in most cases, and also that keys should be made of larger size than is the present practice.

The chief objection to tapered keys is that they are sometimes very hard to remove. This difficulty is not experienced with straight keys, and such keys can be securely held in place by using a small set-screw as a retainer, carried in a hole tapped through the hub of the pulley. Such a design is used by a well-known firm of machine tool builders who manufacture draw-cut shapers. As for the weakening of the shaft by the keyway, I have never seen a shaft break at the point where the keyway was cut, and I have had experience in operating some very heavy planers. I have, however, had considerable trouble through small keys working loose, due to the fact that the keyseats were made too shallow. I have also seen cases in which the corner of the cast-iron pulley has broken off at the keyway, and other cases in which the key has failed by shearing.

Dover, N. J. J. L. Diggory

AN AUTOMATIC FEED FOR BULLETS AND SLUGS

A device that feeds lead bullets or slugs to press tools in a uniform direction, regardless of the way in which it receives them, is shown in Fig. 1. The device is attached to a Waterbury-Farrel press with 4½-inch stroke, and the bullets enter the tube *A* from a hopper located above the press. The hopper is equipped with an agitator tube and a lever for reciprocating this tube, which is moved up and down through the bullets and drops them into the tube *A*. The bullets are taken from the tube *A* by the slide *C*, which is operated by the cam *D* fastened to the cross-head, and carried under the descending punch *E*. The punch-holder *L* is also carried by the cross-head. Should a bullet enter the tube *A* with the rounded side downward, as is the case with the first and third bullets shown in the tube *A*, it is pushed on through dial *F* and into the feed pipe *G* which carries it to the dial plate of the press. The dial, in turn, carries it under the working tools, and such operations as swaging or sizing are performed on it. The construction of the dial *F* and its action when a bullet happens to enter it in this position is shown in Fig. 2. The plungers *H* are chamfered on the end and the punch *E* forces them back against the action of the springs *J*, the



Figs. 2 to 4. Details of Feed Dial F and Clutch P

bullet dropping through the dial into the tube *G*. Should a bullet be in an inverted position, the action of the device is shown in Fig. 3. The flat bottom of the bullet rests on the straight portion of the plungers *H*; this prevents further descent of the punch *E*, spring *K* contracting back of it to take up the motion of the cross-head.

Carried in bracket *L* is the rack *M*, which meshes with the pinion *N*. The index plate *O* is doweled to dial *F* and the clutch *P* is fastened to sleeve *R*. Fiber friction washers *S* are used to prevent breakage should anything out of the ordinary happen. A section through clutch *P* is shown in Fig. 4.

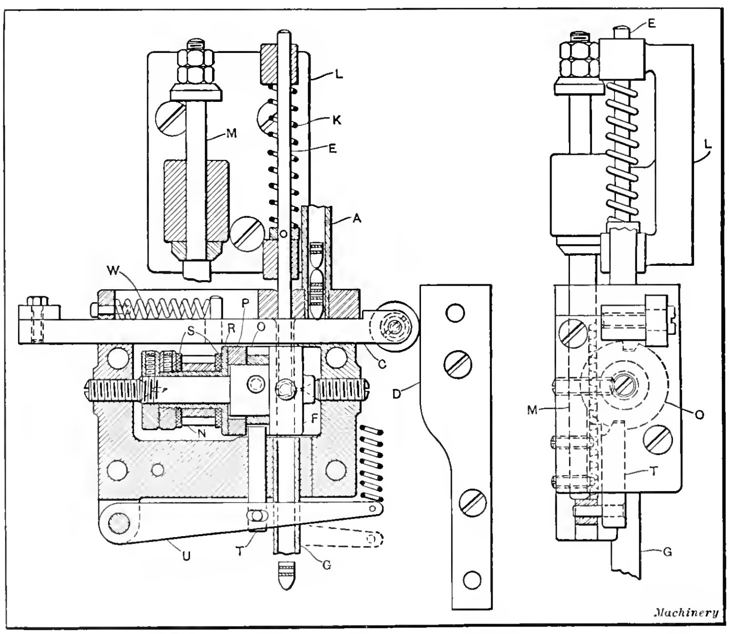


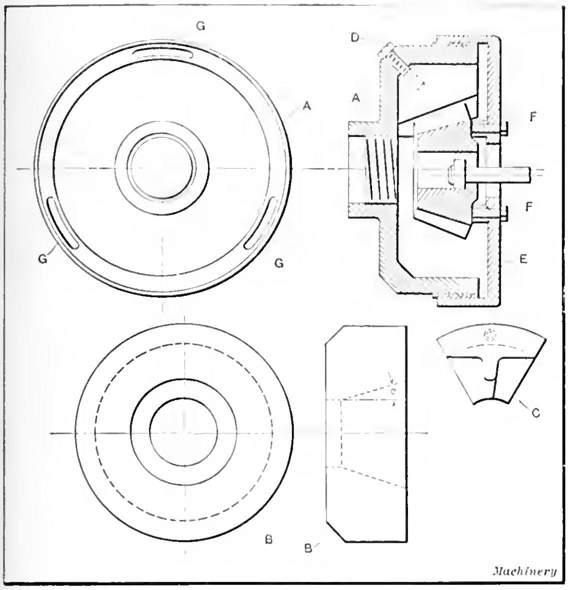
Fig. 1. Automatic Feed Mechanism for Bullets and Slugs

When the cross-head descends, the rack *M* revolves the clutch in the direction shown by the arrow in Fig. 4. The dial *F* is held by the plunger *T* which enters a hole in the index plate *O*. When within ¼ inch of the end of the down stroke (this position is shown in Fig. 1) the rack *M* strikes the lever *U*, pulling out the index plunger *T*. The rack descends far enough to give it time on its return stroke to move dial *F* before the returning index plunger can re-enter its former index hole. On the return stroke, the lost motion of the rack in its bracket gives time for the withdrawal of punch *E* before dial *F* is revolved, and this lost motion can be adjusted so that it reaches the highest point of the up stroke just as the dial *F* has revolved through 180 degrees to its other index hole. However, the friction washers *S* will allow for slippage should the rack carry too high. Referring to Fig. 3, it can be readily seen that the bullet is turned end for end when dial *F* is moved through 180 degrees. The bullet drops out of the dial and down pipe *G* to the machine dial in the same direction as the bullet entering in the opposite direction.

The dial F is carried on hardened centers to give accurate alignment, easy adjustment and light turning. The spring W is used to return the slide C. LAWRENCE FAY

BEVEL GEAR CHUCK

The accompanying illustration shows a chuck which I recently designed for holding bevel gears while grinding the hole. After the chuck A has been made, it is screwed onto the spindle of the machine and finished by grinding. The ring B is next made with the angle a equal to the root angle



Chuck for holding Bevel Gears while grinding the Bearing Hole

of the bevel gear that is to be held in the chuck. Three jaws are cut out of this ring with teeth milled as shown at C. These jaws are made of a good grade of steel in order to enable them to stand up under hard usage. Holes are drilled and tapped in the jaws and the jaws are fastened in the chuck at 120 degrees from each other, one of the cap-screws used for this purpose being shown at D.

The chuck cover is shown at E, the gear being held in the chuck by the cover and screws F. To grind a bevel gear, the jaws are put in the chuck first and fastened by means of cap-screws passing through the three slots G, the screws being left loose enough to allow the jaws to adjust themselves to the gear. The bevel gear is next put into place and the cover screwed down on top of it. After the first gear has been set in place, the cap-screws D are tightened to hold the jaws ready for receiving subsequent gears. Care must be taken in putting gears in the chuck to see that there are no burrs left at the bottom of the teeth of the gear, as this would interfere with the action of the jaws in locating the work properly. The gear finished in this chuck will run within 0.001 to 0.002 inch true.

Farrell, Pa. JOHN BLANAR

PREVENTING WEAR OF CONCRETE FLOORS

About the only objection to the ordinary concrete floor is the fact that the wear to which it is subject—that is, the purely mechanical attrition causes dust. This may, however, be avoided by scrubbing the floor with a stiff brush or broom, letting it dry, and then laying on a coat of a solution of water-glass in three to four times its volume of water. The solution is applied with a long-handled whitewash brush. The more dense the concrete, the thinner the solution may be, and no more of it should be made than can be applied in an hour. When the floor is again dry, it should be scrubbed with water and a coarse cloth. Then a second and a third coat of water-glass solution should be applied, each time letting the floor dry, scouring it with clean water and a heavy cloth. The water-glass should soak into the pores of the concrete and form with the alkali therein an insoluble chemical compound. Any water-glass that remains on the surface is unchanged, and can be washed or scrubbed away. This treatment will increase the durability of the concrete, and make it much more desirable as a floor material.

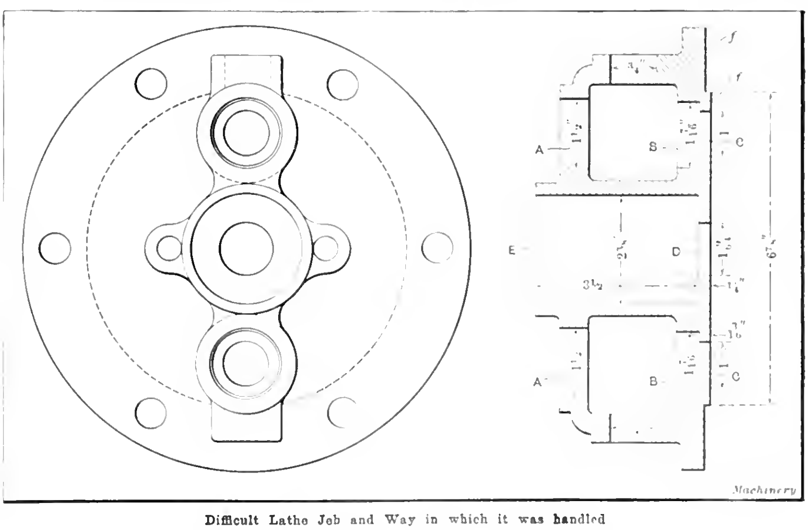
Dresden, Germany. ROBERT GRIMSHAW

RAPID PRODUCTION LATHE WORK

The accompanying illustration shows plan and cross-sectional views of a piece of work in which it was required to machine the holes A, B, C, D and E in a lathe. The first step in machining these castings was to chuck the work and finish the surfaces f, making the diameter of the boss 6⅞ inches. The boss formed in this way was then used to hold the work in a plate jig. The plate jig was first located centrally on the faceplate of the lathe by means of dowel pins, and the hole E was then bored to size and finished to the required depth, the metal at the bottom of the hole being left ¼ inch thick. The hole D was next bored.

The jig was then shifted to bring one of the holes A central and again held in position on the faceplate by dowel pins. It will be noticed that the finished size of the hole A is 1/16 inch larger than hole B, but both holes would be the same size in the rough casting. The hole A was first bored to a diameter of 1 7/16 inch, this size being carried nearly to the right depth in hole B. The tool was next moved away from the operator a distance of 0.221 inch and the hole C bored, the size obtained in this way leaving a little metal for reaming. Without changing the setting of the tool, the carriage was moved to the right so that the tool would clear the work. The tool was then moved toward the operator a distance of 0.252 inch and the hole A rebored to the required size.

The thickness of the plate jig was 11/16 inch, and adding the 3/16 inch required at the bottom of hole B gives a total distance of ⅞ inch as the required length of the pilot on the counterbore used to finish the bottom of the hole B. If this tool is pushed in until the end of the pilot is even with the back of the jig, the required thickness of metal will be left. I handled this operation without any trouble by proceeding as follows: A surface gage was set with the hook scriber 5



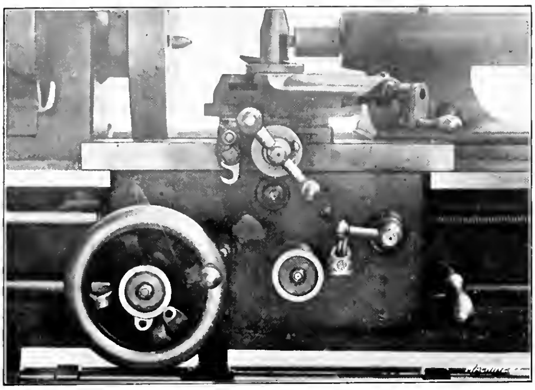
Difficult Lathe Job and Way in which it was handled

inches high, the surface gage being set against the faceplate of the lathe. The end of the pilot of the counterbore was then set at this distance from the faceplate. The counterbore was made with a taper shank to fit in the tailstock spindle, and by using the graduations on the tailstock spindle to work the tool in 5 inches from the original setting the desired thickness of metal was left at the bottom of the hole *B*.

In finishing the holes *A*, *B* and *C* on the opposite side of the casting, the work was simply turned through 180 degrees and then once more secured in place in the plate jig. The 3/4-inch holes in the side walls of the casting were machined in a drill press. The wide-awake mechanic will find that there are lots of jobs that could be handled in this way with a saving of time and expense. C. H. L.

NO MORE BROKEN FEED PINIONS

During the past ten years that I have been teaching machine work, I suppose that no less than twenty-five times I have torn down a lathe, turned up a pinion and gear, and in some cases repaired the rack, all in a hurry to get the lathe ready for the class the following day. Some years ago I wrote a letter to the makers, saying that I thought it would be a great improvement if they equipped their lathes with "fool proof" aprons. I got back a very curt reply telling me that a lathe of the quality of those built by Blank & Co. was too fine a tool for an amateur to work on. However, the apron gear would be sent for about $8 and express charges,



A Simple Method of preventing Feed Pinions from being broken

if desired. I understood then why the apron gear had ninety-nine teeth in it and required compound indexing to cut it.

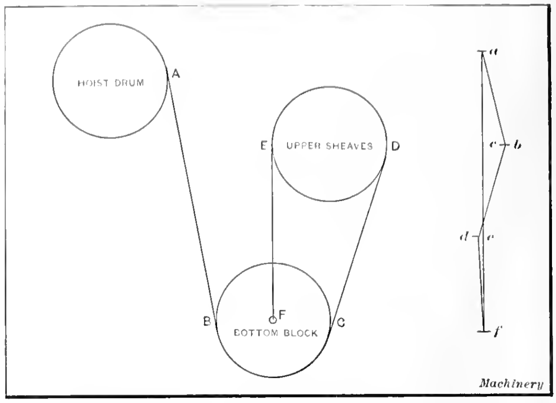
Recently I discovered a very simple method of preventing the breakage of feed pinions. As shown in the accompanying illustration, there are two ears fastened to the wheel and the feed knob. When the feed is out, they are opposite; also, the lock hangs on a stud screwed into the apron and locks the feed nut open. I always keep the lock in one place or the other and find it much easier to move it to suit the workman than to fix the lathe after he has gotten in both feeds and broken the feed pinions.

Menomonie, Wis. F. Hillix

A KINK FOR CRANE DESIGNERS

When laying out a crane trolley it is desirable to locate the bottom block with a fair degree of accuracy. The following outlines a graphical method by means of which the correct position of the block can be determined with ease and rapidity. The accompanying illustration shows a "three-part" lift arrangement, and it is required to find the position of the bottom block as it hangs from the drum and upper sheaves. The location of the drum and sheaves has been fixed and in determining the location of the bottom block, a position for the block is assumed which makes *AB*, *CD* and *EF* represent the directions of the ropes connecting the drum and upper sheaves with the bottom block.

After the position of the block has been assumed, it is necessary to determine whether the assumed position is satisfactory. This is done by the graphical method illustrated herewith. The method of procedure is as follows: Draw a line *ab* parallel to *AB*, making this line of some definite length. Next draw a line *cd* parallel to *CD*, and then draw *ef* parallel to *EF*. The lines *cd* and *ef* are made of the same length as the line *ab*. This is due to the fact that the tension is practically uniform in the rope. If the position of the bottom block has been properly assumed, the closing line *af*



Graphical Method of locating a Crane Trolley Bottom Block

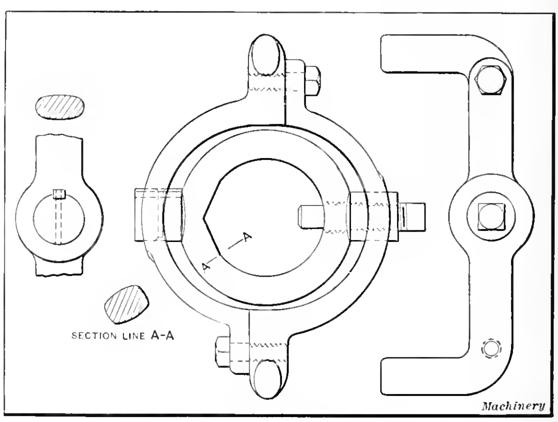
will be vertical; or in other words, the resultant of the rope tensions must lie in a vertical plane. If the line *af* is not vertical, a new position must be assumed for the bottom block and the same process gone through, the operation being repeated, if necessary, until a satisfactory position for the bottom block has been found. This method can be used for any arrangement of ropes.

Toledo, Ohio Carl E. Schirmer

EQUALIZING DRIVING DOG

The accompanying illustration shows a driving dog with equalizing arms, which will be seen to consist of two rings. The inner ring is provided with a set-screw for fastening the dog to the work, and two trunnions which are a sliding fit in holes in the outer ring. In this way the two rings are flexibly connected to each other; the set-screw passes through the center of one of the trunnions and a key is attached to the opposite trunnion to prevent the rings from turning in relation to each other. It will be seen that the outer ring is made of two parts which are held together by means of cap-screws. In using this dog, it is necessary for the work to be placed nearly in the center of the inner ring as the equalizing feature is only sufficient to compensate for an eccentricity of 3/8 inch. The capacity of the dog is for work up to 3 inches in diameter. It would of course be possible to make the same type of dog in sizes to suit a variety of different classes of work.

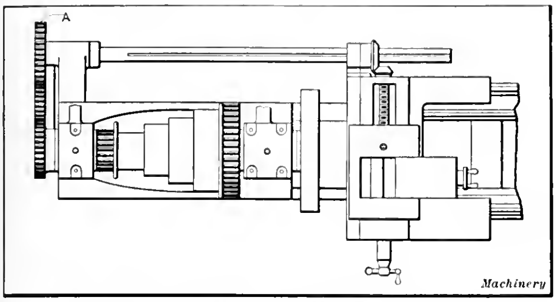
Waterveliet, N. Y. Martin H. Ball



Driving Dog with Equalizing Arms

CUTTING A SPIRAL ON THE ENGINE LATHE

In the April number of MACHINERY, Russell K. Annis described a method employed in cutting a spiral groove in a disk and illustrated the attachment applied to a Lodge & Shipley lathe to adapt it for this operation. The accompanying illustration shows an attachment applied to a Fay & Scott lathe to adapt the machine for handling the same



Spiral Cutting Attachment for a Fay & Scott Lathe

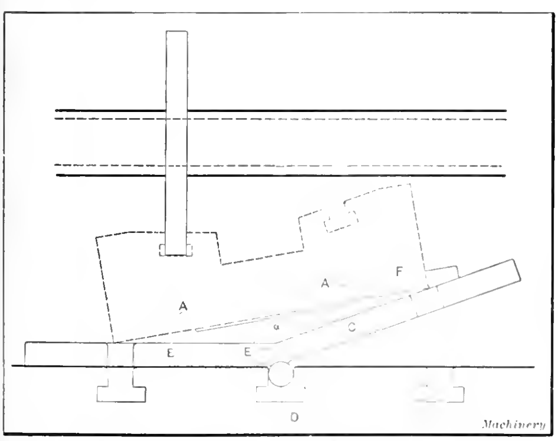
class of work. It will be evident from this illustration that motion is transmitted to the cross-slide through spur gears at the end of the lathe and bevel gears at the cross-feed screw. The gear *A* is a change gear, different gears being employed for cutting spirals of various leads.

The attachment was designed to cut a spiral groove of two inches pitch in a fiber disk. In the writer's opinion this design is superior to the one described by Mr. Annis because only one cross-feed screw is required, which is also used for the regular work done on the lathe. In the attachment described in the April number of MACHINERY a separate cross-feed screw is required for each different lead of spiral that it is required to cut.

Dexter, Me. E. W. TATE

FIXTURE FOR MILLING T-SLOTS AT AN ANGLE

The fixture which forms the subject of this article was designed for milling two T-slots in a long casting, the T-slots being milled in two surfaces which are inclined to each other at an angle *a*. The work is located in the proper position for milling the T-slots by means of the two finished bases *B* and *C* of the fixture, which are machined in the correct relation to the locating surfaces *A* and *F*. A rod *D* is fastened to the base of the fixture at the intersection of the two bases; this rod fits in the T-slot of the milling machine table and holds the fixture in alignment as it is swung from one side to the other. Recesses *E* are cut to allow room for a brush to be used to sweep away chips and dirt from under the fixture, so that it will fit properly against the milling machine table.



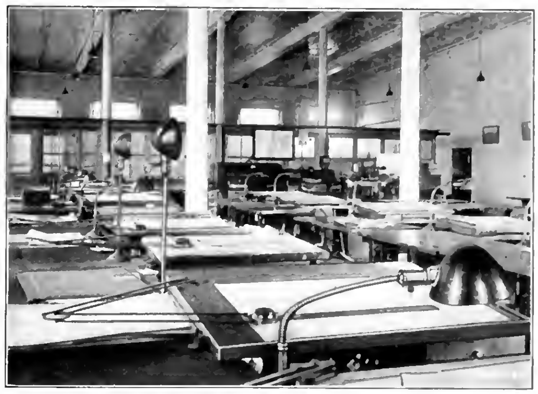
Fixture for milling T-slots in Surfaces Inclined at an Angle

In starting to mill a piece of work, the casting is located against the finished face *F* of the fixture, and clamped in place with ordinary straps. The fixture is clamped to the milling machine table with the regular form of T-bolts. In milling the T-slots, two separate operations are involved; first, a cut is taken with a plain cutter as shown in the illustration, after which a second cut is taken with a T-slot milling cutter. In using the plain cutter, the cut is taken across the casting, and the table is then returned to the starting position, the quick return being used for this purpose. The fixture is next swung into position for milling the second slot, and clamped in place. The cross-feed is then employed to bring the cutter to the correct position, after which the second slot is milled. The cross-feed stops should be set so that all successive pieces will be uniform, without requiring attention from the operator. After milling the straight slots, the T-slot cutter is used in a vertical milling attachment. The operation is the same as in milling the plain slots except that the T-slot cutter will mill on both the forward and return movements of the table. Consequently, in milling the T-slots, the fixture will be indexed after completing the cut to provide for milling the second T-slot on the return of the table.

Providence, R. I. C. KNOWLES

GENERAL AND INDIVIDUAL ILLUMINATION FOR THE DRAWING-ROOM

It seems to be a most difficult problem to illuminate a drawing-room satisfactorily. Theoretically, at least, a soft, uniform, indirect light approximating daylight is to be desired, but the installation of such a system of lighting in an old room presents difficulties. In refitting as a drafting-room, a room for many years used for other purposes, the general scheme of lighting shown in the accompanying illustration has been employed with satisfactory results. The draftsmen



General System of Drawing-room Illumination and Individual Lights for Each Table

use the light without fatigue and the general illumination gives a bright, cheerful room.

As will be noted from the illustration, each desk is individually lighted by means of a 32-candlepower carbon lamp with frosted bulb. This lamp is supported in an 18-inch flexible arm fixture attached to the table at such a point as to be out of the way. A parabolic reflector, also adjustable, is used to direct the light onto the board in such a way as to prevent reflection into the eyes of the draftsmen. During the day the flexible arm is straightened up so that the lighting arrangement is entirely out of the way.

General illumination is by means of suspended 100-watt metal filament lamps. This system has been in use for about two years and on the whole with very satisfactory results. The arrangement, in addition to providing suitable illumination, is neat and mechanical in appearance. The wiring is carried along in conduits under each desk, the terminals being brought up through the floor where necessary. This eliminates unsightly wires coming down from the ceiling to the individual desks.

Holyoke, Mass. W. M. FLEMING

MULTIPLE THREAD CUTTING

The following outlines a method of using the compound rest for cutting multiple threads. Suppose you have to cut a double square thread of ¼-inch pitch and ½-inch lead. Turn the compound rest so that it is at right angles to the cross-slide of the lathe and set the threading tool in the usual way. Now take the first cut, using the cross-feed screw to feed the tool into the work. Having taken a cut on the first thread, turn the compound rest crank to move the tool forward an amount equal to the pitch of thread to be cut, which is 0.250 inch in the present case. The graduated collar on the rest is conveniently used for this purpose. Next take two successive cuts on the second thread and then bring the rest back to the starting point and take a cut on the first thread. This is repeated until both threads are finished.

The only thing that the operator has to remember is to move the compound rest a distance equal to the pitch for each of the different multiple threads. If the screw in the rest is not provided with a graduated collar, scribe a line on the slide of the rest and onto its base. Then move the rest forward until the lines are separated by an amount equal to the pitch of the thread to be cut. These two lines can then be used in moving the tool backward and forward in the way previously described for a rest equipped with a graduated collar. The writer has found this method convenient for handling an occasional job of multiple thread cutting. There are no special fixtures to make and the lathe can be started and run continuously until the work is finished.

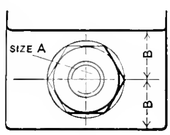
Richmond, Ind. FRANK A. HIATT

CLEARANCE ALLOWANCES FOR HEXAGONAL NUTS

The accompanying illustration shows the position of a hexagonal nut located close to a wall or boss, and the table gives the clearance allowance necessary to enable different sizes of nuts to be turned in such a position. The table is based on a movement of the wrench through an angle of 60 degrees. The information given has been found particularly convenient for reference in cases where the space available for the wrench is limited. The figures give the minimum clearance allowance in all cases.

MINIMUM CLEARANCE ALLOWANCES FOR HEXAGON NUTS

Size of Nut A, Inch	Distance B, Inch	Size of Nut A, Inches	Distance B, Inches
¼	7/16	1¼	1⅜
⅜	⅝	1⅜	1½
½	¾	1½	1⅝
⅝	⅞	1¾	1⅞
¾	15/16	2	2 1/16
⅞	1 1/16	2¼	2 5/16
1	1 3/16	2½	2½
1⅛	1 5/16	3	2 15/16



Machinery

Rochester, N. Y. H. P. RESTON

SLATE DRAWING BOARDS

In making preliminary sketches illustrating details on a large scale or explaining the details of a piece of machinery or part of a structure to customers, engineers, draftsmen or salesmen, nothing can be more satisfactory than the old-fashioned slate, pencil and sponge. Slate drawing boards of this kind are used by a tool manufacturing company in the western part of Massachusetts, and are said to be very satisfactory. A piece of slate about 3 by 5 feet in size is set in a solid frame, the edges of which are accurately finished so that a T-square and triangles can be used in the regular way. The slate drawing board can be used in place of the ordinary drawing board and detail paper; it is more economical and meets every requirement in making rough sketches and outline drawings. Small sharp slate pencils should be used, these pencils being kept pointed by means of an ordinary sandpaper pad.

A number of these slate drawing boards are used by the firm referred to in the preceding paragraph. Some of these are made of relatively thin slate, in which case a board support is provided in the frame under the slate to eliminate danger of breaking it. The frame is set on trestles of a convenient height. Some of the slates are also supported in an almost vertical position and the frames in which they are held are not provided with a board back. Consequently, it is possible to use both sides of a slate supported in this manner. The support is so constructed that the slate can be swung to from 10 to 20 degrees from the vertical.

Portions of drawings on such a slate can be readily removed and the remaining portions not only present a neat appearance but remain clear and sharply defined for an indefinite length of time. The great economy effected by having two or three of these slates about any drafting office will be readily appreciated, as everyone knows what a lot of paper is used up in preliminary work. In the course of a year, this saving of paper would easily pay for the slates several times over. Slate drawing boards of this kind can be purchased from any dealer.

Winter Hill, Mass. FRANK H. JONES

CUTTING SPIRALS ON THE LATHE

The article by Russell K. Annis entitled "Cutting a Spiral on a Lodge & Shipley Lathe," which appeared in the April number of MACHINERY, reminds me of another method which I saw used in a jobbing shop a number of years ago. A short shaft was journaled in brackets at the back of the lathe and the left-hand end of this shaft was fitted for a change gear. A disk turned to a circumference of eight inches was mounted on the shaft and one end of the main spring of a clock was attached to this disk. The other end of the spring was fastened to the cross-slide of the lathe, the cross-feed screw having been removed and a weight provided to pull the slide forward. In this way the cross-slide was held forward against the spring at all times.

Rotation of the disk caused the cross-slide to be moved over at the rate of eight inches for each complete revolution of the shaft. Consequently, by employing change gears on the shaft, it was possible to adjust the attachment to cut a spiral of the desired pitch. The spiral could be cut either right- or left-hand by employing the feed reverse in the headstock.

The shop in which this method was employed also had a lot of chucks to machine. These chucks were used on some sort of wood-working lathe and had a tapered hole 4 inches in diameter at the large end, the taper of the hole being approximately 75 degrees included angle. It was required to cut a coarse buttress thread inside this hole, and the clock spring arrangement previously described was used in connection with the lead-screw, enabling what would otherwise have been a difficult job to be handled with considerable rapidity.

Later, this attachment was put into a more permanent form by placing a gear of eight inches pitch circumference on the shaft and providing a rack on the cross-slide to mesh with it. This rack and gear was substituted in place of the disk and clock spring, but not until the original device had proved its utility by producing several hundred of the spiral chucks.

New London, N. H. GUY H. GARDNER

DIFFERENT METHODS OF DRAWING A GIB

In reply to W. Butz's question in the April number as to the correct method of drawing a gib, his illustration *A* is considered correct. Since the side view is larger than the end view, the first glance at the former will give the determining impression to the workman. At *A*, the workman sees the extreme lines in the side view and he also sees two other lines, one solid and the other dotted. He at once realizes that there is something else to the gib which is not shown in the side view; then he will look more closely at the end view, obtaining at once the over-all dimension of ¾ inch and the necessary bevel.

In the illustration *B*, the side view appears somewhat similar to a rectangular bar and the workman is likely to take the size 5/8 inch and the size 3/16 inch without looking further, thus getting a bar that will be impossible to finish to the required size. Also he sees an angle of 60 degrees and is likely to waste some time in guessing how to chuck it to plane the bevels. If the workman has had no more education than that obtained in the sixth or seventh grade, he will be at a loss to know how to figure out the complement of the angle 60 degrees.

Illustration *C* brings the worst predicament of all. While at first glance, the side view appears identical with the corresponding view *A*, the dimensioning is vague and incomplete. The workman as a rule is not versed in trigonometry, even if he has had training in that subject in the schools, owing to the fact that he has little use to handle that subject in his work. Taking the dimension of 11/16 inch, he will potter around making sketches in order to obtain the missing dimension on either side.

Draftsmen often take for granted that the workmen has had an education equal to his own. But the workmen, as a rule, are recruited from the sons of men already employed in the shops, and at the age of fifteen or sixteen years, so that their education is necessarily incomplete. The simpler the drawing is, with complete dimensions accurately placed, the quicker and more correctly will the workman grasp the idea of what is intended to be made.

Dallas, Tex. SIDNEY HETHERINGTON

HOW ANOTHER PIECEWORK RATE WAS SMASHED

I have enjoyed reading the short article in the April number of MACHINERY, entitled "How a Piecework Rate was Smashed," and am tempted to write of my own experience with a piecework job. While working as a bench hand in a factory making various electric recording instruments, I was given the job of straightening some very thin aluminum tubes about 1/8 inch in diameter and 6 inches long. These tubes were used to convey ink to the pen of the instrument and had to be absolutely straight. The foreman and best mechanics had studied over the job each time a lot came through, but the best method they could find was to roll them between two surface plates. The tubes were so thin, however, that many of them were crushed; indeed it was not unusual to spoil 20 per cent of the work.

Well, I was given this job at a price of 25 cents per hundred and started to work. It seemed as though I spoiled every other tube. I then began to experiment. Finally I hit upon the idea of holding one end of the tube in the spring chuck of a bench lathe, starting up the lathe and then drawing my hand along the tube to the end. The result was a perfectly straight tube in an instant. I finished the lot of 4000 in about six hours; also taking care that the "boss" did not see my method. Then I took the work up to him.

He nearly collapsed when he looked at the pile of finished tubes and saw only a dozen or so broken. He rolled them back and forth to see if they were really straightened. Then he asked how I had done the job. This was where my trouble commenced, for I would not tell how I did the work, or submit to a cut, so I was allowed to resign. I got my $10 for six hours' work, but I never found out whether or not the company discovered my method. Some of the workmen knew it and I suppose they told after I left. J. A. D.

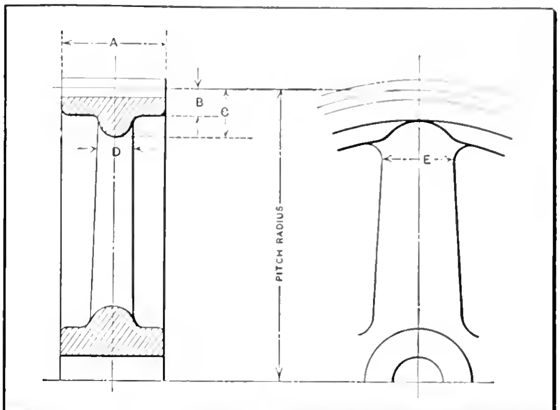
DIMENSIONS OF SPUR GEAR RIMS IN RELATION TO THE PITCH

I have to sketch and estimate the weight of a great many spur gears in the course of a year, and to facilitate this work I have prepared a table covering the thickness of rim, the depth of the bead inside the rim, and the breadth and thickness of the outer ends of the arms of the gear. This table, which is presented herewith, is very useful to me and I offer it in the hope that it may be of service to other readers of MACHINERY. It will be seen that the sizes are given in connection with both the circular and diametral pitch of the teeth, as well as the correct face width for each pitch.

In many cases the information furnished to the designer is very meager, and in the case of gearing this is particularly true. To the lay mind, a gear wheel is "about so big and has a certain number of cogs." This paucity of specific information in regard to matters of fundamental importance is the bane of the designer's life. If, however, he is fortunate enough to be given the horsepower, speed and approximate diameter of the gears, the accompanying table will be found useful. Experience alone will teach the designer the most satisfactory pitch to assume for a given set of conditions, but reference to the table will show the correct face width of the gear for the pitch assumed. The designer is now ready to figure the horsepower which the wheel will transmit. Lewis' formula is as good as any and better than some formulas that are in quite general use.

Reference to the table will now enable him to determine the thickness of the rim and the size of the bead and arms of the pulley. In the matter of estimating the weight of the gear, the use of the table eliminates about one-half the calculation that would otherwise be necessary. The number of cubic inches of metal having been found, this is multiplied by the constant 0.27 in the case of cast iron and 0.29 for steel, the result being the weight of the gear in pounds. The usual constants for the weights of a cubic inch of iron and a cubic inch of steel are 0.26 and 0.28, respectively. Experience has shown me, however, that the higher constants are more accurate for gear work, taking care of the excess weight resulting from rapping the pattern in molding. In very large gears, with arms of I-section, made with cores, allowance must also be made for the core shrinkage and consequent thickening of the metal sections. In large gears this allowance often amounts to between 150 and 200 pounds. The fillets in large gears should be figured separately by referring to MACHINERY'S Data Sheet No. 59, and the result obtained added to the weight of the gear as figured from the table.

DIMENSIONS OF SPUR GEAR RIMS IN RELATION TO THE PITCH



Circular Pitch, Ins.	Diametral Pitch	A	B	C	D	E	Circular Pitch, Ins.	Diametral Pitch	A	B	C	D	E
3/4	4	1 3/4	11/16	1 1/4	3/4	1 5/8	2	1 1/2	6	1 15/16	3 1/4	2 1/4	4 1/4
7/8	3 1/2	2	3/4	1 3/8	7/8	1 7/8	2 1/4	1 3/8	7	2	3 1/2	2 1/2	4 3/4
1	3	2 1/2	15/16	1 1/2	1	2 1/8	2 1/2	1 1/4	7 1/2	2 1/8	4	2 3/4	5 3/8
1 1/8	2 3/4	3	1	1 3/4	1 1/8	2 3/8	2 3/4	1 1/8	8	2 1/4	4 3/8	3	5 7/8
1 1/4	2 1/2	3 1/2	1 1/8	2 1/8	1 1/4	2 5/8	3	1	9	2 5/8	4 3/4	3 1/4	6 1/2
1 3/8	2 1/4	4	1 5/16	2 3/8	1 1/2	3	3 1/2	7/8	10 1/2	3 1/8	5 1/2	3 3/4	7 1/2
1 1/2	2	4 1/2	1 3/8	2 1/2	1 5/8	3 1/4	4	3/4	12	3 3/8	6 1/4	4 1/4	8 1/2
1 3/4	1 3/4	5 1/2	1 9/16	2 3/4	2	3 3/4	..	..	..	..	..	..	..

Machinery

Oakdale, Pa. EDGAR H. TRICK

PATENTABLE INVENTIONS

The address of Prof. Hutton, referred to in the April number of MACHINERY, appears to discuss two distinct topics: "Data" is the subject of the first three basic questions propounded; and "Patentable Inventions," the subject of the

fourth basic question. The distinction between these subjects is quite clearly brought out by the judicial opinion in Fuller & Johnson Co. vs. Bartlett, 68 Wis. 73, a recognized case concerning the relation of employer and employe as regards patentable inventions. The opinion reads: "The mere fact that in making the invention an employe used the materials of his employer, and is aided by the services and suggestions of his co-employes and of his employer in perfecting and bringing the same into successful use is insufficient to preclude him from all right thereto as inventor. The same is true of an invention conceived wholly by an employer and then perfected under his supervision by the aid of the mechanical skill of his employes. These propositions are sanctioned by numerous adjudications."

"The difficulty with the contrary assumption arises from confounding the machine with the invention which it embodies. Of course there must be a machine that will operate before it can be patented. That implies material, workmanship and skill combined. But such combination, of itself, is not enough to secure a patent. It must also embody an original conception of a new and useful method of doing a specific thing. It is this conception, so embodied, evolved from the inventive faculties of the inventor which constituted the invention in question. The law gave him the exclusive property in it. He still retains it except in so far as he has parted with it or agreed to part with it. The material, workmanship and skill which embodied the invention remain the property of the plaintiff (the employer). The workmanship and skill are both the results of instruction, experience and knowledge. They are acquired by being learned. They may aid and stimulate invention, but are no part of it."

The Federal Supreme Court and other courts have decided, even where one is employed to perfect, improve and to develop new devices, that the employer can acquire no exclusive title to inventions made by the employe in the course of the latter's employment, unless the employe is bound by a specific contract to assign such inventions. (Besides the above noted case see also Hapgood vs. Hewitt 119 U. S. 226; Barber vs. National Carbon Co. 64 C. C. A.; Slemmers Appeal 58 Pa. 155.) If the person who is engaged to improve and to develop new devices is privileged to hold title to such inventions, how much more should the subordinate be entitled to his own inventions and to whatever advantage he may secure through them, when such inventions are made entirely outside of his sphere of action—services not contemplated in his contract of hire. The reference data, including drawings, appear to partake of those attributes—material, training, knowledge, skill—which the court said belong to the employer.

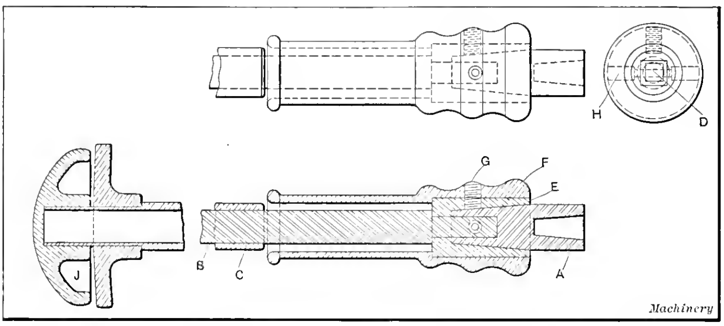
If the principles above set forth are controlling, then the six reasons back of the ethical practice suggested by Prof. Hutton have no application to his fourth basic question. If a draftsman really *invents* something of value to his employer, the latter should not feel that he is being "held up" because that employe invokes his legal rights to secure the best advantage from his creation. If the invention is so important that the employer's operations are literally "held up" for the lack of it, it certainly must be worth something more than the weekly stipend of the draftsman, which would probably have continued even though no invention had been made. It should be gratifying, at least, that the improvement had been made by an employe rather than by a competitor.

Upon what theory does the possession of ample resources or of an adequate plant entitle an employer to the fruits of an employe's inventive creations? The resources may be running to waste and the plant may be dying of dry rot. An employe who devises an improvement or creates a new output which turns the waste into channels of usefulness is as much entitled to a share in the returns which he has produced as the man who helps a weak concern to its feet by supplying necessary capital. Why should not employers subscribe to a code of ethics which embodies a professional obligation not to appropriate the valuable inventions made by their employes?

Central Falls, R. I. EDWIN C. SMITH

SAFETY DEVICE FOR LIGHTNING SCREW-DRIVERS

The present forms of "lightning" screw-drivers are much faster and handier to use than a common screw-driver, but the designers and manufacturers of these tools have overlooked an important feature. Men who have to use these screw-drivers are continually pinching their hands in them, and to avoid these small but painful accidents it was suggested that some sort of guard be developed. The accompanying illustration shows the upper and lower ends of the screw-driver in which the tool-holder is marked *A*. This tool-holder is fastened to the driving screw *B* by means of a small pin *D*. The tool-holder *A* revolves in a brass sleeve *E* which is fastened in the aluminum guard and handle *F* by the grub screw *G*; this screw passes through the sleeve and guard holding them firmly together. The hole shown at *H* allows the pin *D* to be driven in or removed when it is necessary to take the tool apart.



Cross-sectional View through Screw-driver showing Safety Device and Aluminum Handle

The sleeve *C* comes down to the lower handle and is the part which was formerly responsible for pinching the workman's hand. This has been overcome by the provision of the guard *F* which allows the sleeve *C* to move inside it. This guard has been thoroughly tested and has proved satisfactory in every respect; it takes up very little room and makes the tool only a trifle heavier than one with a wooden handle. In addition to the protection afforded, the guard is the means of increasing the speed with which the operator works, as he is not afraid of pinching his hand in the screw-driver. The illustration also shows the upper handle of the tool which is usually made of wood. If the screw-driver happens to fall on the floor, the wooden handle is likely to break and cause a lot of trouble in patching up the broken handle or making a new one. To avoid this difficulty, an aluminum handle has been substituted in place of the wooden one. It will be seen that the handle is recessed at *J* in order to reduce the weight.

Grand Rapids, Mich. GEORGE H. HAMILTON

* * *

APPROPRIATION FOR MUSEUM OF SAFETY

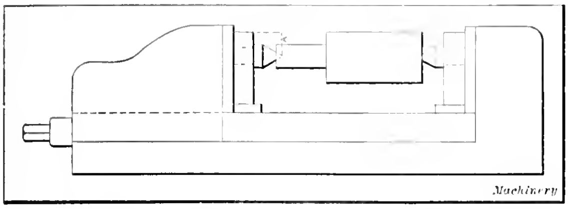
The American Museum of Safety, an institution devoted to the safety, health and welfare of industrial workers and the advancement of science and industry, with headquarters in New York City, has been placed on a footing with the Metropolitan Museum of Art and the American Museum of Natural History by the New York Legislature, which has authorized the Board of Estimate of New York City to contribute not more than $50,000 yearly to the expenses of the museum. Eventually the trustees hope to erect a noble building in which to house the museum's exhibits of safety appliances, anatomical models, occupational dusts, charts, photographs, slides, etc. The museum has a special charter from the State of New York and this latest substantial recognition of its usefulness indicates that its dream may be realized in the not distant future.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

SHAPER CENTERS

In a great many shops shaper centers are not always available, and often, when they are, they cannot be used for work that should be shaped on centers, on account of the shank of the work being too short to leave room for a dog. The accompanying illustration shows a pair of centers which work very satisfactorily, being especially suitable for machining small blanking punches where the punch is shaped right

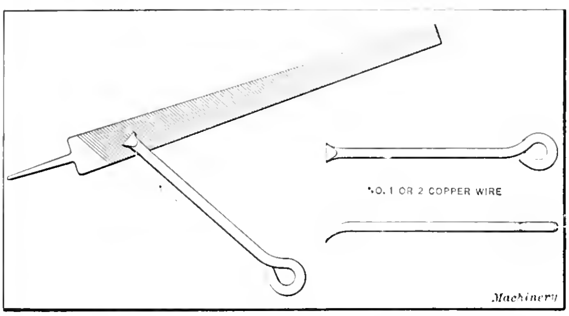


A Useful Form of Centers for Use on the Shaper

up to the shank. These centers may not look practical to many people on account of the work having a tendency to slip, but experience showed that they stood up satisfactorily under a 1/8-inch chip 2 inches from the center. This cut was taken without clamping the jaws much tighter than would be necessary for holding work between the jaws of a vise. Another good point is that in shaping different polygons, a protractor or square can be set on the bed of the vise and the side of the work, thus enabling the operator to proceed without resorting to the use of cut-and-try methods. The distance *A* on the drawing should be made an even fraction of an inch—say 1/2 inch or 3/4 inch—as this helps greatly in setting the tool. C. G.

FILE CLEANER

An excellent file cleaner can be made by flattening a piece of No. 1 or No. 2 copper wire, and bending the flat side over as shown in the accompanying illustration. An eye is formed at the other end to provide a handle, and the flat end is



Efficient Form of File Cleaner made of Copper Wire

ground down to a thickness of about 1/32 inch. This sharp edge is pressed on the file and moved back and forth in the direction of the milling. It soon takes the impressions of the milling and cleans out all residue that is held in the teeth.

Downieville, Cal. CLARENCE I. SIMMONS

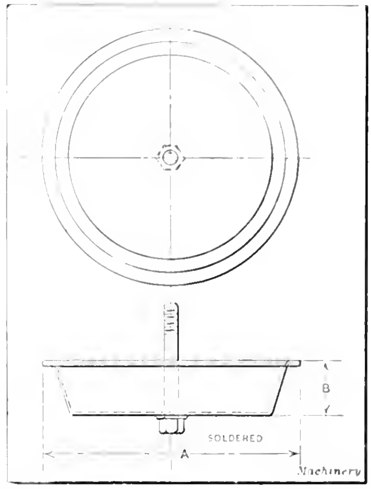
SPACING LETTERING AND SECTION LINES

In the January number of MACHINERY, R. F. Pohle describes a very good method of spacing the section lines on drawings. I have had experience with another method of doing this work which I consider even better than the one described by Mr. Pohle. I take a Starrett V-thread gage which can be obtained with any number of divisions to the inch from six to sixty, inclusive, so that any desired spacing can be obtained. The gage is pressed onto the paper and leaves impressions in which the point of the pencil is located preparatory to drawing each section line. The lines are drawn with a T-square and triangle in the usual way. I have used this method for a number of years and thought that it might prove of value to readers of MACHINERY. The gages are not expensive so that a draftsman can afford to buy those having the spacings which he has occasion to use quite frequently. They are of compact form so that they occupy very little room in the instrument case.

Los Angeles, Cal. GUSTAV STEINKE

DRIP-CUP FOR COUNTERSHAFTS

In most factories an oil-cup is fastened to each hanger or countershaft to catch surplus oil and prevent it from dripping onto the floor. These cups are usually cast-iron devices which are cumbersome and have been known to injure men passing underneath, owing to the cup having worked loose through vibration. I recently saw a drip-cup made of sheet metal which seems to meet all requirements without having the objectionable features of the cast-iron cups. Reference to the accompanying illustration will show that this cup is fastened to the hanger by a bolt and it is made of such light material that the tendency for it to work loose through vibration is practically eliminated. The diameter *A* and depth *B* of the cup can be made to suit the requirements of individual cases. Thousands of these cups are in use in the factory referred to and they have been found to be entirely satisfactory.

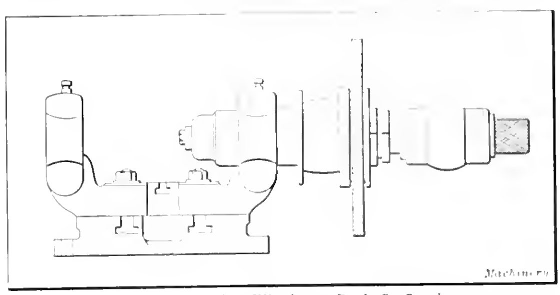


Sheet Metal Drip-cup for Use on Countershafts

G. A. A.

CHANGING WHEELS ON B. & S. GRINDERS

It is frequently necessary to change the wheels on a grinding machine to meet the requirements of different classes of work, and unless the operator is careful the wheels are likely to be broken. The writer has found that by clamping one bearing in the grinder stand—allowing the arbor to over-



Method of changing Wheels on B. & S. Grinders

hang—rigid support is provided and both hands are free for use in removing one wheel and mounting a new one in its place. The idea is clearly shown in the illustration without requiring further description.

Bristol, Conn. LEWIS L. LEIGH

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO ROLL ROUND TUBING TO OVAL SHAPES WITHOUT BENDING OR TWISTING

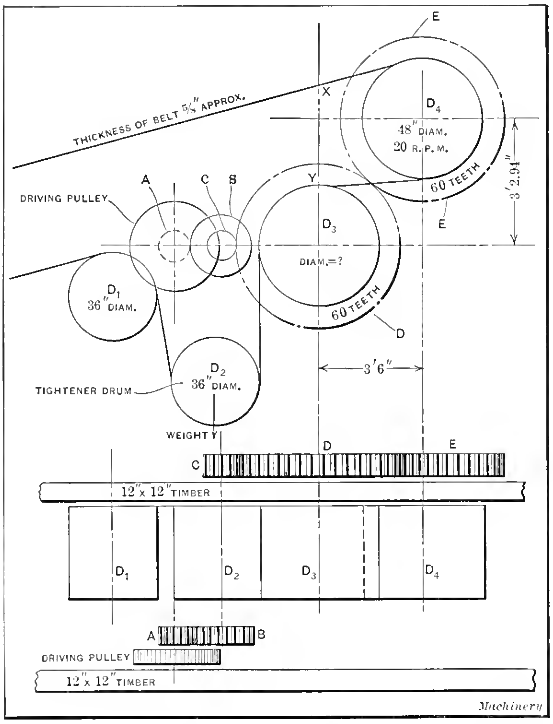
K. G.—Can you tell me how to roll round tubing to an oval shape without bending or twisting? The tubing is 22 gage by ½ inch diameter. We force it through a set of rollers which can be set to the size desired.

The question is referred to the readers for suggestions.

BELT CONVEYOR PULLEY DIAMETERS

O. E. B.—The illustration shows drums and gearing designed to drive a belt conveyor 430 feet long center to center, rise 4½ inches per foot and carrying approximately 600 tons of stone per hour. In order to get proper belt contact without excessive diameters of head drums, the construction shown was adopted. The driving pulley is mounted on the same shaft as gear *A* and drives the drum D_4 through the train of gears *A*, *B*, *C*, *D* and *E*. The gears *D* and *E* are of the same diameter and the belt is approximately ⅝ inch thick. The question is, should the drum D_3 be larger than D_4 or not? If larger, how much so? I believe that D_3 should be slightly larger than D_4 but cannot decide how much. If we assume that the speed of a point about a center varies as the distance from that center, it follows that a point on the inside of a belt travels 6.65 feet slower per minute than a point on the outside when D_4 makes 20 revolutions per minute. The speed on the inside is approximately 251 1/3 feet and the speed on the outside about 258 feet per minute.

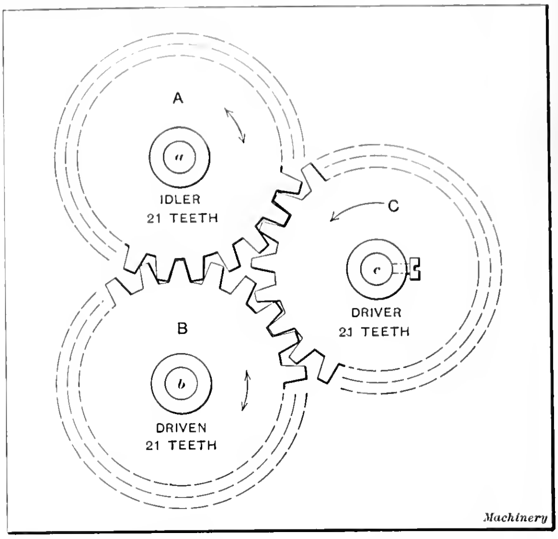
A.—The diameters of drums D_3 and D_4 should be the same. The fact that D_3 drives the belt from one side and D_4 from



the opposite side need not be taken into consideration. The speed of the belt should be figured on its pitch line, that is the center line of the belt. The belt theoretically travels at the rate expressed by $2\ (R + t) \times 3.1416 \times$ R. P. M. in which *R* is the drum radius and *t* one-half the belt thickness. This travel rate evidently should figure out the same for both drums; hence, both drums should be of the same diameter.

REVERSING GEAR

W. E. D.—The illustration shows a reversing gear in which the three gears have the same diameters and numbers of teeth—21. *C* is the driving gear; *B*, a driven gear and shifting gear; and *A*, a shifting gear. *A* and *B* are always in mesh and one or the other is slid on the shaft into mesh with *C*. I desire to make gears *A* and *B* smaller than *C* and would like a formula for determining the diameters and numbers of teeth of *A* and *B* which will have the same relation to *C* as they have in the illustration. In other words, I wish to



shift *A* or *B* into mesh with *C* without changing the angular positions of the gears.

The problem is submitted to the readers for discussion.

DESIGN OF CRANE-LADLE HOOKS AND TRUNNIONS

J. P. P.—The accompanying illustration Fig. 3 shows a crane-ladle with cast steel trunnions riveted to it, these trunnions being engaged by cast steel crane hooks. The total weight of the ladle when filled with molten steel is 120,000 pounds. I would like to see the results of calculations to determine the required diameter *d* of the trunnions and the dimensions d_1 and *t* of the crane hooks. What I would particularly like to know is the approved method of making these calculations. I was recently called upon to design trunnions and hooks for this ladle and have worked the problem out, but would like to check my results.

Answered by William L. Cathcart

The crane hook engaging each trunnion carries a load of $120{,}000 \div 2 = 60{,}000$ pounds. The ladle and its trunnions may be considered either as a simple beam, supported by the hooks and loaded at the inner ends of the trunnions, as in Fig. 1; or each trunnion may be regarded as a cantilever, supported at the ladle and bent upward by a force $P = 120{,}000 \div 2 = 60{,}000$ pounds. In either case, the bending moment *M* at the trunnion support is equal to the product of *P* and its distance from that support. The total length of the trunnion is given as 4½ inches, which would make *P* act at a distance $p = 2\frac{1}{4}$ inches from the support. The trunnions are to be of cast steel. In some very carefully conducted tests of this metal, Prof. Bach of Stuttgart* found an elastic limit of 33,467 pounds per square inch and an ultimate tensile strength of 61,543 pounds per square inch. In the calculations given below, an allowable working stress of 10,000 pounds per square inch is used, that is, the factor of safety is 6. Under the downward thrust of the weight and the upward pull of the hook, the trunnion bends upward, being thus in tension on the lower side and in compression on the upper. The general formula for bending at any section of the trunnion is $M = SI \div c$, in which $M =$ bending moment at the section considered = moment at the support, as above; $S =$ allowable working stress; $I =$ moment of inertia of the cross-section of the trunnion at that point; and *c* the distance of the most remote fiber of that cross-section from the neutral axis, which axis lies in the plane of the

* Zeitschrift des Vereines deutscher Ingenieure, June 10, 1899.

cross-section and passes through its center of gravity, that is, through the center of the trunnion.

For a trunnion 4½ inches long and of diameter d, $p = 2\frac{1}{4}$ inches and $M = P \times p = 60{,}000 \times 2.25 = 135{,}000$ inch-pounds. Substituting this value in the formula, as above, and $I = \pi d^4 \div 64$, $c = d \div 2$, and $S = 10{,}000$ pounds per square inch:

$$135{,}000 = 10{,}000 \times \frac{\pi d^4}{64} \times \frac{2}{d}$$

$$d^3 = 137.5$$

$$d = 5.16 = 5\frac{3}{16} \text{ inches (approximately).}$$

For other lengths of trunnions, the diameters computed in this way are given in Table I. In machine members subjected to repeated shocks, factors of safety of 10 for wrought iron and 15 for steel are frequently used. A fairly high factor—possibly greater than 6—is advisable in this case; first, because the trunnions are to be castings, a condition which always involves some uncertainty—although this element is decreasing with the progress in heat-treatment—and, second, because they may at times be suddenly overloaded either in emergency or through careless handling. For example, if the full ladle were lifted very quickly, its weight would become a suddenly applied load having, in strain and stress, twice the effect of a static load. Again, if the ladle while lowering were suddenly checked, its kinetic energy would produce an additional and suddenly applied load whose magnitude would depend on the velocity of descent and might be relatively large. Finally, the trunnion is abraded and worn by the hook at the middle.

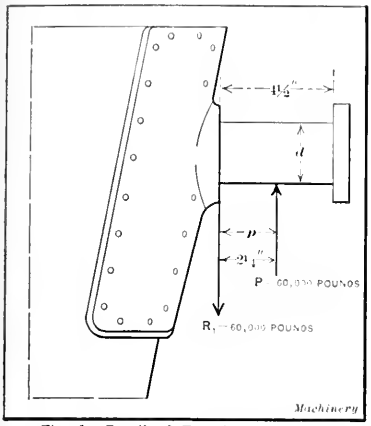


Fig. 1. Detail of Trunnion attached to Crane Ladle

Dimensions of the Crane Hook

Practice as to dimensions of crane hooks varies considerably. Taking an allowable stress of 10,000 pounds per square inch, there are given in Table II the desired dimensions, computed from the formulas of A. E. Holcomb, as stated in Kent's "Pocketbook," 1912. The tabulated trunnion lengths are those for which the diameters were calculated. The extreme width b of the hook, Fig. 2, plus the clearance, is the factor that determines which of these lengths is practicable. It will be seen that, according to these formulas and with this working stress, it is not possible to design a 30-ton crane hook for a trunnion 4½ inches long, when both are of cast steel. Under average conditions of service, the working stress for cast steel hooks of this size should not exceed 11,500 pounds per square inch, while that of wrought iron may be 17,500 pounds per square inch, and 23,000 pounds per square inch has been used for hammered steel. The hook meets the same shock and sudden overload as the trunnion. A low working stress in the latter makes the diameter large; a large diameter increases the leverage of the load on the hook, and, as a consequence, the width and depth of the latter. Further, the calculations assume the load to be central, that is, on the vertical line passing through the center of the opening. If the hook is inclined and the load is farther than this from the rear of the hook, its leverage will be increased. The dimensions of the first three hooks have been given for comparison; the last will meet the conditions with a trunnion length of 6 inches and very limited clearance.

TABLE I DIMENSIONS OF TRUNNIONS AND VALUES OF BENDING MOMENTS

Length of Trunnion, Inches	Bending Moment, Inch-pounds	Diam. of Trunnion d, Inches
5	60,000 × 2.5	5⅜
5½	60,000 × 2.75	5½
6	60,000 × 3	5 11/16

Machinery

The dimensions in Table III have been calculated for cast steel trunnions and hooks of hammered steel, using a working stress for the latter of 15,000 pounds. With the trunnion lengths given these hooks would serve.

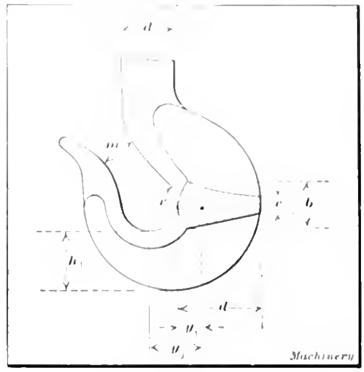


Fig. 2. Diagram of Crane Hook showing Required Dimensions

Maximum Stress in Crane Hooks

The dangerous section of a crane hook is that cut from the back by a plane passed horizontally through the center of the opening; and the maximum stress in that section occurs at the point nearest the center of the hook. The width m of the entrance to the opening is usually three-fourths the diameter of the latter, and should be just great enough to pass readily the rope, chain, or trunnion which the hook is to engage. Therefore, this width determines the radius r of the opening. If the load is central, its eccentricity or leverage is the horizontal distance from the center of the opening to the center of gravity of the dangerous section. Since this leverage should be as low as possible, the radius r should be as small and the inner side of that section (trapezoidal) as wide as practicable, in order to bring the center of gravity of the

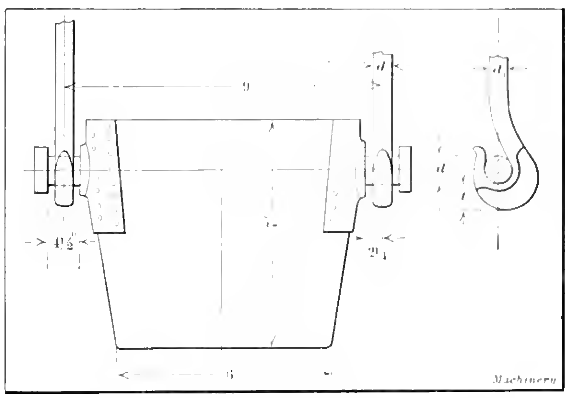


Fig. 3. Crane Ladle for which Dimensions of Trunnions and Crane Hooks are required

section as near as may be to the center of the opening. Until within a comparatively recent period, there has been no accurate theoretical analysis of the relations of these various dimensions. As a consequence, designers have been compelled to trust to formulas based partly on rational and partly on empirical grounds. Experience gained in practice has necessarily been the main reliance, since theory has supplied only the principles governing the action of an eccentric load on a straight bar.

In recent years the true stresses in a curved bar have been analyzed by Prof. C. Bach, of Stuttgart, and more completely by Prof. Karl Pearson* and E. S. Andrews of London University. Practical tests for the investigation of the truth of the theory of Pearson and Andrews have been made by Prof. John Goodman† of the University of Leeds and by Prof.

* "Theory of the Stresses in Crane and Coupling Hooks." Published by Dulau & Co., London.
† Proceedings of Institution of Civil Engineers, Vol. CLXVII.

Walter Rautenstrauch* of Columbia University. In testing a crane hook, the width m as marked in Fig. 2 of the entrance to the opening of the unloaded hook is first measured with the utmost possible accuracy. Then, gradually increasing loads are applied to, and removed from, the hook. Between each of these successive loadings the dimension m is measured. Finally, a limit is reached at which it is found that the measurement taken does not coincide with that of the unloaded hook, that is, that the point of the hook has not sprung back to its original position after the removal of the load, and hence that permanent set has occurred, the last load applied having exceeded the elastic limit of the metal at the point of maximum stress in the dangerous section. In the investigations noted above, there was found a marked agreement between the elastic limits of the hooks tested, as shown by actual loads in the testing machine and as computed from the Pearson-Andrews formula. Prof. Rautenstrauch gives the results presented in Table IV for hooks received from a number of manufacturers.

TABLE II. DIMENSIONS OF THIRTY-TON CAST STEEL CRANE HOOKS

Working stress 10,000 pounds per square inch

Trunnions		r	m	d	b	c	d_1	h_1
Length, Inches	Diameter, Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
4½	5 3/16	3½	5 5/16	8½	5 5/8	1 7/8	4 1/4	6 1/4
5	5 3/8	3 5/8	5 1/2	8¾	5 13/16	1 15/16	4 3/8	6 3/8
5½	5 1/2	3¾	5 5/8	8¾	5 13/16	1 15/16	4 3/8	6 7/16
6	5 11/16	3 7/8	5 13/16	8 7/8	5 7/8	1 15/16	4 7/16	6 1/2

Machinery

This table shows, in most cases, a practical agreement between this theoretical elastic limit and that given by test. For the larger hooks, with one exception, it indicates also that, for their rated capacity, the factor of safety is absent—a result which is due unquestionably to the use of a formula for the stress in a straight bar as the fundamental basis of their design. These tests and those of Prof. Goodman were made about four years ago, and progressive makers have doubtless considered them in their designs. It appears, then, that the Pearson-Andrews analysis, the application of the theory of the stresses in a straight bar to those in a curved bar, like a crane hook, will give inaccurate results, the magnitude of the error increasing with the curvature of the bar. This error seems to be due mainly to the assumption of a uniform distribution of the stress due to tension, while, on the contrary, the theory shows that the intensity of this stress is relatively great at the inner side of the section and decreases rapidly toward the outer, being analogous in this respect, as Prof. Goodman has pointed out, to the stresses in a thick cylinder subjected to internal fluid pressure. This increase in the tension at the point of maximum stress would account largely for the reduction in the assumed factors of safety of the old method. While this theory has been criticised somewhat adversely by a few authorities, the results of the tests cited above make it advisable to test the dangerous section of the proposed hook by the Pearson-Andrews formula:

TABLE III. DIMENSIONS OF THIRTY-TON HAMMERED STEEL CRANE HOOKS

Working stress — 15,000 pounds per square inch

Trunnions		r	m	d	b	c	d_1	h_1
Length, Inches	Diameter, Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
5	5⅜	3⅝	5½	7 3/8	4 7/8	1⅝	3 11/16	5 3/8
5½	5½	3¾	5⅝	7 7/16	4 15/16	1⅝	3 3/4	5 7/16

Machinery

$$S_t = \frac{W}{A}\left\{\frac{y_o}{R_1 F_2}\left[\frac{1}{\left(1-\frac{y_1}{R_1}\right)^{\frac{5}{4}}} - F_1\right] + 1\right\}$$

* Transactions of American Society of Mechanical Engineers, Vol. XXXI.

Referring to Fig. 2, the notation in the preceding formula is as follows:

S_t tensile stress, in pounds per square inch, at point of maximum strain in the cross-section;
W load on hook in pounds;
A area of cross-section in square inches;
y_o distance from load line to center of gravity of cross-section;
R radius of gyration of cross-section;
R_1 radius of curvature at center of gravity of cross-section. Usually in hooks, $R_1 = y_o$.
y_1 distance from center of gravity of cross-section to point of maximum tensile stress;
F_2 a function whose value, for the usual hook sections, Prof. Goodman gives as $\frac{Ry_1}{1.2 R_1^2}$;
F_1 a function whose value Prof. Goodman gives similarly as $1 + 1.1 F_2$.

This formula is more tedious than difficult in its application. For example, take the hammered-steel hook for a trunnion 5½ inches in diameter, whose dimensions are given in Table III. For this hook, $r = 3¾$ inches, $d = 7\ 7/16$ inches, $b = 4\ 15/16$ inches, and $c = 1⅝$ inch. For simplicity, neglect the curvature of the inner and outer sides of the section of the hook, although in designing, this curvature should be carefully considered. Neglecting it, we have:

$$A = d(b + c) \div 2 = 24.4 \text{ square inches.}$$
$$W \div A = 60{,}000 \div 24.4 = 2459$$
$$y_1 = d(b + 2c) \div 3(b + c) = 3.1 \text{ inches.}$$
$$y_o = y_1 + r = 6.85 \text{ inches}$$
$$R = \sqrt{\frac{d^2}{18} \times \frac{(b^2 + 4bc + c^2)}{(b + c)^2}} = 2.04$$

Taking $R_1 = y_o$:

$$F_2 = (Ry_1) \div 1.2y_o^2 = 0.11$$
$$F_1 = 1 + 1.1F_2 = 1.121$$
$$y_o \div R_1F_2 = y_o \div y_oF_2 = 1 \div F_2 = 9.1$$
$$1 - y_1 \div R_1 = 1 - y_1 \div y_o = 0.54$$
$$(0.54)^5 = 0.0461$$
$$\sqrt[4]{0.0461} = 0.46 = (0.54)^{\frac{5}{4}}$$

Substituting the required values in the formula, we have

$$S_t = 2459\left\{9.1\left[\frac{1}{0.46} - 1.121\right] + 1\right\}$$

= 25,955 pounds per square inch.

The Pearson-Andrews formula thus gives a maximum tensile stress which is 73 per cent greater than the working stress used in designing this hook. This maximum stress is, however, for the designed load, well within the elastic limit of the metal, which should be at least 50,000 pounds. With a suitable factor of safety, the formulas used in this case for the tabulated dimensions of hooks will give sufficient strength.

TABLE IV. TESTS OF CRANE HOOKS—LOADS AT ELASTIC LIMIT IN POUNDS

Rated Capacity, Tons	Material	Capacity by Test, Pounds	Capacity by Pearson-Andrews Formula, Pounds
30	Cast steel	56,000	55,080
20	Cast steel	30,000	29,925
15	Cast steel	48,000	50,750
15	Wrought iron	16,000	15,000
10	Cast steel	18,000	16,500
10	Wrought iron	16,000	15,000
5	Cast steel	18,000	18,950
5	Wrought iron	14,000	14,100
3	Cast steel	8500	8600
2	Cast steel	4700	4400

Machinery

* * *

Gas flames are used to burn the fuzz from the thread or yarn used in knitting stockings. The yarn is passed through the flame at the rate of 300 feet a minute. The singeing process makes the yarn soft and silky, giving the stockings a smoother and more highly finished appearance than would be possible without it.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

DETRICK & HARVEY PLANER

The accompanying illustrations show a large open-side planer built by the Detrick & Harvey Machine Co., Baltimore, Md. Reference to these illustrations will show that the machine is equipped with an auxiliary housing by means of which it may be converted into a planer of the usual form. Fig. 1 shows the machine equipped as an open-side planer; and in Fig. 2, the auxiliary housing is shown set up in place, this illustration showing the machine operating as a standard planer. A good idea of the arrangement of the drive will be obtained by referring to the side view of the machine shown in Fig. 3. The capacity is for work up to 96 inches high by 132 inches wide between the housings, and work up to 24 feet in length can be handled. When the auxiliary housing at the left-hand side of the machine is removed, the cross-rail is run back in its housing and the machine operated as a standard open-side planer. Operated under these conditions, the capacity is for work 96 inches high by 96 inches wide, and up to 24 feet in length.

The table is direct connected to the motor without the use of belting. The motor is of the reversing planer type and equipped with a contactor panel and master switch, two field rheostats, the necessary grid resistance and a pendant switch and circuit breaker. The cutting and return speeds may be independently adjusted. A 220-volt direct-current motor is used for raising and lowering the cross-rail. This motor is equipped with a reversing controller, a panel with a double throw switch and a contactor connected to the controller, so that the controller handle may be turned to the "off position" before the motor can be started after the failure of the voltage.

The planer bed is a massive casting with two V-ways and a flat way at the center. The bed has six longitudinal vertical ribs which extend the full length of the bed under the ways; these ribs are tied together at short intervals by double web girths of box section. The distance between centers of the V-ways is 70 inches. A bearing 10 by 102 inches in size is finished on the bed and the main housing is tongued and bolted to this bearing. The bed for the auxiliary housing is bolted to the side of the bed of the machine, and the upper surface of this auxiliary bed is brought exactly parallel with the ways. It is fitted with T-slots to which the housing is secured. The table is of the box type. The upper surface is carefully machined and the guides are fitted to the ways in such a manner that the table is always maintained perfectly level. T-slots and cored openings are provided for holding the work. The table is so constructed that chips are prevented from dropping into the openings in the bed. The table is driven by two forged steel driving racks, each of which has a face width of 9 inches. The reversing stops can be quickly adjusted to give any desired travel up to 24 feet.

Fig. 1. Detrick & Harvey Convertible Planer, with Auxiliary Housing removed for Use as an Open-side Planer

The main housing is of rectangular box section and provided with suitable connections for attaching the cross-rail housing and its braces. The auxiliary housing which carries the outer end of the cross-rail is of curved box section. It is possible to slide this auxiliary housing to and from the planer bed through a distance of 36 inches, this adjustment being made by hand. When the cross-rail and ties to the main housing are run clear, it is possible to remove the auxiliary housing without difficulty, in order to enable the machine to carry work of more than 132 inches in width. The cross-rail housing is attached to the main housing by

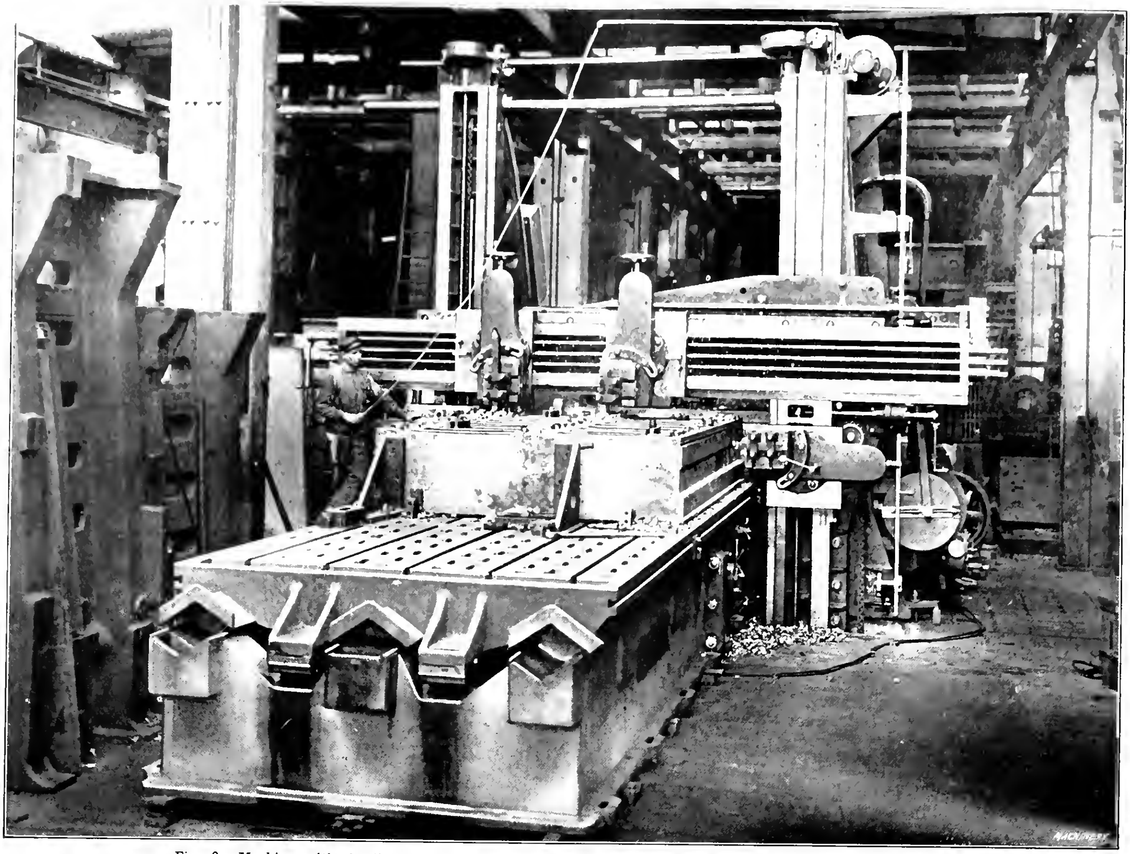


Fig. 2. Machine with Auxiliary Housing in Place, converting it into the Equivalent of a Standard Planer

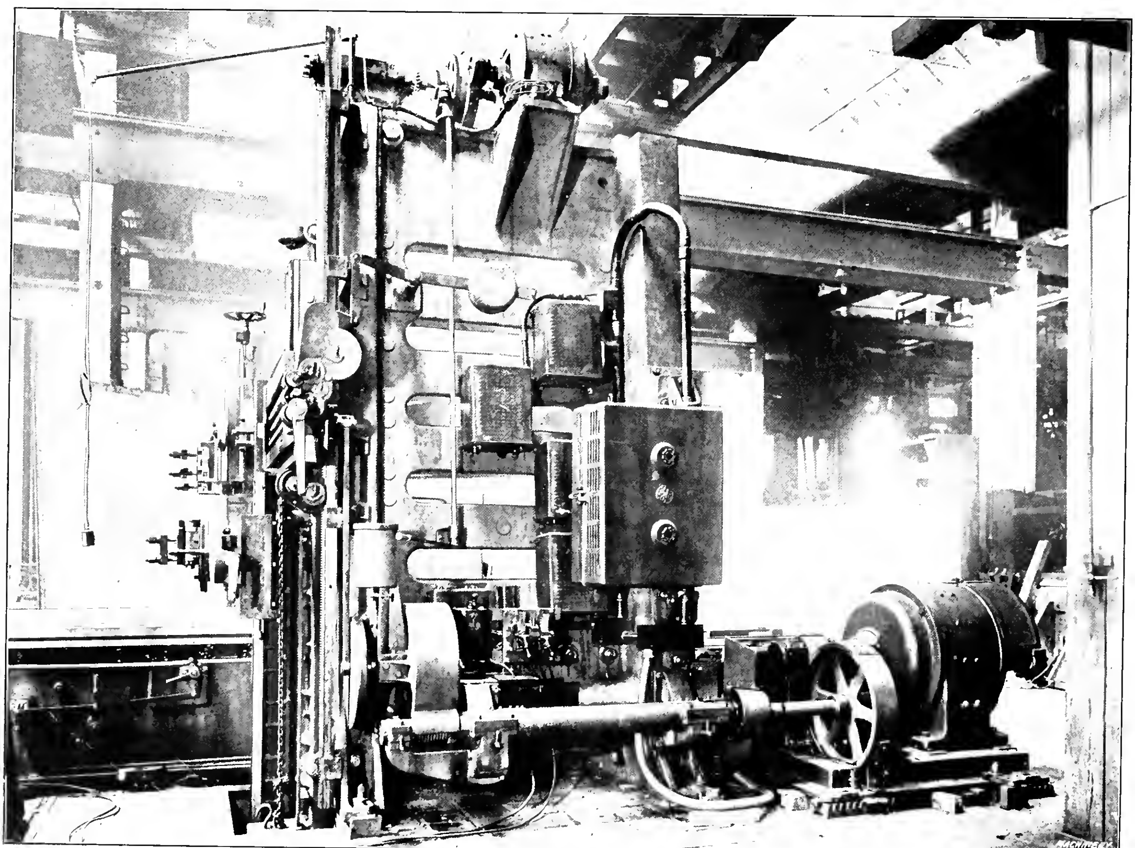


Fig. 3. Side View of Convertible Planer shown in Figs. 1 and 2 illustrating Arrangement of Drive

one vertical leg. This housing carries the cross-rail on its upper or horizontal leg. The vertical leg has a bearing of 12½ feet on the main housing, to which it is bolted. This vertical leg is faced to carry one of the side heads. The cross-rail is braced at the rear by a triangular casting extending back to the inner face of the main housing.

The cross-rail has a sliding fit in the housing to which it can be securely clamped in any desired position. It has a face width of 24¾ inches and carries two tool heads. The cross-rail can be run back through its housing by hand to clear the outer housing, when it is desired to operate the planer as an open-side machine. Four tool heads may be used, two of which are mounted on the cross-rail and one on each of the vertical housings. The heads on the cross-rail are equipped with independent automatic feed in all directions. The heads weigh about 1800 pounds each. The side heads have a vertical feed by hand or power of 96 inches with a horizontal adjustment of 22 inches. These heads are counterbalanced. The four heads are so arranged that they can be used simultaneously on work of any width which comes within the capacity of the machine.

The reversing motor is coupled to a shaft that is geared to two driving shafts. Each driving shaft is provided with a phosphor-bronze spiral pinion 21 inches long that engages a forged steel rack which is rigidly secured to the under side of the table. The steel bevel gears have a face width of 8 inches, and the face of the steel spur gears is 6 inches. The cutting speed is from 20 to 30 feet per minute and the maximum return speed, 60 feet per minute. The cross-rail is raised and lowered by screws geared to the smaller motor provided for this purpose. This motor also furnishes the power for the tool-head feeds through a positive friction device which only consumes power when feeding. The traverse of the cross-rail is obtained by screws driven by hand. The table, cross-rail and tool heads are equipped with suitable stops to prevent over-running. All of the gearing used in the machine is of steel or bronze and the control apparatus is located within easy reach of the operator.

This planer was subjected to careful tests in the manufacturer's shops before being shipped. A box-shaped steel casting about 3 feet square and 12 feet long was planed on three sides simultaneously. The four tools took the maximum cut with the maximum feed that is obtainable with modern high-speed steel. A finishing cut was then taken on the three sides and when calipered, the finished width of the casting did not vary more than 0.001 inch. The test piece was then turned over and finished on what had formerly been the under side. After completing this operation, the piece was again calipered, and it was found that the finished height did not vary more than 0.001 inch. These operations were conducted with the auxiliary housing in place, and after they were completed, this housing was removed and the same test conducted with the machine operated as an open-side planer. The results obtained were equally satisfactory.

"AMERICAN" HEAVY SERVICE SHAPER

The working efficiency of any shaper depends primarily upon its ability to perform all classes of work at the highest speeds and coarsest feeds practicable, and at the same time to produce a finished product of dependable accuracy. To obtain these results a shaper must combine ample power, rigidity and a suitable range of cutting speeds and feeds, with a high standard of workmanship. Therefore, the relative or comparative value of a machine of this type must be determined by a careful consideration of these features, both individually and collectively, the ultimate decision being given in favor of the machine in which these points are developed to the highest degree. When designing the new "American" heavy service shaper, these conditions were borne constantly in mind by the American Tool Works Co., Cincinnati Ohio, with the consequent result that the objectionable features of former designs have been superseded by new features of proven efficiency. The workmanship is of the same high standard that has characterized this company's products in the past, a complete system of jigs and templets being used, which insures accuracy of the highest standard, as well as the absolute interchangeability of parts. The limit of error allowed is only 0.001 inch up to the full capacity of the machine.

Power

One of the first points considered when laying out this new shaper was that of power input. The approximate power a shaper of this size would require for performing the heaviest classes of work was determined, and then sufficient extra power was added to provide a safe working margin. Consequently, this machine is provided with greater power than will ever be required for the average heavy work, and when doing such work it will not be constantly working up to the limit of its capacity. Before deciding on the stroke range, a very thorough investigation was made to determine the proper cutting speeds for metals of various kinds and lengths. As a result of this investigation, a range of eight strokes from 6.5 to 90 feet per minute was provided, this range being in geometrical progression and calculated to give the best results on all classes of work. It will be interesting to note here that while a wider range could easily have been furnished, it was found that a slower speed than 6.5 feet per minute is entirely unnecessary and a faster one than 90 feet per minute impracticable, on account of the excessive vibration caused by the rapid stroke and the undue wear on the machine. Therefore, by confining this range to productive limits a closer speed increment is obtained, which, in turn, gives the machine a higher working efficiency. The length of stroke may be easily changed at will without stopping the machine, the device for positioning the stroke being located on the ram near the head; and it may be operated while the machine is running. A pointer on the ram traveling along an index shows the length of stroke as set.

The Ram and Rocker Arm

The ram and rocker arm are of an improved design, which provides a very rigid and efficient construction. The rocker arm is rigidly connected to a pivot shaft at the bottom of the column, which supports all the weight of the arm and other parts, thus relieving the ram from any dead weight and eliminating undue vibration. The connection between the rocker arm and ram is by means of a double link which is arranged so as to pull down on the ram during the cutting stroke, thus tending to neutralize the upward thrust of the tool. The rocker arm is made in a complete U-section for its entire length and is further strengthened by heavy transverse and cross ribbing. The ram is very heavy and is designed for uniform rigidity throughout its entire length of stroke. It is thoroughly braced by internal ribs, and has long wide bearings on the column with a continuous taper gib having end screw adjustment for taking up the wear.

One of the most vital features of this shaper, and one which is absolutely essential to the life and accuracy of the machine, is the use of full length taper gibs for taking up the wear. These gibs are arranged for end screw adjustment, by means of which a perfect full length bearing can be constantly maintained and the rate of wear kept down to a minimum. The importance of this feature cannot be overestimated, for the rate of depreciation of a machine tool is directly proportionate to the rate of wear in its bearings. The full length taper gib undoubtedly affords a more efficient and convenient method of taking up wear than is provided with flat gibs, which require the use of a series of set-screws for adjustment. Full length metal-to-metal contact is impossible with the latter type of gib. Moreover, it is also very difficult to make the necessary adjustment. With this full length taper gib construction, the original degree of accuracy can be retained throughout the life of the machine, and a full length metal-to-metal contact is assured at all times.

The Cross Feed

The cross feed is both automatic and variable, providing a nicely graded range of thirty-two graduated feeds from 0.006 to 0.200 inch per stroke of the ram. Feeds can be changed and accurately set while the machine is running, by means of a conveniently located knurled knob. The feed is thrown in or out, and also reversed through a knob on the feed plunger. The reversal of the feed at the opposite end of the

ram stroke is accomplished by a plunger in the face of the swinging gear on the bonnet. This plunger engages either one of two holes in opposite sides of the gear. Whether the feed takes place at the beginning or end of the stroke depends upon which hole is engaged by the plunger. All parts of the feed mechanism are compact and present a neat and symmetrical appearance; and all of the gears in this mechanism are securely covered. An automatic safety device is provided, the connection between the feed mechanism and cross-feed screw being made by means of a fiber adjustable friction. This forms a "fool proof" feature which will protect the feed works from damage should the tool accidentally be fed into the cut, or the apron be fed into either end of the cross-rail. This fiber friction can be adjusted to

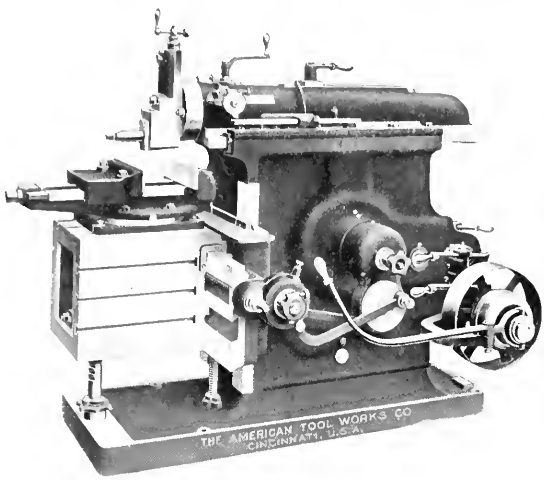


Fig. 1. Front View of American Heavy Service Shaper

pull the heaviest cut without slippage and it is not affected by atmospheric conditions, temperature, or the action of oil.

In order that the unusual power of this shaper may be utilized to advantage, every part of the machine has been designed to afford the greatest rigidity and to easily withstand the severe stresses that the use of this high power would impose upon the various parts. The column is unusually deep and wide, tapering slightly toward the top and giving the machine a neat, graceful and substantial appearance. It is strongly braced internally, the braces being so disposed as to meet the heaviest strains. The column is further reinforced outside on the line of strain, by a wide, deep rib cast integral with the wall. The top of the column projects at the front and rear and provides an exceptionally long bearing for the ram. The base is of large proportions, very deep and strongly ribbed, affording an excellent foundation for the machine. It is of the extension type, with a pad at the end to receive the table support. It is of pan construction both inside and out to catch oil drippings, thus protecting the floor and foundation. Means are provided for draining off the oil collected on the inside.

The Table

The table is made in a complete box section, and is therefore not liable to spring or deflect when heavy work is bolted on its side. The T-slots are all planed from the solid; and the side slots are set in the horizontal plane, thus obviating the possibility of the work bolted to the side dropping down on the base when the clamping bolts are loosened. The top of the table extends over and bears upon the top of the apron, thus increasing its rigidity and preventing dirt from working down between the table and saddle. This construction also removes the strain from the clamping bolts and, at the same time, adds a considerable amount of working surface to the table. In order to further safeguard the bearings of the rail and column, a dirt guard of pan construction is fastened to the rail, which catches chips and dirt that might otherwise work into the bearings. Felt wipers are provided on both ends of the saddle which remove the dirt and chips from the top of the rail, and at the same time lubricate the surface. This table is firmly fitted to the apron by means of five bolts, three at the top and two at the bottom. The rigidity of this connection is further materially increased by two dowel pins extending through the top of the table into the saddle. These pins permanently locate the table in its proper position on the saddle, and also greatly increase its rigidity by preventing vibration under a cut.

The cross rail is of box form, very heavy and strongly ribbed, and of exceptional length, which gives the table a long horizontal range of travel. Three extra wide bearings for the apron are provided, which insure rigidity at that point. The rail is bolted to the column by clamps and bolts of improved design, which prevent its dropping away when the binder bolts are loosened. A stationary elevating screw of large diameter is provided, a ball thrust bearing being used on the elevating nut to facilitate the elevation of the rail. This screw enables the machine to be set on a concrete or other floor without requiring a hole to be bored through to accommodate the travel of the screw.

The head is operative at any angle within an arc of 100 degrees and has a convenient and efficient locking device. The down slide is fitted with a continuous taper gib having an end screw adjustment for taking up wear. The down feed is of unusual length, the feed-screw having an adjustable graduated collar, reading in 0.001 inch. A large toolpost is supplied for using holders with inserted bits and has a tool-steel toolpost screw and tool-steel serrated back plate. The table support furnished with this shaper represents quite a radical departure from established practice. It consists of a notched bar supplied with an adjustable nut at the bottom, and is operative throughout the full traverse of the rail. The notches are spaced one inch part and are engaged by a spring plunger after the rail has been properly adjusted, any further adjustment necessary being accomplished through the nut at the bottom of the notched bar which bears on the planed surface of the base. This support is rigid and positive and provides the further advantage of relieving the

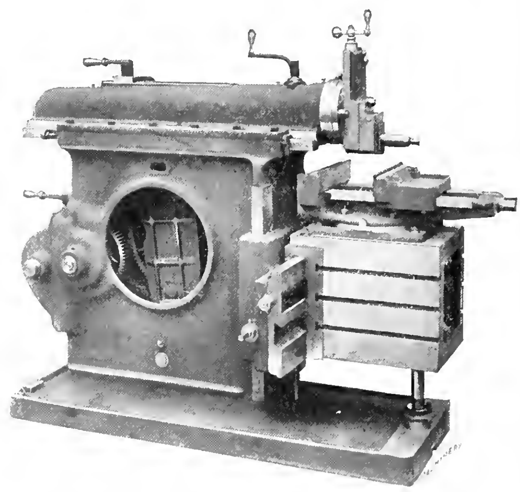


Fig. 2. Opposite Side of Machine shown in Fig. 1

rail of the weight of the table and work, thus insuring a high degree of accuracy in the work produced and less wear on the bearings.

Keyseating Capacity

The rocker arm is made with a double section at the top, which in connection with the large opening through the column permits a shaft four inches in diameter to be passed under the ram for keyseating. Larger shafts may be keyseated by setting over the table to allow the shaft to pass outside of the column, using the head set on an angle. The vise is of a heavy pattern and the jaws are deep and wide. They are faced with steel and provide an unusually large opening. The vise is clamped by four bolts to the swivel base, which is graduated in degrees, the latter being exceptionally large, covering nearly the entire area of the table

top to which it is clamped by four bolts. The vise screw has a bearing at both ends and is always in tension when holding the work.

Method of Lubrication

Special attention has been paid to the thorough lubrication of all working parts, thereby insuring long life and satisfactory service from the machine. The ram slides are oiled by means of a gravity system, oil reservoirs being provided in the ram and clamps from which felt wipers take their supply of oil and distribute it through grooves to the extreme ends of the slides, thus doing away with a multiplicity of oil holes. The felt wipers also effectually strain the lubricant, thus insuring clean oil at all times. The ram slides are provided with felt wipers at the front of the column, assisting in perfect lubrication and also preventing oil from dripping down over the front of the machine. A large quantity of oil is stored in a pocket cast integral with the rocker arm, which, with suitable means for distribution, insures thorough lubrication of the crank-pin and sliding block in the rocker arm. A felt strip inserted in the crank-pin journal insures constant lubrication.

The material used throughout is said to be of the best obtainable for the purpose used. All gears are cut from the solid with special cutters, each gear being cut with a separate cutter especially adapted to the number of teeth in the gear. This method insures a quiet running machine with a minimum of wear on the gears. The pinions are all made of

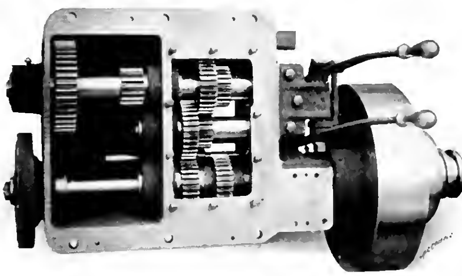


Fig. 3. Gear-box Unit for Machine with Single Pulley Drive

bar steel and the bevel pinions are planed from the solid steel. All shafts are made of crucible steel and accurately ground, and all running bearings are bushed, thus providing for easy renewal in case of wear. The bearings for the driving pulley and bull wheel are very massive and are cast integral with the column. The cone pulley is supported by a large steel sleeve which eliminates all belt pull from the driving shaft. This sleeve is provided with an efficient automatic oiling arrangement which supplies a continuous flow of oil through the journals. The steel bushing is very long, extending well into the pulley and eliminating the necessity of an outboard bearing.

The Speed Box

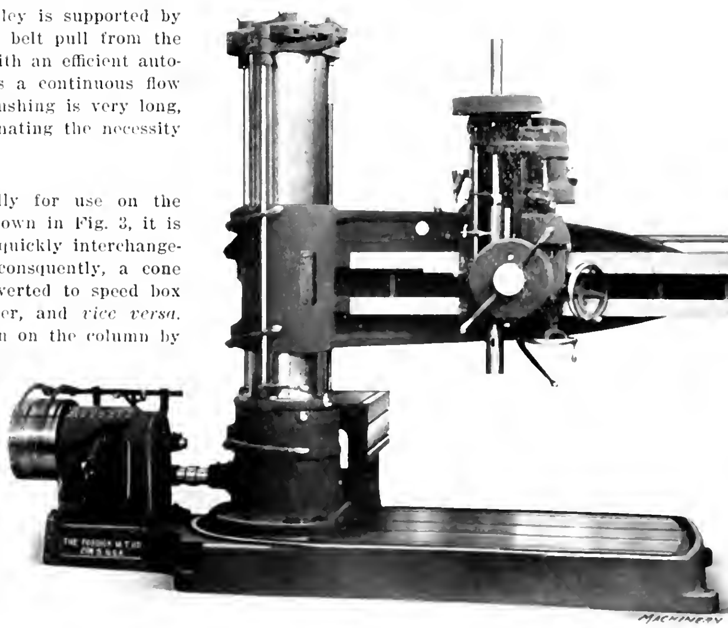
The speed box was designed especially for use on the "American" heavy service shaper. As shown in Fig. 3, it is a complete unit which is absolutely and quickly interchangeable with the cone pulley drive unit; consquently, a cone pulley driven shaper can be readily converted to speed box drive without any complications whatever, and *vice versa.* This unit is located in its proper position on the column by means of dowel pins and is held firmly in place by ten large bolts. The speed box drive provides four changes of speed, which, combined with the back-gear drive, produces a total of eight different cutting speeds for the ram. The speed changes in the box are accomplished while the machine is running, by means of seven heat-treated steel gears, the teeth of which are machine-rounded to facilitate meshing, and two operating levers which are located so that the operator can handle them without effort.

One of the features of this mechanism that should certainly appeal to the operator is the fact that there is not a loose running part in the whole speed box. Every gear is tight on its shaft; consequently, the oiling troubles common to practically all other mechanisms of this kind are absolutely eliminated. All shafts are of crucible steel; they are of large diameter and given a large center bearing which materially increases their rigidity and reduces the overhang of the gears. All shaft bearings are phosphor-bronze bushed and are oiled by means of an efficient gravity oiling system. A recessed bushing is used which forms a retainer for the oil, which, in turn, is fed to the bearing by means of a strip of felt placed in a slot cut lengthwise in the bushing. This felt not only filters the lubricant, but regulates its flow and prevents it from running out and being wasted. A return oil groove cut in the bushing also tends to keep the oil circulating to and fro in the bearing, thus preventing its escape. To further insure the efficiency of this mechanism, it has been designed so as to be oil-tight in order to permit the transmission to run in oil. Thus a very quiet and long lived drive is provided.

A long friction lever, extending well to the front of the machine for operating convenience, controls a large diameter friction incorporated in the driving pulley, by means of which the machine can be started or stopped instantly. Acting in unison with the friction clutch is a friction brake located on the opposite side of the box, which stops the ram instantly when the friction clutch is thrown out. The countershaft has tight and loose pulleys 14 inches in diameter by $3\frac{3}{4}$ inches face width for cone drive, and 14 inches in diameter by 5 inches face width for speed box drive. The regular equipment includes a vise, countershaft, all the necessary wrenches and an automatic safety stop. This shaper can be equipped with power down feed, a circular attachment, a mold maker's vise and table, a tilting top for the box table, a universal table with a tilting side, a four-speed gear box and electric motor drive when so desired.

FOSDICK HEAVY RADIAL DRILL

In the August, 1913, number of MACHINERY, the three-foot heavy radial drill made by the Fosdick Machine Tool Co., Cincinnati, Ohio, was illustrated and described. Since that time, this company has added to its line a 5-foot machine of similar design which is illustrated herewith. To provide for handling the lubricant for heavy drilling and tapping operations in steel, a liberal oil channel is cast around the base. This channel extends completely around the column and



Fosdick 5-foot Heavy Radial Drill

drains into a reservoir of ample proportions. This construction provides for the full ribbed cross-section at a point immediately in front of the column where the greatest rigidity is required; and it also allows the T-slots to extend back beyond the front of the column, thus making the full working surface of the base available.

Another feature of the machine is the table which is also provided with oil channels draining into a pocket at one corner. This arrangement eliminates the necessity of employing a pump and piping. The column is of the double tubular type with a fixed inner column extending to the top. The arm is of pipe and beam section designed in such a way as to give the maximum resistance to torsional and bending strains. The clamping levers are located at the front where they are convenient for the operator. The head is easily run along the arm by means of a compound ball bearing spiral gear. The feed box is placed low on the head, giving support to both sides of the worm, which is mounted on a ball thrust bearing and runs in oil. All feed changes are made with a single lever.

DIAMOND MOTOR-DRIVEN SURFACE GRINDERS

The Diamond Machine Co., Providence, R. I., has recently re-designed its line of automatic surface grinders. The construction of the machines has been improved in many ways, although the general design and method of operation remains essentially the same. One important change has been made,

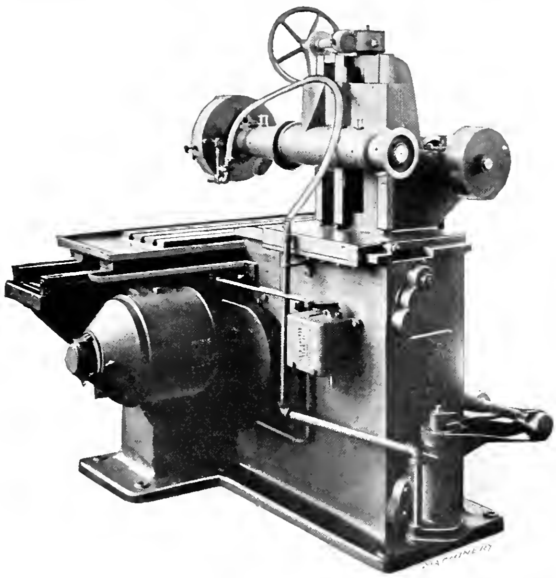


Fig. 1. Diamond Motor-driven Surface Grinding Machine

however, *i. e.*, the application of electric motor drive on machines of this type. It will be seen from the illustrations that the motor drive eliminates the use of countershafts and overhead belting. Either direct- or alternating-current motors can be used.

Two motors are employed which are of a special type developed for the Diamond Machine Co. One of these is a 2-horsepower constant speed motor running at 1200 revolutions per minute; and the other, a ½-horsepower, high resistance frame, specially wound reversing motor which runs at 600 revolutions per minute. The 2-horsepower motor drives the spindle and the ½-horsepower motor is for the table. Controllers for both motors are mounted at the front of the grinder. The spindle drive is accomplished by belting from a drum fastened to the motor shaft direct to the pulley on the driving shaft of the machine. The belt is kept tight by an idler. The remainder of the transmission is the same as on belt-driven machines, power being transmitted from the driving shaft to the spindle by a second belt. The table is driven by the reversing motor through a cloth pinion which

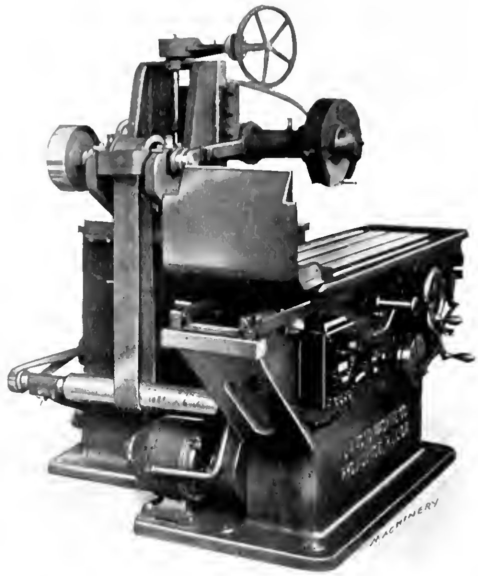


Fig. 2. Opposite Side of Machine shown in Fig. 1

transmits power through an idler gear and bronze pinion to a gear on the feed pulley shaft.

HARRINGTON "UNDER" MILLING MACHINE

The style B "under" milling machine built by the Harrington Machine Co., Erie, Pa., is shown in the accompanying illustrations. This machine is especially designed for milling drop-forging dies and for other classes of irregular open work. A taper cutter is used to give the die the desired clearance in all directions, and as the cutter is on the bottom or under side of the work, the term "under milling machine" has been applied.

The table is provided with movable chucking jaws which are tongued into grooves in the table. They may be removed and clamps used for securing larger work than comes within the capacity of the chuck jaws. The longitudinal and traverse travel is obtained by square threaded screws fitting in bronze nuts. Adjustment for wear is provided so that lost motion can always be taken up. The spindle is of high-carbon steel with the seat for the collet hardened and ground. It runs in three bronze bearings which are made adjustable

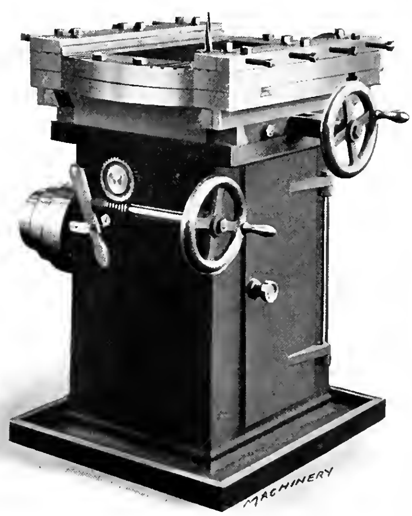


Fig. 1. Harrington "Under" Type of Milling Machine for Die Work

Fig. 2. Opposite Side of Machine shown in Fig. 1

for wear, and is driven by bevel gears which transmit power from a three-step cone pulley. The gearing is completely encased to exclude dirt and chips. The capacity is for cutters 1 3/16 to $1\frac{3}{8}$ inch in size. The table can be raised to use the small part of the cutter for milling sharp corners. The longitudinal traverse is 14 inches and the transverse traverse is 7 inches. The rotary table top enables angle lines to be followed. The floor space occupied is $42\frac{1}{2}$ by $44\frac{1}{2}$ inches, and the weight of the machine and countershaft 1920 pounds.

BARNES DRILLING AND TAPPING MACHINE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now building a 20-inch all-geared drilling and tapping machine which is provided with a self-oiling system. The all-geared feature provides for building a machine of heavy construction, with exceptionally high power for its swing. This combination of high power with the self-oiling feature, makes a machine of unusually high efficiency. Every bearing, with the exception of the spindle sleeve, is self-oiling and there are eight changes of geared speed and eight changes of geared feed, all of which are under instant control of the operator from the front of the machine. All gears are fully enclosed, thus meeting the requirements of modern safety laws. The capacity of the machine is for high-speed twist drills from $\frac{1}{4}$ to $1\frac{1}{4}$ inch and these drills may be driven to their maximum capacity.

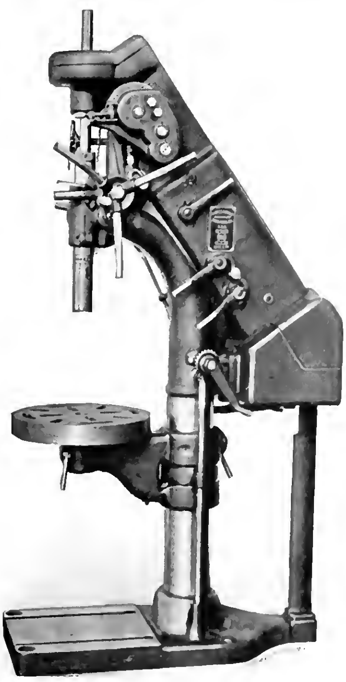


Fig. 1. Barnes 20-inch All-geared Drilling and Tapping Machine

The machine is equipped with back gears and automatic stop for the geared feeds, and the same machine is also built without back gears. Reversing friction clutch gears and automatic reverse may also be provided when so desired. Both types of machines can be equipped with motor drive and for fast high-speed drilling with drills less than 1 inch in diameter, special crown gearing is provided to double the spindle speeds. The oil for the self-oiling system is delivered by a geared pump which draws the lubricant from the reservoir of the machine and distributes it to all gears and

Fig. 2. Opposite Side of Machine shown in Fig. 1

bearings, including the crown gears and gears in the feed box. This self-oiling system is used by the Barnes Drill Co. under license from the Kearney & Trecker Co., of Milwaukee, Wis.

It will be seen from the illustrations that the frame of the drill is of unusual design and that it is of exceptionally massive construction. The spindle is made of machinery steel, double splined and ground to size; it is fitted with a special ball thrust bearing. The spindle is counterbalanced and the nose is extended to bring the drift hole below the sleeve. The graduations on the sleeve are in inches and millimeters. The gears for the speed changes are located on the diagonal shafts; they are cut from special chrome nickel steel bar stock and tempered, the stock used for this purpose having a tensile strength of 270,000 pounds per square inch. The eight changes of speed—four of which are obtained without the back-gears—may be easily and quickly obtained without requiring the drill to be stopped. These changes are made by simply operating the proper shifting lever, which is within easy reach of the operator when standing at the front of the machine. The back-gears are operated by a small lever which is also accessible from the front

of the machine, and may be instantly engaged or disengaged while the machine is running.

Either of the eight changes of geared feed may also be obtained while the spindle is running idle by placing the index lever in the proper notch on the segment. The feeds are indicated in plain figures so that there should be no danger of mistake. A safety device prevents overloading and reduces the chance of breaking the drill. The star-wheel lever which controls the hand feed is entirely different from the common ratchet lever. It operates through a pinion meshing with an internal gear, the ratio being 4 to 1. This makes the star-wheel handle equivalent to a common lever of four times its length. The star-wheel also acts as a quick return lever, thus eliminating the necessity for using a ball handle for this purpose. The machine is usually equipped with a round table but a square table with an oil channel can be substituted. The table is raised and lowered by a crank which operates the elevating screw through bevel gears. The table can be swung around on the column and clamped in any position. The machine has an automatic reversing mechanism which is a very desirable feature.

For tapping operations, the friction clutch gears give reverse speeds of $1\frac{3}{4}$ to 1 and these gears are located at the driving end of the machine instead of on the spindle. As the machine is geared down to 13 to 1 in front of the clutch gears, this eliminates the excessive wear and tear which would result if the clutches were placed directly on the spindle. The machine has an automatic reversing mechanism for depth tapping. The trip can be set so that when the tap has reached any required depth, the spindle is automatically reversed, thus backing out the tap at an increased speed. The shifting lever can also be set so that when the machine is tripped—either automatically or by hand—it will return to the neutral position, thus stopping the spindle instead of reversing it. The small hand trip lever shown in the illustration is always ready for instant use if it is desired to reverse the machine or stop the spindle at any point in the operation. When the machine is to be motor-driven, a 2-horsepower motor running at about 1200 revolutions per minute is recommended for use on this 20-inch drill. This arrangement possesses the well-known advantages of individual motor drive.

CARROLL-JAMIESON LATHES

The Carroll-Jamieson Machine Tool Co., 257 Davis St., Batavia, Ohio, is now building the 14-inch tool-room and manufacturing lathe illustrated in Fig. 1; and also the 13-inch back-geared screw cutting lathe shown in Fig. 2. The name of the first machine referred to indicates the scope of work for which it is intended, while the 13-inch screw cutting lathe was particularly designed to meet the requirements of automobile repairing and general machine shop practice. A careful study of the requirements of this class of work showed the designers of this machine that it was necessary to provide a heavy, rigid construction to stand up under the varied classes of work for which a tool is used in service of this nature. Having made this brief introductory statement, the features of the two lathes will be taken up in some detail. The 14-inch lathe shown in Fig. 1 is equipped with a selective sliding gear mechanism and single pulley drive. The head is absolutely oil-tight and dust-proof and the gearing runs in an oil bath. All of the gearing in the head is cut from high-grade steel blanks and then heat-treated and hardened. The driving pulley runs in an extended bronze bushing which relieves the driving shaft of strain and undue wear. The handwheel at the top of the head controls eight changes of speed and the back-gears are engaged by means of the vertical lever seen immediately below and to the right of the handwheel.

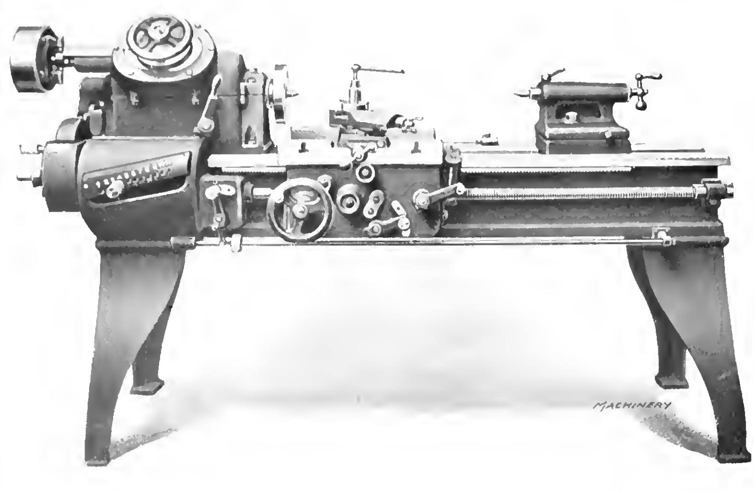


Fig. 1. Carroll-Jamieson 14-inch Tool-room and Manufacturing Lathe

The geared head was particularly designed to facilitate rapid production. It has already been mentioned that the handwheel on the head provides for obtaining either of eight changes of speed; these speeds are in geometrical progression and the change can be made instantly while the machine is running at its highest rate of speed. The arrangement of the gears by which these speed changes are obtained is shown in Fig. 3. The main driving gear stops automatically when the handwheel is pulled forward and it is impossible for any two speeds to be engaged at the same time. The gears in the head have short, stub teeth; the spindle is made of special hammered crucible steel and is finished by grinding. The bearings are bushed with a special hard bronze and scraped to an accurate fit; and provision is made to compensate for wear. The head is substantially ribbed to secure the necessary rigidity and all bearings are self-oiled. The quick-

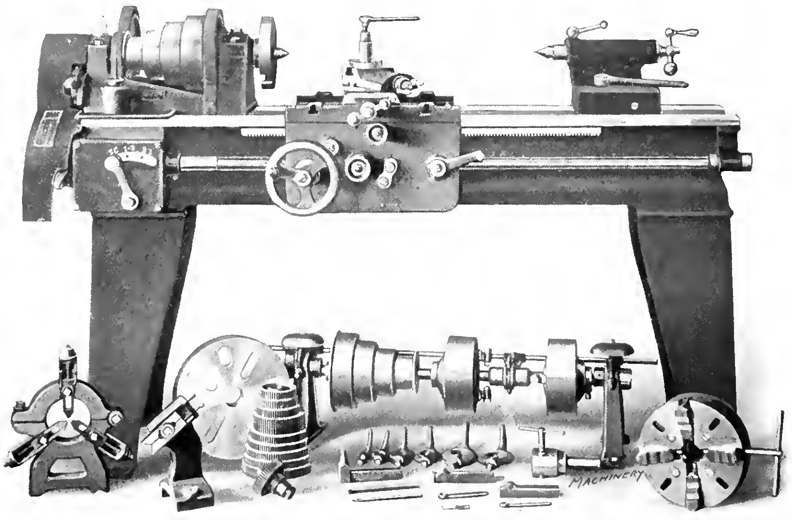


Fig. 2. Carroll-Jamieson 13-inch Back-geared Screw-cutting Lathe

change gear mechanism is of simple construction and provides for cutting threads from 3 to 64 per inch including all standard and odd threads as well as 11½ pipe threads. Reverse is provided in the head as well as the apron. Fig. 4 shows the arrangement of the back gears and the lever for throwing them in or out of engagement. All bearings in the apron which carry moving shafts are bronze bushed. The alignment of the spindle is accurate to 0.0005 inch in 12 inches and the error in boring and turning operations will not exceed 0.001 inch in 12 inches

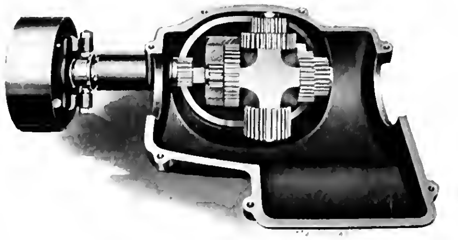


Fig. 3. Arrangement of Speed Change Gears on 14-inch Lathe

The head of the 13-inch back-geared lathe shown in Fig. 2 is fitted with a hardened steel spindle which is accurately ground to size. The spindle runs in chilled cast-iron bearings which are scraped to an accurate fit. The error in the alignment of the spindle does not exceed 0.001 inch in 12 inches. It will be seen that the machine is driven by a 4-step cone pulley which is arranged to carry a 2-inch belt. The machine is back-geared in the ratio of 7 to 1. The tailstock is of the cutaway pattern, permitting the compound rest to be swung around to an angle of 90 degrees. It is fitted with a 1 11/16-inch sleeve which is bored to No. 4 Morse taper. The tailstock can be set over for turning tapers. The carriage is gibbed at both the front and back and the cross-slide is 6 inches in width. The cross-feed screw has the usual graduated collar reading to 0.001 inch and the compound rest is graduated to 360 degrees. The apron has power cross feed and longitudinal feed, and there are three changes of feed obtained through sliding gears which are secured by placing the lever in either of the three stations on the feed box. Change gears are provided for cutting from 5 to 36 threads per inch, including 11½ pipe thread. There is also one extra compound gear to cover all odd and special threads from 3 to 72 per inch. The regular equipment of the lathe consists of a large and a small faceplate, a follow-rest, a steady-rest, a compound rest, a full set of change gears and double friction countershaft.

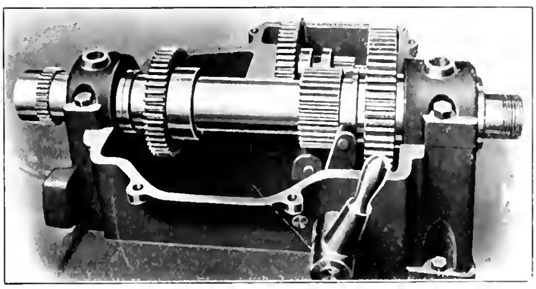


Fig. 4. Back-gears on 14-inch Lathe and Lever for throwing them into Engagement

Experience with the work that comes to the average garage shows that there is not enough large size work to warrant investing in a lathe swinging over 14 inches. The large lathe is not convenient for the general run of repair work and it is only occasionally that a job is met with which is too large to be handled on the 14-inch lathe. To meet the requirements of these occasional jobs which exceed the capacity of a lathe of this size, the Carroll-Jamieson Machine Tool Co. has designed an attachment for increasing the swing of its 13- and 14-inch lathe. Equipped in this way, the 13-inch lathe swings 18¾ inches over the ways—which is ample for the maximum requirements of garage work—and the 14-inch lathe swings 22 inches over the ways. This attachment can be placed on a lathe as quickly as a steady-rest and will be found a very convenient equipment for the repair shop. The spindle is accurately lined and will handle boring and turning operations with a high degree of accuracy. The nose of the spindle conforms to the nose on the lathe spindle so that the same faceplates, chucks or centers can be used. The attachment takes up 8 inches on the lathe bed. The attachment consists of head and tail piece, the compound rest, swivel block and one steel gear that fits the nose of the lathe spindle and drives the intermediate gear of the attachment. When the attachment is received it is ready to place on the lathe.

INGERSOLL-RAND AIR COMPRESSOR

The steadily increasing use of low-grade fuel oil for power purposes has led the Ingersoll-Rand Co., 11 Broadway, New York City, to add to its line the oil engine driven air compressor, which is illustrated herewith. This unit is of the direct-connected straight line type and in this respect it is somewhat similar to the standard line of small compressors built by this company. The main frame is designed for a splash system of lubrication; it is wholly enclosed and provided with removable covers. The feature of greatest interest is the design of the driving end of the unit. This consists of a single oil engine cylinder set behind the air cylinder and direct-connected to the air piston by means of an extended piston rod. The general design follows a type known as the "hot bulb engine" which is really a development of the Diesel engine, and combines high thermal efficiency with simplicity of construction.

No auxiliary air compressors are employed and this, combined with a lower working pressure, makes an ideal equipment for compressed air service. The power cylinder is of the single-acting, two-cycle type. It is water jacketed and provided with an efficient system of lubrication. A torch is provided for heating the ignition bulb preparatory to starting the engine, but after the compressor is well under way, the use of this torch is unnecessary. The fuel is automatically injected into the combustion chamber by means of a small pump operated by the main shaft. It enters in the form of a finely atomized spray and is immediately ignited by the hot bulb, thus dispensing with the use of an electric sparking device. The stroke of the fuel pump is regulated by a centrifugal governor located in the flywheel: and this regulates the amount of fuel injected into the cylinder, making it proportional to the load. This method of regulation is supplemented by a regulating device on the intake of the air cylinder.

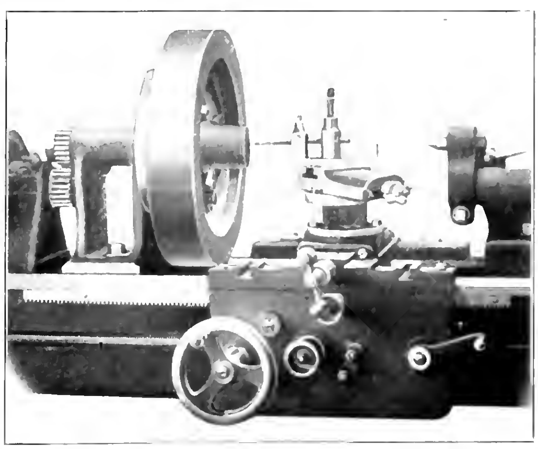
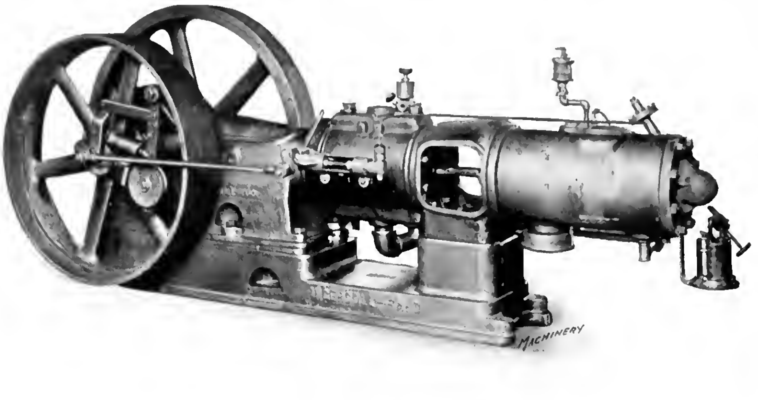


Fig. 5. Attachment for increasing the Swing of Carroll-Jamieson 13- and 14-inch Lathes

The method of operating this unit is accompanied by none of the losses common to many two-cycle gasoline engines, in which part of the incoming charge follows the exhaust gases through the outlet ports. This is due to the fact that the

fuel is not vaporized by an outside agency and introduced with the air used for "scavenging"; but is injected directly into the cylinder at the end of the compression stroke, as previously mentioned. This means that pure air is used during the scavenging period of the stroke, with the result that the inlet and outlet ports can be arranged in such a way that more thorough scavenging is effected without any loss of fuel. The absence of a carbureter with its needle valves, springs and delicate adjustments, which require constant attention to suit varying atmospheric conditions is also a material advantage.



Ingersoll-Rand Oil Engine Driven Air Compressor

Another feature of the engine is the provision of means for inducing a small quantity of water from the cylinder jacket into the combustion chamber. This water performs the function of regulating the temperature in the cylinder, thereby preventing an undue rise in the temperature of the piston and cylinder walls, which would be liable to result in a disassociation of the fuel oil. This practice reduces the maximum pressure in the cylinder but slightly increases the mean effective pressure, making a smooth running and highly economical engine. The amount of water injected is regulated according to the load on the compressor. At present, this unit is made in but one size which has a capacity for 66 cubic feet of free air at 100 pounds pressure and 73 cubic feet at 80 pounds pressure, when running at 325 revolutions per minute. Under average operating conditions, the fuel consumed at this speed is about 2.2 gallons of kerosene per hour. The engine is adapted for the use of either kerosene, fuel oil or distillate. The unit occupies a floor space of 8 feet 10 inches by 2 feet 5 inches and the weight is 3000 pounds.

NEWTON LOCOMOTIVE LINK GRINDING MACHINE

Front and rear views of a link grinding machine which was recently built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., for use in the Baldwin Locomotive Works, are illustrated in Figs. 1 and 2. When it was necessary for locomotive builders to grind links which were required to be hardened, the operation was the cause of considerable trouble. The nearest approach to economical production was obtained by taking a heavy planing machine, equipping the rail with a grinding spindle and mounting the link to be ground on a swiveling table which was oscillated by a guide traveling in a straight channel, the angle being adjustable to suit various radii. A brief consideration will make it evident that this method gave only approximately accurate results.

To enable this operation to be handled more efficiently, the machine which forms the subject of this article was designed and built by the Newton Machine Tool Works. This machine possesses a material advantage over the equipment referred to in the preceding paragraph, in that the table carrying the link can be adjusted for depth of cut and from side to side, without disturbing the radius control. The machine has a compound spindle slide. The smaller slide, which is at the front, has a reciprocating motion of ⅝ inch which permits of the use of large diameter grinding wheels having a face broad enough to cover the entire surface to be finished. The secondary slide has a vertical feed to permit of using small diameter wheels which are required, owing to the slight amount of clearance, and which are too small to provide the requisite strength if made the full length of the finished surface. This feed works vertically and has an automatic reverse for both directions of travel. In operation, the links are placed on pins attached to the top table which, in turn, is held parallel by pull pins at each end. The radius bracket shown in Fig. 2 is adjusted to the required location which is determined by a scale. The drive for the spindle and for the table travel are independent and can be varied to suit different requirements. The maximum capacity of the machine is for links up to 120 inches radius by 5 inches face, and the weight of the machine is 12,000 pounds. The accuracy of the work done by this machine is well up to the standard of other modern machine tools, while that of the planer attachment was merely approximate.

Fig. 1. Operating Side of the Newton Link Grinding Machine

Fig. 2. Rear View of Newton Link Grinding Machine

STANDARD WIRE DRAWING MACHINES

A wire drawing machine which is built in four sizes by the Standard Machinery Co., Elmwood Ave., Auburn, R. I., is illustrated in Figs. 1 and 2. These machines are adapted for drawing steel and copper wire as well as wire of the precious metals, and are particularly suited for drawing steel wire from 5/8 inch down. The machine illustrated is the smallest size; it has a drum 22 inches in diameter by 8½ inches high, the drum operating at a lineal speed of 50 feet per minute. The "draw-out" drum which performs the preliminary operation operates at 19 feet per minute. This machine occupies a floor space of 4 feet 6 inches by 7 feet 6 inches and has an approximate weight of 4000 pounds.

It will be seen from Figs. 1 and 2 that the machine is driven by a single pulley, this pulley being provided with a friction clutch. The driving shaft is back geared to the large spur gear shown in Fig. 1. On the same shaft with this gear there is a bevel pinion which meshes with the large bevel gear on the vertical spindle that drives the drum. The machine is started by engaging the friction clutch which is controlled by the handle at the extreme left of the machine. The handle at the extreme right is for the purpose of engaging an internal clutch located inside the drum, which sets the draw-out drum in motion.

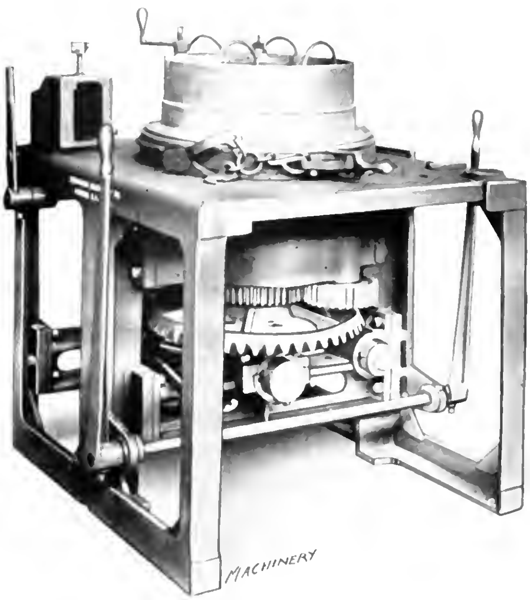


Fig. 2. Closer View of the Machine showing Arrangement of the Drawing Drums

The die is supported in a holder shown at the corner of the table. In preparing for a drawing operation, the stock is pointed so that it can be put through the die and have a length of 3 inches extending out to be gripped by the tongs. This pointing of the stock is done by either a hand or rotary swager or by any other suitable method, a hydraulic squeezing press being used in some cases. After the stock has been pointed and threaded through the die in this way, it is gripped by the tongs and the internal clutch is then engaged to start the draw-out drum. When the draw-out drum has made one-half revolution, the lever shown in Fig. 2 engages a trip which disengages the tongs, causing them to release their hold on the work. The machine is then stopped and the end of the wire, which has been drawn out, is brought up and clamped to the main drawing drum, after which the machine is again started and the drawing operation completed.

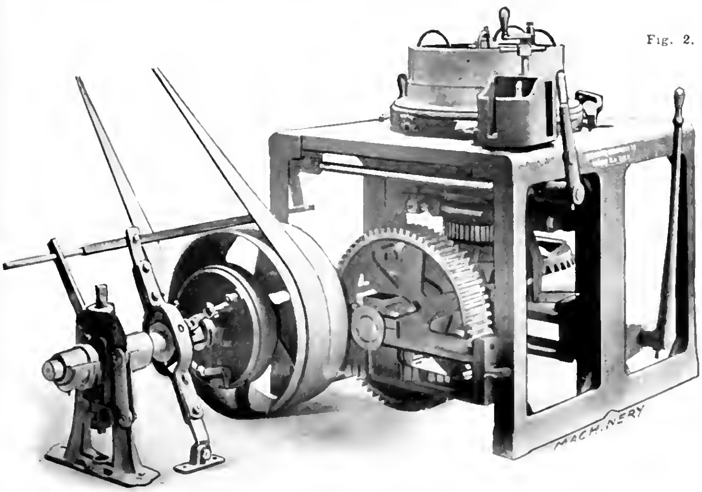
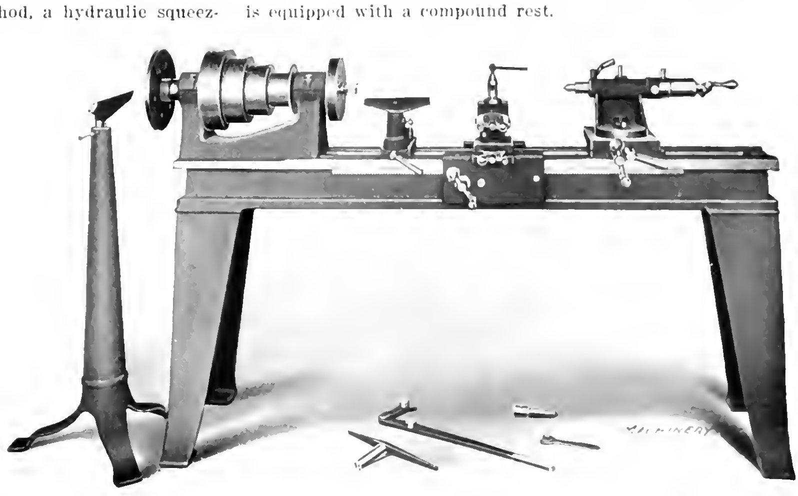


Fig. 1. Wire Drawing Machine built by the Standard Machinery Co.

Various methods of lubricating the work are employed. Some use waste and silk wiper cloths saturated with oil, these being placed on the work at the far side of the die and supplying the necessary lubrication. Others rub a special palm-oil soap on the wire. In some cases it is found advantageous to pass the wire through a bath of oil that is set upon the table of the machine.

BLOUNT PATTERNMAKER'S LATHE

The patternmaker's lathe which forms the subject of this article is a recent product of the J. G. Blount Co., Everett, Mass. This machine swings 16 inches and has a bed 6 feet in length. The spindle is hollow and forged from high-carbon steel; it runs in self-oiling bronze bushed bearings. The outer end of the spindle is threaded to receive a faceplate for turning work of large diameter and the tripod rest shown at the left-hand end of the lathe is provided for use in connection with work of this nature. In addition to the usual hand rest, the lathe is equipped with a carriage that has rack and pinion feed. The carriage has hand operated cross feed and is equipped with a compound rest.


Blount Patternmaker's Lathe and Tripod Rest for Use in connection with the Faceplate

The tailstock has screw and lever feed and is made with a graduated base so that any required taper may be bored or turned. A taper pin provides for bringing the tailstock back into alignment. The base of the tailstock is provided with a slide and the tailstock may be fed crosswise by operating a ball handle. The equipment of the lathe includes a plain countershaft with tight and loose pulleys or a friction countershaft with two friction pulleys.

C. & E. RATCHET WRENCH

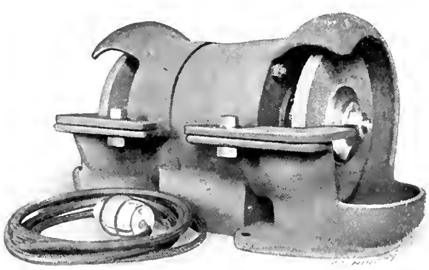
The combination ratchet and alligator wrench illustrated herewith is a recent product of the C. & E. Mfg. Co., Marshalltown, Iowa. This wrench has only three working parts and is made of drop-forged carbon steel. It is strong and not likely to get out of order. There are four different sizes of ratchet jaws provided, any of which may be put on the

The "Marshalltown" Wrench made by the C. & E. Mfg. Co.

wrench by turning the handle through part of a revolution. The ratchet feature enables the wrench to be operated through a half revolution and is particularly convenient in removing nuts in cramped positions. The ratchet jaws have capacities of ⅜, 7/16, ½ and 9/16 inch, respectively.

FORBES & MYERS BENCH GRINDERS

In the August, 1913, number of MACHINERY the polyphase grinder made by Forbes & Myers, 178 Union St., Worcester, Mass., was briefly described. In response to a demand for a lighter machine of similar type, which can be used on electric light circuits, this company has added four new models to its line. In designing these machines, particular attention has been paid to the starting current in the smaller sizes. The motor will develop a full 1/6 horsepower, but the current is small enough so that there is practically no danger of burning out the fuses when attached to a lamp socket. The construction of the rotating element is similar to that of the standard polyphase machines. The grinders are made with two forms of frame, one of which



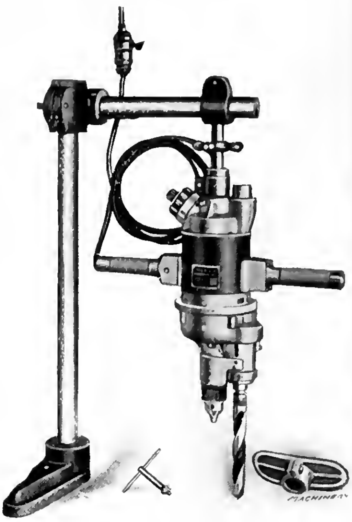
Forbes & Myers Bench Grinder for Operation on Lighting Circuits

has a water basin, adjustable tool rest and wheel guards, while the other is similar with the exception that the guards do not extend over the top of the wheels. The equipment includes two wheels 6 inches in diameter by ½ inch face width and 10 feet of reinforced lamp cord.

The larger sized machines of this line are equipped with ½ horsepower motors which may also be used on a lighting circuit, although they are really larger than should ordinarily be used in this way. A simple and reliable centrifugal device is used to open the circuit of the starting winding when the motor has come up to the required speed. The grinders equipped with the ½ horsepower motors are also provided with wheels 6 by ½ inch in size, and are powerful enough for grinding lathe and planer tools and handling a variety of other machine shop work.

STOW TWO-SPINDLE DRILL

Stow Mfg. Co., Binghamton, N. Y., is now manufacturing the two-spindle, two-speed drill which forms the subject of this article. One of the spindles of the tool is fitted with a Jacobs chuck for handling straight shank drills up to ½ inch in diameter. This spindle runs at 450 revolutions per minute. The other spindle takes Morse taper shank drills up to ¾ inch in diameter and runs at 225 revolutions per minute. The tool can also be arranged so that it is possible to remove the chuck from the small spindle and mount it in the large spindle. With this tool, the small spindle provides high speeds for driving small drills, while the large spindle provides ample power for drilling larger sized holes. The spindles of the tool can be easily reversed so that it can be used for tapping operations. Either direct- or alternating-current motors may be provided and the motors are suited for connection to an ordinary lighting circuit.

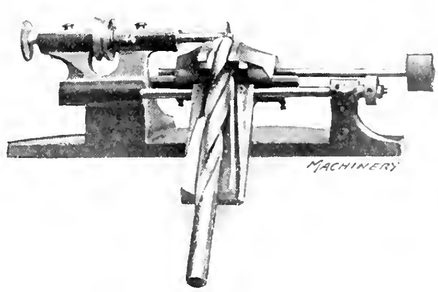


Stow Two-spindle Two-speed Drill

MATHER TWIST DRILL SLOTTING MACHINE

E. B. Mather, 1415 Lake Ave., Rochester, N. Y., is exploiting a patented method of slotting the point of twist drills and the machine used for this purpose. The machine is shown in the accompanying illustration, and by its use a small slot is ground across the point of the drill. This is said to give the drill several important advantages over a twist drill with a point of the standard form. The drill cuts faster and it is claimed that the feed pressure and torque are materially reduced, with the result that the slotted drill operates about 50 per cent faster than a drill of standard design. It is also said that the drill will operate longer before it requires re-grinding, and that when drilling in brass there is no tendency for the drill to catch as it comes through.

Tests of these slotted drills were recently conducted in the experimental engineering laboratories of Sibley College at Cornell University. Drills ½, 5/16 and 3/16 inch in diameter were used, one set of drills being slotted and the other left plain, but neither set of drills had been previously used. The feed pressure required was determined by applying the pressure through a piston rod connected to a piston



Machine for slotting Twist Drills by the Mather Process

working in an oil cylinder. The use of a pressure gage enabled the feed pressure to be determined. The torque was determined by a spring balance used in connection with a radial arm. The results of the test showed that the slotted drills cut at a higher speed than the plain drills were capable of reaching under the same feed pressure. The power required to drive the slotted drills was somewhat greater, but the quality of the work was about the same in both cases. The torque was considerably less for the slotted drill. Another series of experiments was conducted to determine the tendency of the slotted drill to run out as compared with that of the plain drill. The results showed that the slotted drills were superior to the plain drills in this respect.

HESS-BRIGHT BALL BEARING

The Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., has added to its line what is styled the Bright "2-RO" ball bearing which is illustrated herewith. This bearing was particularly designed for use in automobiles and for other classes of service in connection with bevel gears, where a bearing is required for carrying both thrust and radial loads.

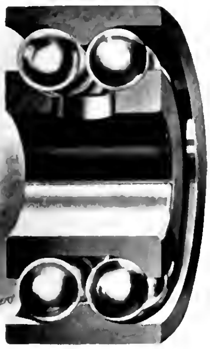


Fig. 1. The Bright "2-RO" Ball Bearing

Simplicity is the striking feature of the design of this bearing. The inner and outer races are of forms which lend themselves readily to accurate grinding. The balls are of the usual degree of accuracy found in a high-grade ball bearing and have two points of contact. The arrangement of the filling opening provides for filling the races with balls, and when the bearing is completely assembled the points of contact are so far from the filling opening that there is no danger of the balls striking the edge of it. It is stated that the location of the opening is such that it does not weaken the race.

The angle of both the thrust and radial loads, or the combination of two such loads, is such that the balls are kept away from the filling opening and this condition is further

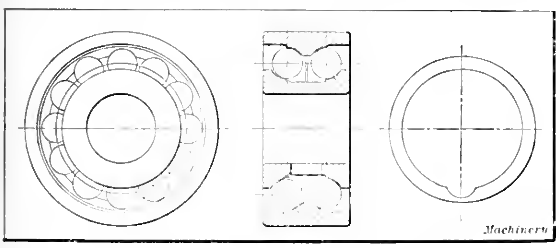


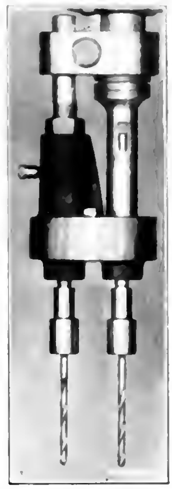
Fig. 2. Details of the Bright "2-RO" Ball Bearing

assured through the action of centrifugal force. The split inner ring is in no sense a separator; its function is to simply float between the two rows of balls and keep them away from the filling opening. It is only in unusual cases that the ring is required, as at such a time when an undersized ball stops opposite the filling opening; under normal conditions none of the balls enter the opening when the bearing comes to rest.

Assuming that the mounting is properly aligned, the bearing has a high capacity for carrying radial loads, as such loads are uniformly distributed over two rows of balls. The bearing also has a comparatively high capacity for carrying thrust loads in either direction, the thrust load either way being sustained by one full row of balls. This, of course, assumes that the mounting is properly lined up. If this condition is not fulfilled, a uniform distribution of the load will not be secured, and the bearing will not operate at its maximum efficiency.

SELLEW TWO-SPINDLE AUXILIARY DRILL HEAD

A simple form of auxiliary drill head especially adapted for use in connection with small sized sensitive drilling machines, where a number of holes are drilled in fixed locations, is illustrated herewith. It will be seen that one of the drills is held in a spindle which has a taper shank carried in the spindle of the drilling machine. This taper shank is geared to the second spindle of the drill head. Above the driving gears there is a hub extension, and the head is clamped by a single screw in the yoke block which fits the quill of the drilling machine. Lightness and simplicity are the distinguishing features of this drill head, and its application on a machine effects a considerable increase of capacity on those classes of multiple drilling operations which come within its range. This two-spindle drill head is the latest product of the Sellew Machine Tool Co., Pawtucket, R. I.



Sellew Two-spindle Drill Head

STEVENS TURRET TOOLPOST

Fig. 1 shows a lathe turret toolpost which is made by A. H. Stevens, 138 Thacher St., Hornell, N. Y.; and Fig. 2 shows the toolpost in use on a lathe. It will be seen that it consists of a turret which carries several tools, any one of which can be quickly brought into the operating position. The toolpost is fastened directly to the cross-slide of the lathe and may be quickly put in place or taken off. It is of compact and rigid construction. The turret is only free to revolve in one direction and is positively locked to prevent the thrust of the tool turning it.

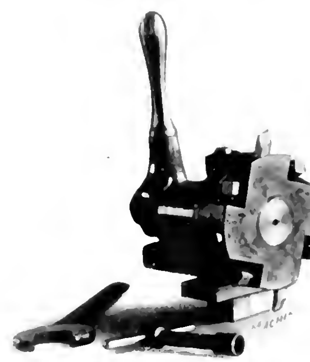


Fig. 1. Stevens Turret Toolpost

Two simple movements of the lever are sufficient to change the position of the turret; moving the lever toward the operator revolves the turret and moving it away from him locks the turret, which is automatically located after being brought to an approximate position. The pin encased in the base is of hardened tool steel and engages a slot in the turret; there is no tendency to spring, as the turret is located

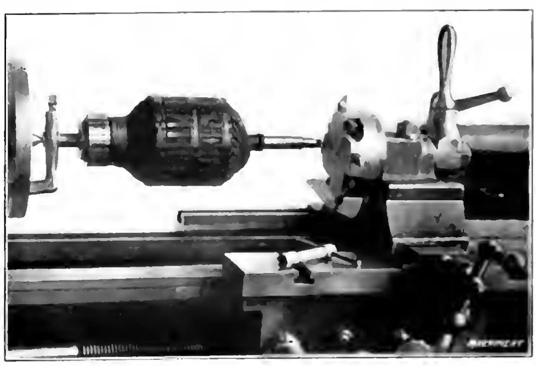


Fig. 2. Stevens Turret Toolpost in Operation on the Lathe

directly over the support. It will be evident to the reader that this toolpost is intended for machining those classes of work where several successive operations are performed, and its use saves a considerable part of the time occupied in changing tools.

GARDNER COMBINATION PATTERNMAKER'S MACHINE

The experience of the Gardner Machine Co., Beloit, Wis., with the disk grinding machines and roll sanding machines of its manufacture, has led to the combination of these two types of machines in a single unit. This is known as the No. 20 combination patternmaker's machine. The machine is

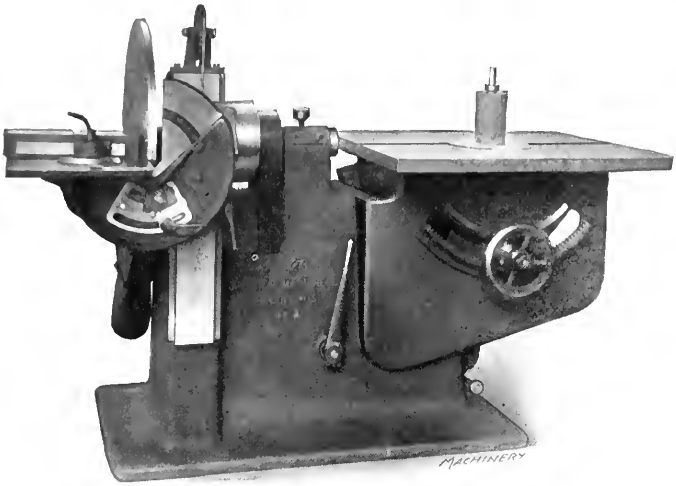


Fig. 1. Gardner Combination Disk Grinder and Roll Sander for Use in the Pattern Shop

shown in Fig. 1 with both the roll sanding spindle and adjustable work table set at right angles. Fig. 2 shows both ends of the machine in operation, and it will be noticed that in this illustration both the roll sanding spindle and the work table are shown set at an angle, in order to illustrate the adjustment which is possible. These adjustments are particularly convenient in many classes of patternmaking work where it is desired to finish surfaces at an angle with each other.

At the disk wheel end, the machine is equipped with a wheel 30 inches in diameter which runs at 950 revolutions per minute. This wheel is faced with "netbac" garnet paper which is attached to the wheel without requiring the use of an arbor press, or the wheel to be removed from the spindle in order to have a new disk applied. A universal work table is provided, which is mounted on a dovetail slide back of the cutting plane of the disk wheel. The table may be raised or lowered and instantly locked in any desired position, the use of a counterweight within the column of the machine enabling the position of the table to be adjusted without undue exertion on the part of the operator. The table is also provided with angular adjustment in relation to the face of the disk wheel, the table being shown at right angles to the wheel in Fig. 1 and set at an angle in Fig. 2. A graduated segment at the end of the table provides for making accurate angular settings, and one turn of the handwheel locks the table in the desired position. The axis about which the table swings is so arranged that the edge remains close to the face of the disk wheel regardless of the position in which the table is set. This is a particularly advantageous feature when working on small size patterns.

There are three work gages provided for use in connection with the table. One of these is a universal angle gage which is particularly serviceable in producing patterns having compound angles and for squaring up patterns. As its name implies, the duplicating gage is used for producing duplicate pieces and for generating parallel surfaces. The circle generating gage is used in connection with the production of round shaped pieces which are usually handled on the lathe. Its use enables external arcs of various radii to be accurately produced.

The sanding roll at the opposite end of the machine is used for generating and finishing internal curves which have been roughed out on a band saw. The piece is finished complete on this machine, which does much of the work usually performed by hand carving or on the lathe, but in a fraction of the time which would be required by either of these methods. Four different diameters of rolls are provided, all of which are 7 inches in length. As the diameters vary from 2 to 6 inches, it is evident that the smaller rolls must be driven faster in order to give a suitable cutting speed. This speed variation is provided for, the range of spindle speeds available being from 2000 to 6000 revolutions per minute. The sanding rolls are made of cast aluminum and accurately balanced. They are covered with a sheet of "netbac" paper which is cut at an angle, so that the joint runs in a complete spiral around the roll instead of being on a straight line. This does away with the vibration which would be caused by having the joint on a straight line. When the "netbac" paper on the roll becomes worn, it is merely necessary to soak the roll in water for a few minutes to soften the cement, after which the abrasive paper is peeled off and a new sheet substituted.

The roll spindle has a vertical reciprocating motion of 1/8 inch for the purpose of avoiding the production of ridges

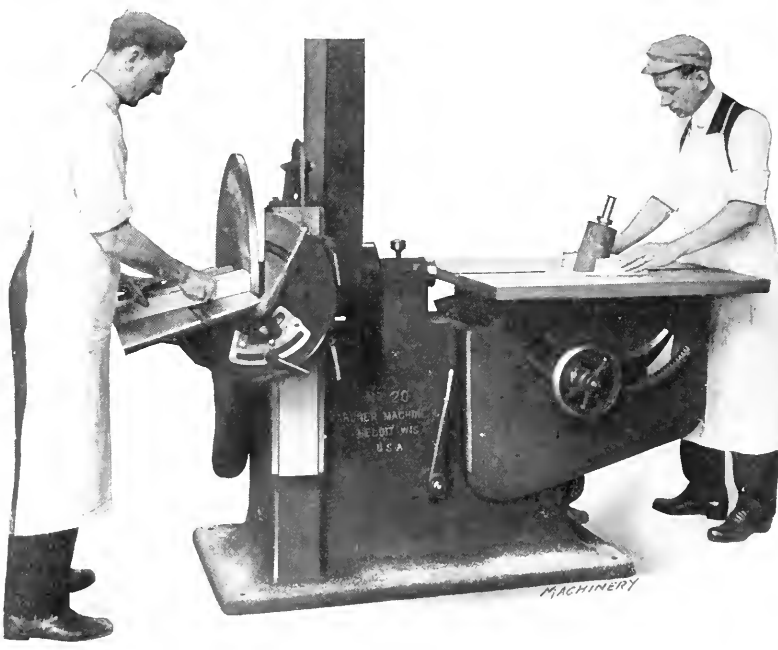


Fig. 2. Machine shown in Fig. 1 with Both Ends in Operation

in the work; this also increases the rapidity with which the roll cuts. The reciprocating motion is provided by having the roll spindle engage with a pivoted fork which works over a cam. The mechanism is positively driven by spiral gears and the entire weight of the spindle and roll is supported on a ball bearing. Another important feature of the roll end of this machine is that angular surfaces can be finished as readily as those which make an angle of 90 degrees with the table. For this purpose, the work spindle is set at the desired angle with the table rather than resorting to the alternative of setting the table at an angle with the roll spindle. The table at the roll end of the machine remains horizontal at all times. The angle to which the roll is set is accurately registered on a graduated segement which is lo-
accurately registered on a graduated segment which is located directly behind the locking handwheel. In shops where floor space is at a premium, this combination of two standard machines into a single unit effects a material saving in the room required for equipment.

If the main spindle which carries the disk wheel is in operation, the sanding roll can be started or stopped as frequently as necessary. The motion of the roll spindle is controlled by a clutch which is operated by a handle at the front of the machine. The disk wheel is provided with an efficient dust hood and the sanding roll throws but little dust into the air. When it is desired to make provision for removing the dust from the roll, the best plan is to suspend an exhaust pipe from the roll with an enlarged opening of suitable size. The driving spindle can be mounted in either babbitt lined bearings or ball bearings as required. The machine shown in the accompanying illustrations is provided with plain bearings. The machine is well adapted for direct connected motor drive and where this method of driving is employed, the motor is mounted on a bracket at the rear and connected to the main driving spindle by a silent chain. A few of the more important dimensions of the machine are as follows: The disk wheel table is 36 by 15 inches in size and the sanding roll table 31½ by 36 inches; the four sanding rolls provided for use on the machine are 2, 3, 4 and 6 inches in diameter by 7 inches in length; the speed variation of the roll spindle is from 2000 to 6000 R. P. M. and the disk spindle operates at 950 R. P. M. The power required to operate the machine at its full capacity is 5 horsepower and the operating space required is approximately 6 by 12 feet. The weight of the machine is about 3000 pounds. The regular equipment furnished with the Gardner No. 20 combination pattern-maker's machine includes a 30-inch disk wheel and four aluminum sanding rolls 2, 3, 4 and 6 inches in diameter by 7 inches high; a supply of "net bac" garnet paper disks and sanding strips; a supply of cement and grease; three work gages; a countershaft; and the necessary wrenches.

NUTTER & BARNES CUTTING-OFF MACHINE

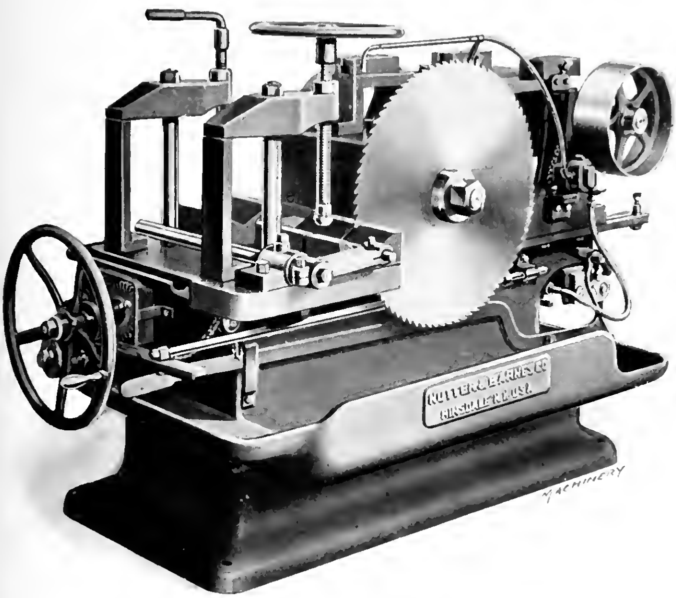


Fig. 1. Nutter & Barnes 10-inch Cutting-off Machine

The 10-inch cutting-off machine illustrated in Fig. 1 is a recent addition to the line of metal cutting saws built by the Nutter & Barnes Co., Hinsdale, N. H. This saw follows the general lines of design adopted in the construction of the other types of machines built by this company. The 10-inch machine differs from the smaller sizes, however, in that the saw carriage is automatically returned after completing the cutting stroke. Other features of this machine not found on the smaller sizes are the increased size of the work table, the double set of screw clamps for securing the work, and the heavier construction of the machine to adapt it for heavier work. Aside from these features, the machine is quite similar to the Nutter & Barnes 8-inch cutting-off machine which was illustrated and described in the December, 1910, number of MACHINERY.

The introduction of fast feeds and speeds in cutting metal has made it necessary to provide easy means for handling the stock to be cut, and for supplying a liberal quantity of lubricant to keep the saw and work cool. The cutting lubricant is stored in a reservoir in the base of the machine and delivered to the saw by a geared pump. An improvement has recently been made by attaching a combination saw guard and lubricator to the end of the piping. One of these combination guards is shown in Fig. 2, from which an idea of the construction will be obtained. The guard affords protection to the operator and also does away with the danger of breaking the saw when material is being placed on the work table. As it is possible to deliver a large volume of cutting lubricant at the exact point where it is most needed, this device is the means of enabling higher speeds and feeds to be employed with a corresponding increase in production. The combined guard and lubricator is quickly adjusted to suit different sizes of saws and can be raised to clear the saw when it is desired to remove it for sharpening. A special throttle is provided for changing the direction of lubricant

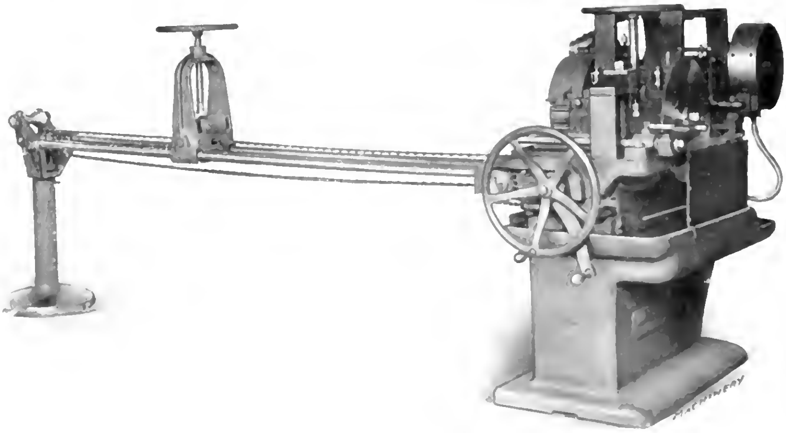


Fig. 2. Combination Guard and Lubricator for Nutter & Barnes Machines

as it is delivered to the cutting point, or for stopping the flow entirely while the machine is running.

In most cases, metal-cutting saws are employed to cut bar stock of various lengths, but the length of the work is usually great enough so that the use of an independent stock rest is necessary. The usual method of feeding the stock requires the operator to leave his machine and push or pull the bar along by hand, after each cut has been completed. Fig. 3 shows a stock feed attachment which has recently been brought out by the Nutter & Barnes Co. to provide for feeding the stock mechanically. This equipment is shown in connection with the 6-inch size cutting-off machine but may be applied to any of the machines built by this company. The device consists of a pedestal support containing an idler roll which supports the weight of the stock at the outer end. Two round bars connect this standard to the base of the machine; and the traveling stock rest or carriage in which the stock is clamped moves along these bars, the movement being controlled by a crank at the front of the machine. This crank is connected to a chain which, in turn, is attached to the stock carriage. The usual length in which this stock feed attachment is furnished is 6 feet, but the length may be easily increased by providing longer or shorter connecting bars and a chain of corresponding length. In operation, the

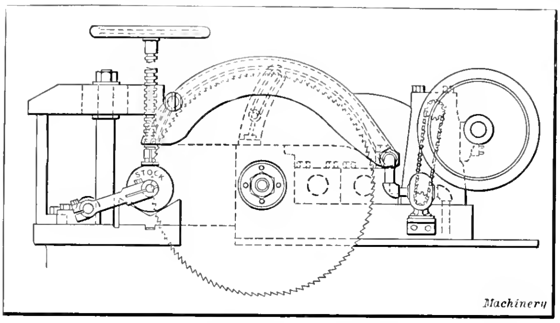


Fig. 3. Nutter & Barnes 6-inch Cutting-off Machine equipped with Stock Feed Attachment

stock clamp on the machine is released and the stock brought forward by turning the crank at the front of the machine, until the end of the bar has been brought into contact with the stock gage, which is set in accordance with the length of the piece that is required to be cut off. The clamp on the machine is again tightened and the saw started. This sequence of operations is repeated until the traveling clamp has reached the full length of its traverse, after which the clamp is released and moved back to the starting position at the opposite end of the connecting bars.

BECKER MILLING CUTTER

A high-power inserted tooth milling cutter which has recently been placed on the market by the Becker Milling Machine Co., Hyde Park, Mass., is shown in Fig. 1; and Fig. 2 presents details of the construction of this tool. The most important feature is the solid backrest for the cutter teeth, inserts being provided in the cutter body, against which the teeth have a solid bearing, as shown in the cross-sectional view *A–A*. The inserts which back up the teeth are prevented from moving in or out by means of screws, one of which is shown in the cross-section *B–B*. The section *C–C* shows one of the adjusting screws. These screws have 5/8 inch adjustment and provide for taking up wear on the cutter teeth as

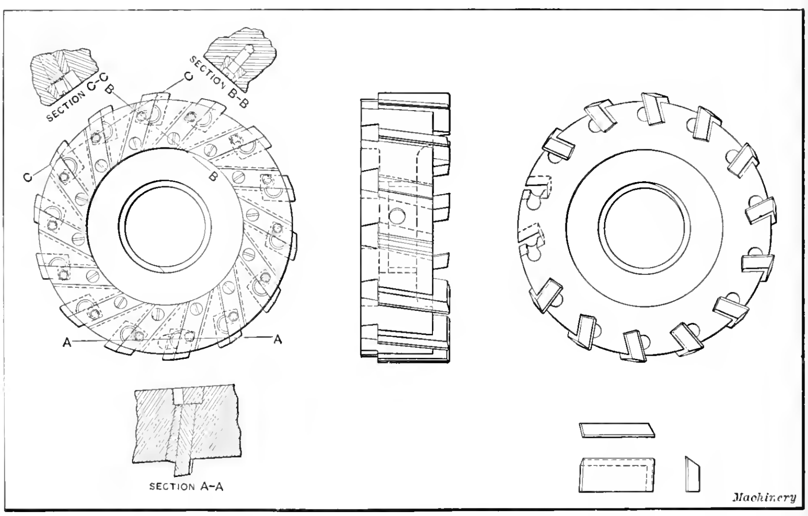


Fig. 2. Assembly and Cross-sectional Views of Becker Inserted-tooth Milling Cutter showing Construction


Fig. 1. Opposite Sides of the Becker Inserted-tooth Milling Cutter

they become smaller through repeated grinding. The teeth are held in the body by means of hardened tool steel pins.

The body of the cutter is made of nickel steel and the blades of "Novo Superior" steel. In assembling the cutter, it is important to observe that the blades must not drive so tight that the adjusting screws will not work them. The teeth are set back of the center line at an angle of 15 degrees and a rake of 10 degrees. In a recent test conducted with one of these cutters on a Becker high-power milling machine, the cutter was run at a peripheral speed of 115 feet per minute with a feed of 3/8 inch per revolution. Operating under these conditions, cast iron with 20 per cent steel was removed at the rate of 52 cubic inches per minute and the cutter showed no sign of chatter or vibration.

NORTON GRINDING WHEEL STAND

This machine is the result of the experience of the Norton Co., Worcester, Mass., in the use of grinding wheels on many types of floor stands; and the designers have endeavored to incorporate into it every feature that will help to obtain greater production, and to give longer life to the grinding wheels and the machine itself. While it is not a radical departure from the machines now common in the better equipped shops, it is evident that its designers have given careful attention to such features as rigidity, safety, convenience of operation, and means of lubrication and dust removal. Particular attention has also been paid to the general appearance of the machine as indicated by its freedom from sharp corners, recesses and uncovered bolts. While the foundation space occupied by the machine is small, its weight and rigidity permit of a very desirable overhang of the bearing-bed. This feature allows ample foot-room for the operator. Each bearing is divided into two parts and the large bearing surfaces help to insure long life. The diameter of the spindle in the bearings is made 1/16 inch

oversize, allowing sufficient stock for regrinding when this becomes necessary. The portion of the spindle outside the bearings is made sufficiently long to take taper wheels of $\frac{1}{2}$ or $\frac{3}{4}$ inch taper per foot, which have the same width of face as the maximum width of straight wheels. End play on the spindle is easily taken up. The inside flanges are fitted loose on the spindle and driven by a key, making their removal a simple matter. Taper flanges of any make may be used on these machines, if the hole is the right size, by cutting a spline in the hole of the inside flange to fit the square key in the spindle.

Oiling is accomplished by the splash system, insuring positive lubrication. The oil reservoir, which is located under and between the two parts of the bearing, holds a supply of oil sufficient for several months. The design allows ample space for the oil to drain back into the reservoir and be used over and over again. All lubricant can be easily and quickly removed from the reservoirs which are readily accessible for cleaning. Dustproof covers protect the bearings and oil chambers and an oil guard inside the bearing-chamber prevents the oil thrown up by the splasher from working out through the joints of the bearing-bed and bearing-cover. The under side of the overhanging bearing-bed is provided with a machined seat and T-slots; and the work-rest brackets, protection hoods and surface grinding attachments are secured by bolts placed in those T-slots, in which they may be attached or removed very quickly. All attachments

Fig. 1. The Norton Model D Grinding Wheel Stand

are independent and interchangeable. Whenever it is desired to grind large work that requires the removal of the work-rest, the work-rest bracket can also be removed. This permits the grinding of large pieces without interference of projecting brackets, even if the wheel in use is of minimum diameter. The top surface of the work-rest is chilled, insuring long life; and is of ample size to give adequate support for large and heavy work.

A substantial belt guard, which permits any belt angle from vertical to 45 degrees, extends two inches above the top line of the maximum size of wheels. This, besides affording protection to the operator, serves to protect the belt when long pieces are ground on the surface grinding attachment. A protection- and dust-hood, designed especially for the Model D floor stand shown in Fig. 1, is for the purpose of providing protection against injury in case of accident to the wheel; and also, when the hood is connected with some suitable dust removal system, against injury to health from inhalation of dust. The bracket which supports the hood serves also as a dust exhaust pipe. The closed hood consists essentially of a heavy band of boiler plate and two heads or side plates. The hood surrounds about five-sixths of the wheel, leaving a 60-degree opening, and a heavy steel slide provides adjustment for wheel wear. The slide travels in grooves, describing an arc around a center other than the spindle center so that, irrespective of the size of a wheel, 60 degrees of the periphery of the wheel is exposed for grinding purposes and protection is always afforded. This type of hood covers the end of the spindle, thus preventing accidents due to clothing becoming caught on the nut on the spindle. Through the employment of a special lock-nut the outer head or side plate is easily removed to permit making a change of wheels.

In addition to the Model D type of hood, the Norton Co. is also placing on the market a Model E hood which is designed along the lines of the former and adaptable to any make of floor stand conforming to the general contour of the Norton stands. In applying this hood, it is simply necessary to provide a suitable bracket to which may be attached the


Fig. 2. Protection- and Dust-hood of the Norton Model D Grinding Wheel Stand, shown Closed and Open

inner head, which, in turn, holds the entire structure. This hood is so designed that it is adjustable about the wheel, permitting the grinding to be done on top, at the front or at the bottom of the wheel. Instead of having the bracket by means of which the hood is fastened to the wheel, serve the additional purpose of a dust exhaust pipe, the inner head of the hood is solid and the exhaust pipe is located on the boiler-plate band. The exhaust pipe is mounted on a steel plate of the same radius as the band and is firmly bolted to the latter. Model E hoods are furnished with a full size band and the exhaust connection is not attached. The user can readily cut the opening at any desired point and attach the exhaust connection after the hood is located on the machine.

These machines are made in four standard sizes with spindles $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$ and 2 inches in diameter, and a special machine can be built to order with a spindle $2\frac{1}{2}$ inches in diameter. The principal dimensions of the machine with a 2-inch spindle are as follows: Distance between wheels, 62 inches; height of spindle above the floor, $30\frac{1}{2}$ inches; length

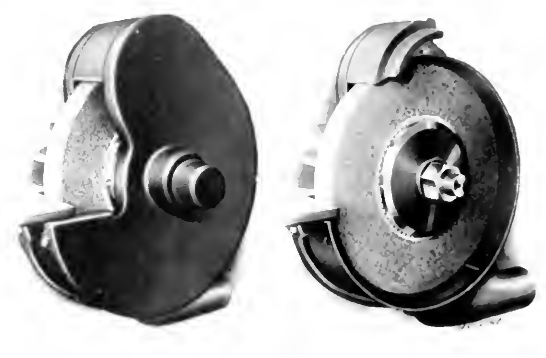


Fig. 3. Protection- and Dust-hood of the Norton Model E Grinding Wheel Stand shown Closed and Open

of bearings, $16\frac{1}{2}$ inches; diameter of spindle bearings, $2\frac{3}{16}$ inches; diameter of safety flanges, 12 inches; size of cone pulley steps, $9\frac{1}{4}$, $8\frac{9}{16}$ and $5\frac{3}{4}$ inches; foundation space required 27 by 42 inches; floor space occupied by machine, 27 by $88\frac{1}{4}$ inches; size of wheels used, 24 inches in diameter by 4 inches face width; net weight of machine and hoods, 1765 pounds.

FITCHBURG GRINDING MACHINES

The Fitchburg Grinder Co., Fitchburg, Mass., is the manufacturer of the 6 by 15 inch plain grinding machines shown

in the accompanying illustrations. Fig. 1 shows the front view of the style A machine and Fig. 5 shows the front view of the style B machine. Referring to these illustrations, it will be seen that a large pilot wheel has been substituted on the style B machine in place of the power table traverse employed on the style A grinder. By omitting the transverse gear box and automatic feed, it has been possible to build an efficient machine at a comparatively low price, for grinding short cylindrical pieces in large quantities. In other respects, the styles A and B machines are quite similar and the detailed description which follows is applicable to either type.

These machines are essentially manufacturing grinders for producing either straight or taper cylindrical work in quantities. The wheels used are 16 inches in diameter and 2 or 3 inches face width. The work may be supported on either dead or live centers. It has already been stated that the style A machine is fitted with power table traverse and work change gear boxes, each of which is independent of the other and provides suitable speeds and feeds for various classes of work which come within the range of this machine. A single lever provides for starting or stopping

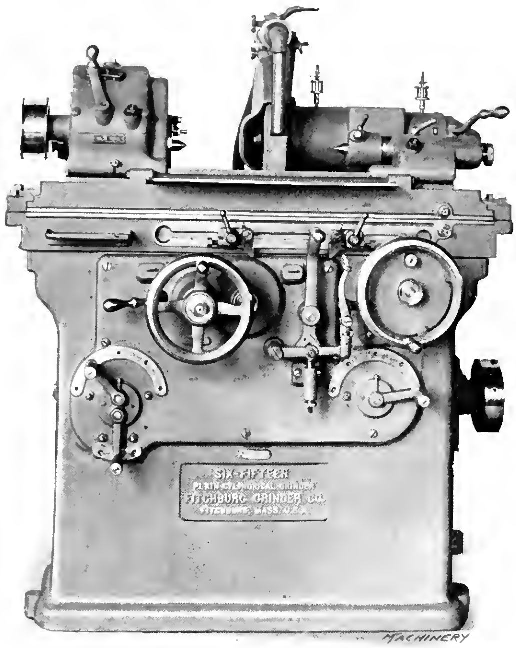


Fig. 1. Front View of Fitchburg Style A Plain Grinding Machine

the table travel at any point in its stroke and for simultaneously engaging or disengaging the traverse handwheel. The style A machine also has automatic cross feed and positive stops for use in the production of duplicate work. All shaft bearings in the machine are ground and fitted with removable bushings, and many of the bearings are self oiled.

The base of the machine is of massive proportions and internally braced to give the required rigidity. It is of compact design and the units are so located as to be easily accessible. Any unit may be removed from the machine without requiring the other units to be disturbed. Wide bearing surfaces of the V- and flat type are provided. An oil reservoir for automatically oiling the ways is located in the bed. A pan of liberal proportions is provided at the back of the machine to catch the water. The wheel spindle is made from a special alloy steel, and after hardening, is ground and lapped to the required size. Bearings are bushed with phosphor-bronze, and large self-feeding lubricators are provided to insure having a liberal supply of oil delivered to the boxes.

The wheel head is of massive proportions, and slides on long flat- and V-ways. It is held in place by gravity and is provided with a safety gib to guard against danger of lifting

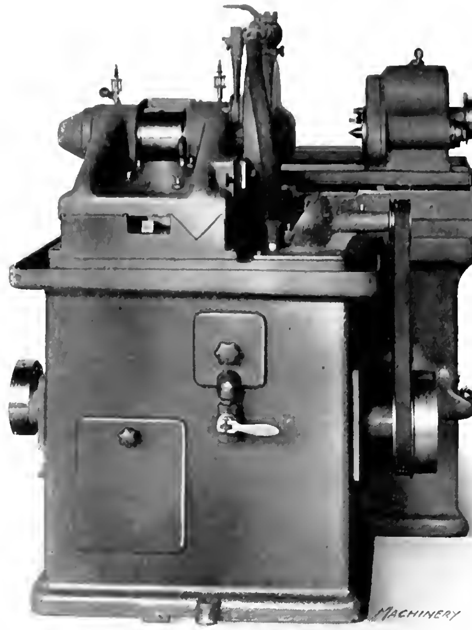


Fig. 2. Opposite Side of Machine shown in Fig. 1

under normal conditions. The table slide is unusually heavy and is powerfully ribbed to resist torsional strains. The swivel table has a liberal bearing on the table slide and pivots on a large central stud. This table provides for grinding tapers; it is graduated to read in degrees and tapers expressed in inches per foot.

The headstock slides on the ways of the table and is clamped in position by a hook bolt. It is of the geared type, the spindle being ground and fitted in removable bronze bushings which may be replaced when worn. The moving parts are lubricated by the splash system. The spindle is hardened and finished by grinding and lapping; it may be revolved for grinding parts which require a live spindle. The work is started and stopped by a lever mounted on the headstock. The footstock is secured to and preserves its alignment on the swivel table in the same manner as the head-

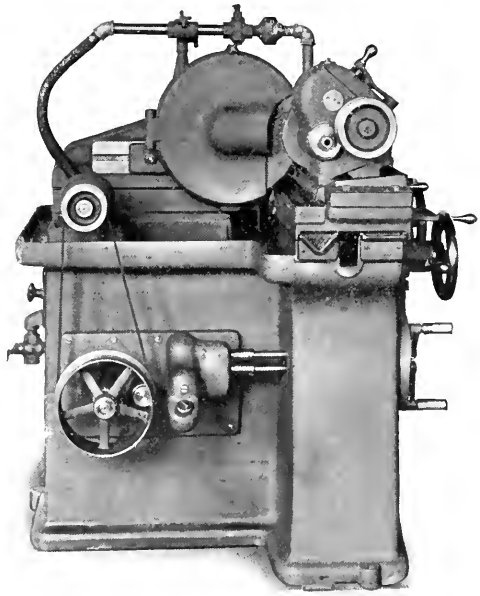


Fig. 3. End View of Fitchburg Style A Plain Grinding Machine

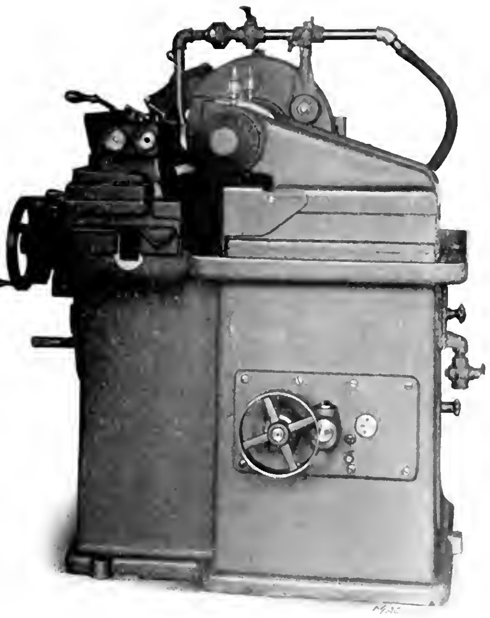


Fig. 4. Opposite End of Machine shown in Fig. 3

stock. The wheel side of the footstock base and the spindle are flattened, which reduces the movement of the wheel slide when truing the wheel. The diamond point for this purpose is mounted on the footstock spindle which may be rigidly clamped for supporting the center to the work.

The universal back-rests provided on this machine have both vertical and horizontal movement and very delicate adjustments can be made. The pump is of the fan type and revolves in a horizontal plane; it is kept immersed so that it is constantly primed and no packing is required. The water tank is of ample size and provided with settling pans which are easily accessible for cleaning. The self-contained countershaft provides three changes of speed for the grinding wheel and all rotating members run on Hyatt roller bearings. All overhead belt changes are operated from the front of the machine. The equipment of the grinder includes self-contained overhead works, a universal back-rest, a center grinding attachment, water guards, dogs, two grinding wheels and the necessary wrenches.

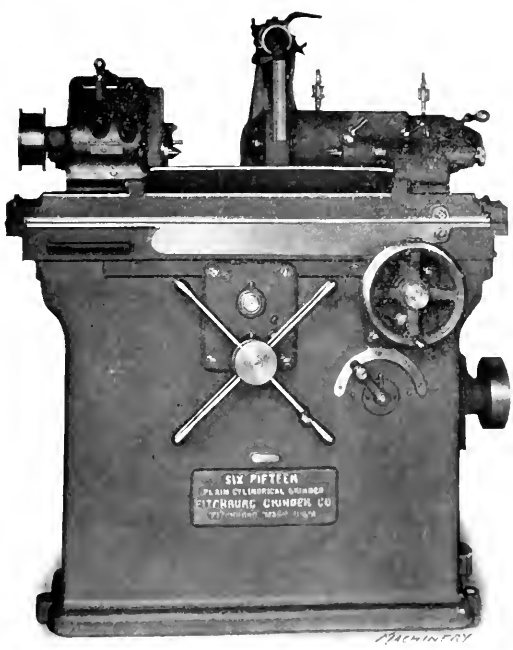
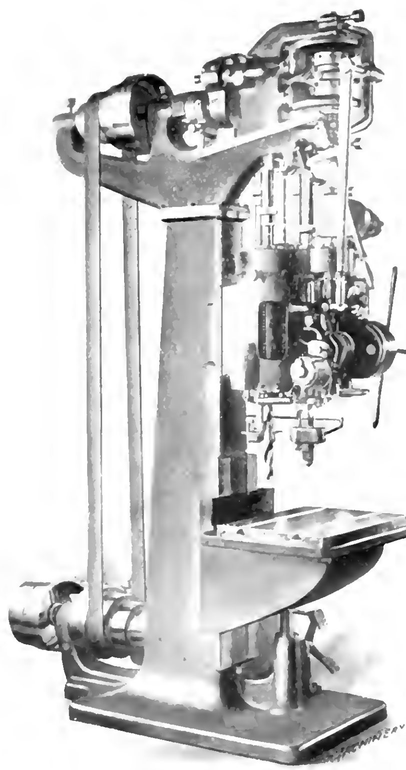


Fig. 5. Front View of Fitchburg Style B Plain Grinding Machine

The principal dimensions of the style A machine are as follows: Swing over table, 6 inches; distance between centers, 15 inches; swivel table graduated to an angle of 13 degrees or to a taper of 5 inches per foot; number of work speeds, 10; range of work speeds, 30 to 345 R. P. M.; number of traverse table feeds, 10; range of traverse table feeds, 10 inches to 92 inches; number of grinding wheel speeds, 3. The power developed by the motor which drives the machine is 7 horsepower. The floor space occupied is 52 by 66 inches; and the net weight of the machine, 3600 pounds. Similar dimensions apply to the style B machine except that there are no power movements for the table, and the net weight of the machine is 3350 pounds.

TURNER AUTOMATIC TURRET DRILL

With the view of increasing production by having a series of tools available for performing successive operations on a piece of work without requiring it to be reset or the tools to be changed, the Turner Machine Co., Danbury, Conn., has brought out the Model F turret drill which is illustrated herewith. This machine is of heavier construction than the other types of turret drills built by this company, the present machine being intended for relatively heavy work. It frequently happens, however, that some small holes have to be machined in a piece in which it also is required to drill relatively large holes, and to enable these small holes to be drilled efficiently, the use of drill speeders is recommended. Each spindle in the turret carries a different tool which is successively and automatically registered in exactly the same position. The mechanism by which this automatic indexing is obtained is not complicated and the machine can be operated rapidly by an average workman and produce work of extreme accuracy. The accompanying illustration will give the reader an idea of the design.



Turner Model F Heavy-duty Turret Drilling Machine

The column and base are cast integral, the column being of rectangular section and tapering from 8 by 15 inches at the base to 5 by 11 inches at the top; it is internally ribbed and cross braced to provide the required rigidity. It will be seen that the turret is vertical; it rotates automatically and when the operator returns the spindle to its full height, the turret indexes to bring the next spindle into the operating position. The detents are adjustable for both wear and accuracy. They are made of a special chrome-vanadium steel which has a compressive strength exceeding 400,000 pounds per square inch when heat-treated according to the method used by this company. As the detents are located further from the center of the turret than the working tools or spindles, a high degree of accuracy is obtained. The spindles are of heat-treated nickel steel, the elastic limit of which is in excess of 90,000 pounds per square inch; the spindles are completely finished by grinding. The spindle driving gears are made of heat-treated chrome-nickel steel, and Feichtel & Sachs ball thrust bearings are mounted under the spindle gears on the top of the turret and also at the bottom of the spindle in order to support the thrust of the tools and increase the smoothness of drive.

The feed mechanism is driven from the vertical shaft which drives the spindle and the feed may be engaged or disengaged without stopping the machine. An automatic trip is provided to throw out the feed at any predetermined point in the spindle travel. The feed gears are enclosed in a dust-proof case and provide four changes of feed, the drive being direct on the coarser feeds. The feed gears, in connection with the two spindle speeds, provide a range of eight changes for the machine. The feed is actuated by helical gears which operate very smoothly. The feed gears are only running when the feed is in operation. Three sets of helical gears are used in the feed mechanism; the first two sets run at higher speeds and lower pressure than the final set. The thrust of the first two sets of gears is taken by a system of multiple washers and the thrust of the final set is carried by a ball thrust bearing. One gear of each pair is of chrome-nickel steel and the other is of a special grade of hard bronze.

The spindles may be fed by either hand or power. For the hand feed, either a handwheel or lever is used, the former being more sensitive and better adapted for profiling and other milling operations. The inactive spindles are positively locked in their extreme upper position and as each spindle is automatically swung into the working position, the positive lock is released. The spindle projects approximately 1½ inch under the sleeve and a ball thrust bearing is interposed between the nose of the spindle and the end of the sleeve. The bearing is packed with grease and surrounded by a dust-proof brass collar. The sleeve is 12 11/16 inches in length and the spindle has a 4-inch bearing within the sleeve at each end, with an oil chamber at the center. The upper end of the spindle is guided in the turret. This method of supporting the spindles close to the nose—together with the long bearings placed far apart—gives exceptionally rigid support.

A feature which makes the machine suitable for driving small and delicate tools, such as drills and taps, is that each tool has its own individual feed, which may be operated by hand if desired. This offsets the weight of the machine, which would otherwise be poorly adapted for driving delicate tools. It is not feasible to provide in a single machine the extreme range of speeds and feeds which are necessary for driving tools of widely divergent sizes. For example, a machine powerful enough to drive drills from 1 to 2 inches in diameter could scarcely be made suitable for driving small sized drills. Yet it is often desirable to have such operations follow each other on the same piece of work. As previously mentioned, the Turner turret drill is adapted for work of this character by using drill speeders to drive the smaller sized tools.

The back gears are operated by a friction clutch and may be rocked out of engagement when not in use, in the same way that the back gears of a lathe are disengaged. The gears which operate the reverse mechanism for tapping and threading operations, back out the tap or die at 1.6 times the forward speed. The tapping gears may be disengaged by means of an intermediate gear and friction clutch when the tapping mechanism is not required. Both the back gears and the tapping gears may be engaged or disengaged without requiring the machine to be stopped. The control levers for all members of the machine are within easy reach of the operator. All shaft bearings are bronze bushed so that they may be easily renewed when necessary. Wherever it is possible, lubrication is provided by grease cups. The table is adequately ribbed and has a working surface 18 by 23 inches in size. The oil groove is of ample proportions to prevent lubricant from overflowing, the lubricant being supplied by a gear-driven pump and delivered through a flexible supply pipe. The table is supported from the knee, on which it has a three-point bearing. In changing the machine over from one job to another, it is merely necessary to change the tools for the successive operations to be performed, and to locate the jig or fixture that is to be used on the table. Each tool is automatically brought to the same center until the sequence of operations has been completed.

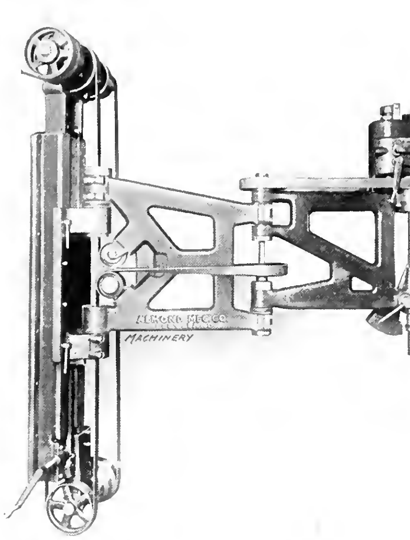


Fig. 1. Almond Post Type Radial Drill with Arm extended

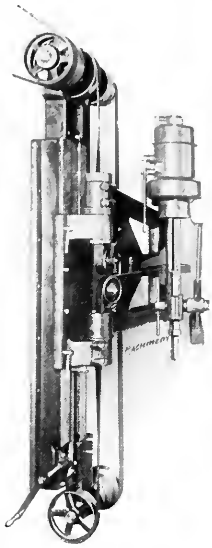


Fig. 2. Machine shown in Fig. 1 with Arm Closed

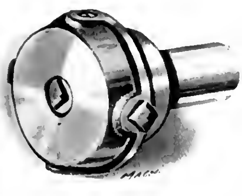
ALMOND POST TYPE RADIAL DRILL

A post type radial drill designed to be fastened to either a column or wall, and used for light drilling and tapping operations, is illustrated in Figs. 1 and 2. This machine has a drilling radius of 4 feet and will handle twist drills up to ⅞ inch and standard taps up to ¾ inch in diameter. The machine is entirely self-contained and may be driven direct from the lineshaft or by an individual constant-speed motor. Six changes of spindle speed are provided, these speeds being in geometrical progression and ranging from 175 to 1000 revolutions per minute. The machine is equipped with ball bearings throughout so that it is well suited for operation at high speed. The saddle that carries the swinging arm has a vertical adjustment of 2 feet, an elevating screw with the thrust supported by a ball bearing being provided for this purpose. The main driving belt passes through the trunnions on which the main frame swings, so that the belt tension and alignment are not affected by the swinging of the arms or by the vertical adjustment. Provision is made on the machine for maintaining the tension of the driving belts at the required point. The weight of the swinging frame is supported by ball thrust collars and provision is made for taking up any wear which may develop at the trunnions.

The geared tapping attachment is one of the features of this machine. When the spindle is run on either of the three open belt speeds which are obtained by the three steps on the cone pulley, the reversing gears are not running, these gears being automatically locked out of engagement when the machine is operating under these conditions. When the tapping attachment is thrown into operation, the spindle speed is reduced to 1/3 of the open belt speed and a quick reverse of approximately 2 to 1 is available. Owing to the fact that the belt speed is not reduced, this arrangement gives ample power as well as the proper speeds for large drilling, reaming, counterboring and stud set operations, in addition to tapping. The change from the drilling speed to the tapping speed is made while the machine is running by means of the operating levers shown on the side of the head. The hand feed lever has a ratchet adjustment and a counterweight is attached to it. This counterweight supports the weight of the spindle and tool, and provides for returning the lever into a convenient position for the operator. This machine is manufactured by the Almond Mfg. Co., Cleveland, Ohio.

SMILLIE TURRET LATHE DRILL CHUCK

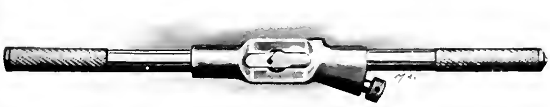
C. M. Smillie, 130 E. Larned St., Detroit, Mich., is the manufacturer of the turret lathe drill chuck illustrated herewith. This chuck is not self-centering. It is provided with means for setting the tool either way from the chuck center in order to line the tool up properly with the machine spindle. This adjustment is made by two cap-screws which move the jaws in a transverse slot in the body of the chuck. The chuck is set in the turret with the jaw slot either horizontal, vertical or at an angle, with the line of travel of the jaws crossing the axis of the machine spindle. The adjusting screws are then regulated to bring the tool into exactly the required alignment. If it is necessary to remove the tool for grinding, this is done by simply loosening one screw and after grinding the tool, replacing it in the chuck and tightening the screw up again. Where this method is followed, the alignment is not disturbed. The chuck can be quickly set up on the machine and it is of simple and substantial design so that ample wear is assured. The tool is made in three sizes which have respective capacities for drills from No. 42 to ½ inch, from ¼ inch to ¾ inch and from ½ to 1 inch in diameter.



Smillie Turret Lathe Drill Chuck

F. E. WELLS TAP WRENCH

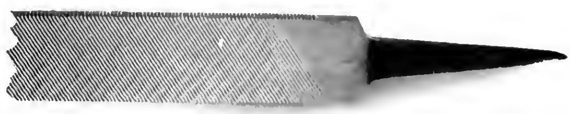
An adjustable tap wrench of simple design, which is a recent product of F. E. Wells & Son Co., Greenfield, Mass., is illustrated herewith. This wrench consists of four essential parts in addition to two connecting pins, and there is practically nothing to get out of order. The centers are drop-forged and the handles and jaws are in one piece. An independent screw is provided for tightening the movable jaw on the tap shank, the arrangement being such that the jaw cannot work loose. The jaws are milled flat to give the best possible grip on the shank; they are made of carbon steel, hardened and tempered. It will be seen that the center has a mottled or "gun metal" finish and that the handles are knurled to prevent the hands from slipping when they are covered with oil. This tap wrench is made in eight sizes and the range of the complete set is from 1/16 to 1½ inch.



F. E. Wells Tap Wrench of Simple Construction

AMERICAN SWISS FILE & TOOL CO.'S "WAVECUT" FILE

The American Swiss File & Tool Co., 24 John St., New York City, has added to its line a file known as the "wavecut." The cut consists of diagonal rows of cutting edges which give the file its wavy appearance, hence the name "wavecut." This new file removes metal in curly shavings rather than the granular filings produced by ordinary files. The new file operates at a high efficiency, and it is durable and of excellent appearance. Tests which have been made show that the "wavecut" file is equally serviceable in filing silver, brass, copper, nickel, cast iron and steel. At present, these files are only being made in the hand shape, and in 8-, 10-, 12- and 14-inch sizes, each size being made in coarse, medium and fine cuts.

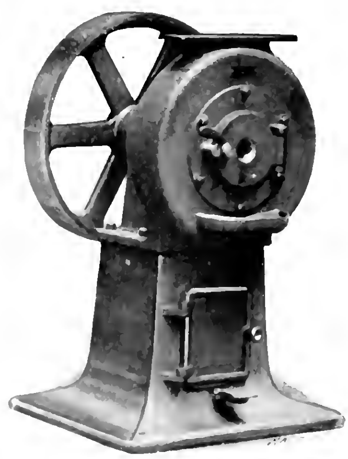


American Swiss File & Tool Co.'s New "Wavecut" File

Heretofore, the American Swiss File & Tool Co. has not made files exceeding 12 inches in length, but in response to an insistent demand, 14-inch files have been added and files of this size are now carried in stock. These files are made in the hand, round, square and mill shapes and three different cuts.

WATERBURY-FARREL SWAGING MACHINE

The demand for machines for pointing, reducing and shaping round stock and tubing by the cold process has led the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., to build a line of standard rotary swaging machines which are made in several different sizes with capacities from ¼ to 1½ inch in diameter. These machines are largely used in rod and tube mills for pointing material preparatory to drawing it through dies on a "bull block," and they are extensively used in the manufacture of various staple articles in the metal trade such as hose nozzle, tapered shells and screw and bolt work.



Waterbury-Farrel Swaging Machine for reducing Round Bar Stock or Tubing

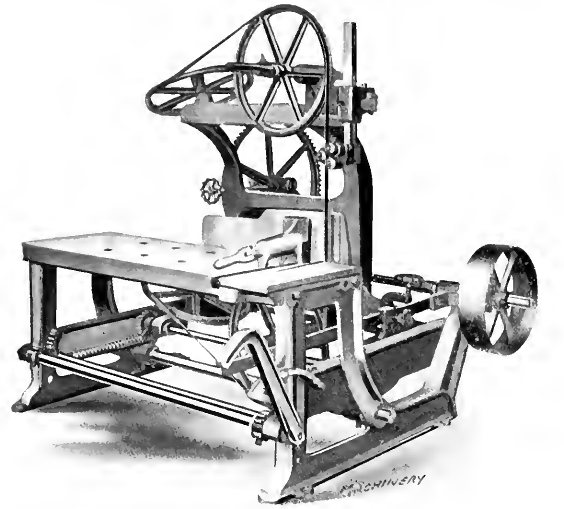
These swaging machines are extensively used by jewelry manufacturers for reducing a bar or ingot of pure or plated metal to a small size, which is suitable for drawing on individual blocks or continuous wire-drawing machines. They are of very simple construction and built exceptionally strong to enable them to stand up under various severe service conditions.

The design has been worked out in such a way that the dies and working parts of the mechanism are readily accessible. In the operation of this machine, a series of very rapid impressions is made in the rod or tube by a pair of die blocks which have a concentric or rotary motion around the work, thus effectually eliminating the possibility of developing a fin or burr.

SHINN METAL CUTTING BAND SAW

M. E. Shinn & Co., 1846 W. Lake St., Chicago, Ill., are now building the vertical, gravity-feed band saw which forms the subject of this article. This machine is designed for cutting metal into various lengths and at any required angle. It will be evident from the illustration that the design of the machine is such that there is nothing to interfere with the bar to be cut, no matter what its length may be. An easily adjusted swiveling table back, and a vise which operates in a groove on the table, enables the material to be cut at any angle, and to be rigidly held during the cutting operation. By loosening a single cap-screw, the saw may be adjusted to provide for ripping sheet metal lengthwise.

An important feature of this machine is the way in which the non-cutting part of the saw is returned, by passing over



Shinn Metal Cutting Band Saw equipped with Gravity Feed

idler wheels in such a way as to obviate the possibility of its interfering with the material that is being cut, and at the same time leaving the cutting edge of the saw perfectly vertical and free from twist. This arrangement enables the saw to run straight in the line of cut and insures accuracy and long life to the saw blade. The frame supporting the band saw wheels is mounted upon four ball bearing wheels, and provision is made for holding the frame in accurate alignment. The inclination of the track-way on which the wheels supporting the saw frame run is altered by means of the operating lever shown at the front of the machine at the right-hand end, the feed being regulated by setting the track-ways at an angle in this way. The cutting part of the saw maintains a vertical position during the entire length of cut and the gravity feed is constant although it can be increased or decreased by the lever referred to.

The action of the machine is entirely automatic and after the cut is completed, the saw is stopped by means of a dog operating a clutch attached to the driving pulley. This machine has a capacity for cutting metal up to 12 by 11 inches in size and leaves a smooth finished surface. The floor space occupied is 45 by 45 inches. The band saw used is 15 feet 6 inches long by ⅝ inch wide by 0.0312 inch thick. An idea of the capacity may be gained from the fact that the machine will cut a 2½-inch cold-rolled shaft in 3 minutes.

K. & E. SLIDE RULE INDICATOR

It frequently happens that after setting the indicator or "runner" on the Mannheim or duplex type of slide rules made by the Keuffel & Esser Co., Hoboken, N. J., it is impossible to read the result because certain important figures are hidden by the frame which holds the glass. Several figures are often obscured in this way, causing some inconvenience to the user of the rule. With the view of overcoming this difficulty, the frameless indicator shown in the accompanying illustration has been designed and patented by this company. It will be evident from the illustration that there is nothing to cover the scales on the rule, so that every figure is always visible. This improvement greatly increases the ease and rapidity with which a slide rule can be used and will doubtless be appreciated by the many engineers, draftsmen and others who have occasion to use these useful instruments in making rapid calculations. Hereafter, the K. & E. adjustable slide rules of the Mannheim and duplex types will be equipped with frameless indicators.

AMES BENCH FILING MACHINE

The Ames bench filing machine designed particularly for work on which it is desired to file surfaces perfectly straight and true to any required angle is shown in Fig. 1. This machine is adapted for filing dies, jigs, templets and for similar classes of service. The height from the bench to the table of the machine is 18 inches and the table is 9 inches in diameter. The length of stroke may be adjusted from 2 to 5 inches to meet the requirements of various classes of work. It will be seen that the machine is driven by a three-step cone pulley, and an idea of its size will be gained from the fact that the machine and countershaft weigh about 145 pounds.

This filing machine will not take regular stock files. Special parallel files are used which are supported at both ends, as in the case of a jig saw. These special files are 8 inches in length and are used in much the same way as a hack-saw blade; either saws or files can be used in the machine and accurate work is produced in both cases. The machine is particularly adapted for die work; and the dies are taken from the machine with straight, true surfaces of known clearance. This machine is a recent product of the B. C. Ames Co., Waltham, Mass.

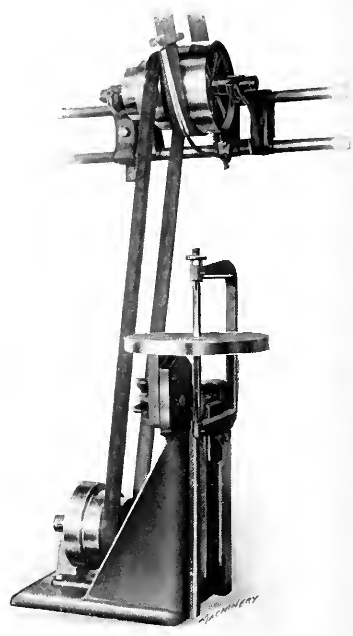
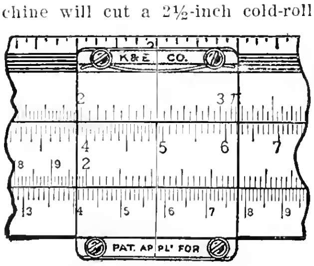


Fig. 1. B. C. Ames Bench Filing Machine



Frameless Indicator for K. & E. Slide Rules

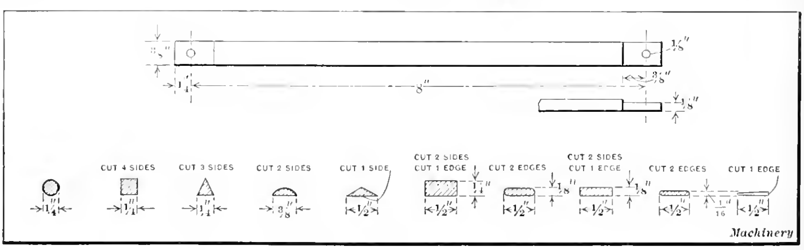


Fig. 2. Examples of Special Files for Machine shown in Fig. 1

EAMES ARBOR PRESSES

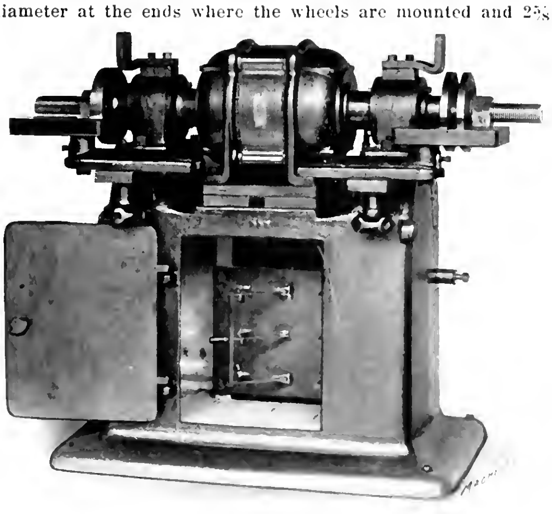
The G. T. Eames Co., Kalamazoo, Mich., has added to its line of arbor presses three small sizes known as the Nos. 0, 1 and 1½. These small machines were developed to meet the demand of shops where the work requires no great amount of power. The Nos. 0 and 1 machines are built with the ordinary vise type of handle, while the No. 1½ machine has a ratchet attachment so that the lever may be used in

Eames Nos. 0 and 1½ Arbor Presses

the most convenient position. The design and construction of these tools is in accordance with the most modern practice and is such as to enable them to stand up under hard service conditions.

RANSOM BALL BEARING GRINDER

The accompanying illustration shows a motor-driven dry grinding machine built by the Ransom Mfg. Co., Oshkosh, Wis. The motor is 5 horsepower and runs at 900 revolutions per minute; it is intended for use on a 60-cycle, 3-phase circuit. The motor is bolted to the main frame of the machine and is usually of the open type, although it can be enclosed if so desired. The rotor spindle is 2 inches in diameter at the ends where the wheels are mounted and 2⅝



Ransom Ball Bearing Motor-driven Grinder

inches in diameter between the bearings. It is made of high-carbon steel and supported on either side of the motor by S. K. F. ball bearings of the double row, self-aligning type. The ball races are exceptionally heavy. The grinder is equipped with two abrasive wheels 24 inches in diameter by 4 inches face width.

With the view of testing the durability of the bearings, one of these machines was recently kept in constant operation on heavy foundry grinding for a period of five months. Two operators were employed to have the machine running under full load at all times. At the end of this test a careful examination failed to show any appreciable wear in the bearings. The wheels are covered by steel guards provided with exhaust pipe connections. The guards have been removed from the machine shown in the illustration in order to illustrate the bearings to better advantage, but the supporting points for the guards are shown. Although the ball bearings cost more than babbitted bearings, they are the means of reducing friction and maintenance costs, preventing the rotor from hitting the starter due to play which may develop in plain bearings, and the ball bearings are easily replaced should they become worn. As previously mentioned, the machine shown in the illustration is equipped with wheels 24 inches in diameter by 4 inches face width, but grinders of this type are built in sizes for wheels from 16 inches in diameter up. They are made in both the belt- and motor-driven types.

ROCHESTER CASEHARDENING FURNACE

The Rochester Casehardening Co., Rochester, N. Y., has recently brought out the oil-fired furnace shown in Fig. 1, which was designed by G. L. Schuetz, the manager of this company. While the furnace can be supplied in several different sizes, the one in the illustration has a firebox 12 inches high by 24 inches wide by 48 inches long. For convenience

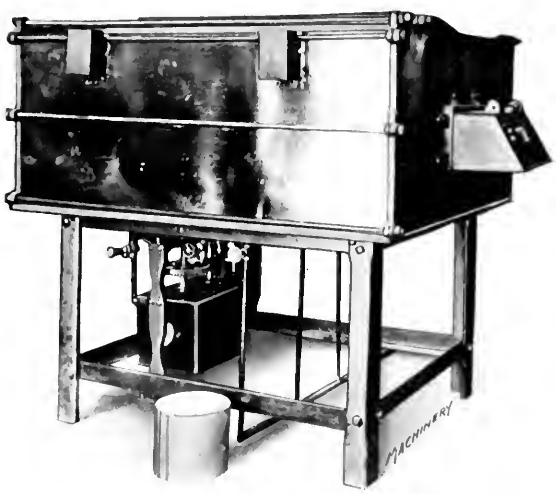


Fig. 1. Rochester Casehardening Furnace

in loading the furnace a door is placed at the rear end in addition to the one that is shown at the front.

This furnace is of the over-fired oil burning type, although it can also be equipped to burn gas. The oil burners are two in number and are located at opposite sides of the furnace near the top. The roof of the furnace is arched and the final combustion takes place in the upper part of the chamber, close to the roof. There is no vent in the roof of the furnace, it being claimed that the combustion is so complete that no objectionable products are given off. It is also said that because there is no vent, the opening of the furnace door does not create a draft.

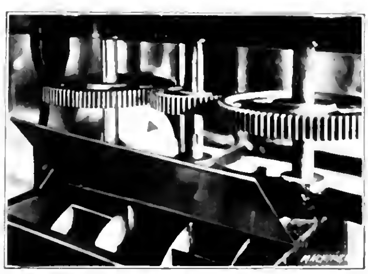


Fig. 2. Mechanism for revolving the Sections of the Furnace Floor

This furnace is fitted with revolving sections in the floor of the firebox so that work requiring very particular treat-

ment may be heated evenly. One of the floor sections is shown lying in front of the furnace. This is 9 inches thick and represents also the thickness of the walls at all sections—a feature that makes a great saving of fuel. The revolving sections of the furnace are rotated by the same air pressure that is supplied for atomizing the oil in the burners. The rotating mechanism is shown in detail in Fig. 2 and consists of a fan box having two bladed fans, against whose blades the air is directed. From the fan shaft, bevel gearing transmits motion to a central shaft, and from a spur gear on this shaft the shaft of the two revolving sections are turned by means of other spur gears. The amount of power required for turning the sections is extremely small, even when the furnace is filled with work. The fan travels at a rate of four hundred revolutions per minute and the revolving plate turns at a speed of 1.7 revolution per minute.

One of the principal advantages claimed for this furnace is that it can be operated on an extremely small amount of fuel. On average work the furnace shown in the illustration uses but two and one-half or three gallons of crude oil per hour. Therefore, at the present price of oil, the furnace can be run at a cost of from twelve to fifteen cents per hour.

KOKOMO HIGH-SPEED DRILL

Recognizing the need of more perfect lubrication of the high-speed parts of vertical drilling machines, the Superior Machine Tool Co., Kokomo, Ind., has added to its line a 21-inch machine in which the friction back-gears and spindle driving gears are completely encased in oil retaining housings. This is the means of avoiding damage due to failure on the part of the operator to pay the necessary attention to oiling his machine. In addition to serving as a means of lubrication, these housings completely enclose the gearing and protect the operator or those passing the machine from injury.

The back-gear case is cast integral with the yoke, with the exception of the gear case cover. It is completely machined as a unit ready to receive the removable bronze bushed bearings with which the machine is equipped throughout. The gear case cover is packed to form an oil-tight compartment in which the splash system of lubrication may be employed. One supply of lubricant will last for months and assure having the parts lubricated in a way which prevents undue wear. In addition, the gears and bearings are protected from dust and dirt and it is impossible for oil to be thrown on the floor or operator. In designing the machine, particular attention has been paid to the provision of means for rapid and constant production, together with a high degree of accuracy. All bearings are bronze bushed and the gears are cut from steel. The machine is equipped with friction back gears and a patented friction quick return.

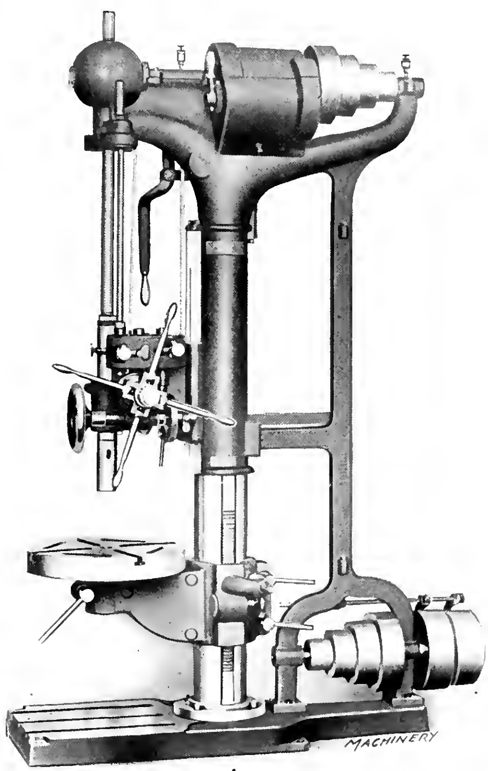


Fig. 1. Kokomo 21-inch Self-oiling Drill

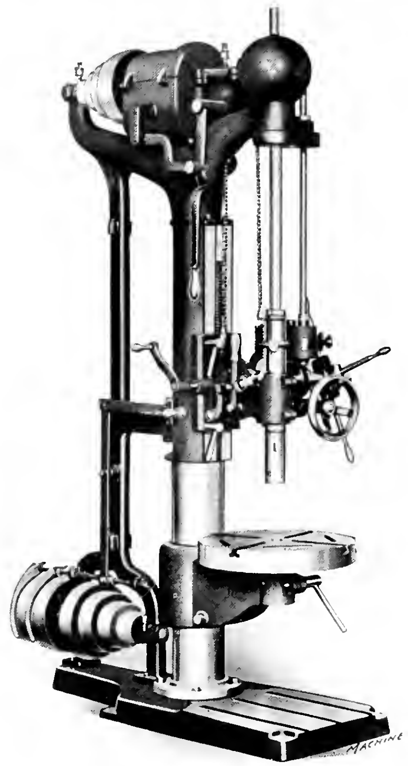


Fig. 2. Opposite Side of Machine shown in Fig. 1

INTERNATIONAL LATHE REVERSE MECHANISM

The International Machine Tool Co., Indianapolis, Ind., has recently designed a mechanical reverse mechanism for use in connection with the "Libby" heavy-duty turret lathe. This

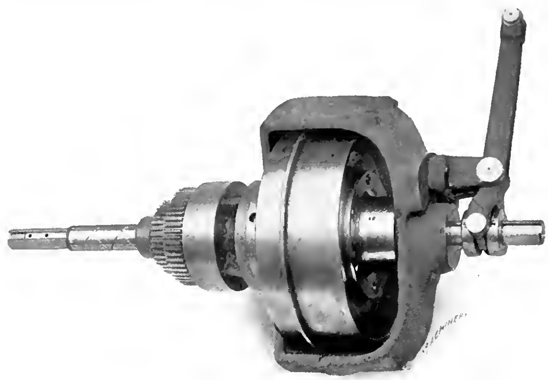


Fig. 1. Reverse Mechanism for Use on the "Libby" Turret Lathe

does away with the necessity for using a reversible countershaft or reversing motor in cases where the performance of tapping operations requires the lathe to be reversed at fre-

quent intervals. Fig. 1 shows the complete reverse mechanism and reference to this illustration will make it clear that this is a self-contained unit which can be easily applied in place of the standard driving pulley, thus making it feasible to add this equipment to any 18-inch "Libby" turret lathe which is now in service. Fig. 2 shows the reverse mechanism set up on a machine and the control at the front of the machine

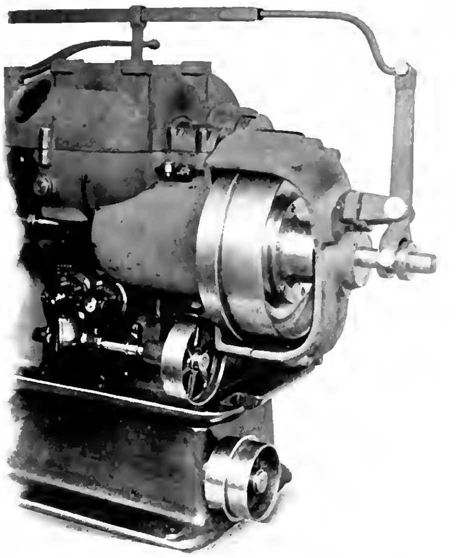


Fig. 2. Reverse Mechanism in Place on the Lathe

where all of the control levers are located. This reverse mechanism is of strong and compact design and is sufficiently durable to stand up under the most severe operating conditions which exist in the average machine shop. All gears are of steel and all bearings are bronze bushed. The gears are engaged by a band friction 7½ inches in diameter which is controlled from the front of the machine as previously mentioned.

NEW MACHINERY AND TOOLS NOTES

Truck Crane: General Vehicle Co., Long Island City, N. Y. An electrically-driven truck crane which can be run about the shop to enable heavy castings and other parts to be handled. The crane has a capacity for lifting work up to 2000 pounds in weight.

Autogenous Welding Outfit: Waterhouse Welding Co., Boston, Mass. A welding and cutting torch which may be used in connection with any type of pressure generator, although it is particularly adapted for use in connection with the safety storage type of acetylene cylinder and an oxygen tank.

Two Electric Tachometers: Electric Tachometer Co., Philadelphia, Pa. One of these instruments is a recording tachometer and the other is a combination recording tachometer and cut-meter, which enables surface speeds to be determined in feet per minute. The instrument can be placed at any desired distance from the shaft, the speed of which is to be determined.

Multiple Spindle Drilling Machine: Michigan Press Co., Ypsilanti, Mich. A machine especially designed for drilling gas burners, but which could also be applied to good advantage on a variety of similar classes of work. The capacity is for drilling from 50 to 100 holes simultaneously in pieces up to 10 inches in diameter. The drills are driven by a crank motion at one end of the spindles.

Cutter Grinder: Flint Specialty Co., 16 Waltham St., Boston, Mass. A grinder adapted for sharpening various types of cutters such as gear cutters and a variety of other formed cutters. No attachments are required except in handling such work as sharpening and backing off saw teeth. The capacity of the machine is for gear cutters up to 3 pitch and saws up to 8 inches in diameter.

Gear-cutting Attachment: Garrett Attachment Co., 14th Ave. and Clinton St., Nashville, Tenn. An attachment which enables milling, gear-cutting and drilling operations to be performed on the lathe. In addition to facilitating work of this nature, the attachment may be used on an upright drill for drilling holes in plates or shafts, where it is necessary to have the holes equally spaced.

Horizontal Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. A high power machine equipped with single pulley drive. The spindle is belt driven, and the machine is double back geared. These millers are built in four sizes of plain and four sizes of universal machines, and the design is similar in many respects to the high power vertical miller of this company's manufacture.

Regenerator Furnace: W. S. Rockwell Co., 50 Church St., New York City. A furnace for use in the forge shop, in which a special economizer shield is provided over the working opening to prevent the loss of the large amount of heat which usually escapes at this point. A novel arrangement of blast acts as a barrier between the operator and the furnace, thus enabling him to work closer to the furnace than would otherwise be possible.

Tumbling Barrel: Warner Bros. Co., Bridgeport, Conn. A tilting tumbling barrel which is intended for cleaning and polishing small stampings, forgings or castings. The barrel may be used for wet or dry rolling of plated stampings, a method which is now finding application in place of hand burnishing. The machine is driven by a single pulley and friction clutch operated by a lever conveniently located for the operator.

Broaching Machine: Pawtucket Mfg. Co., Pawtucket, R. I. A machine designed to cover a wide range of broaching operations. It is operated by a rack and pinion, the pinion and pinion shaft being cut from a single steel forging; and the rack which operates the cutter bar is a steel casting. The work is held in position by means of a bushing through which the broach passes; consequently, it is unnecessary to fasten the work to the machine.

Pneumatic Hammer: Pennsylvania Pneumatic Co., Erie, Pa. A pneumatic hammer for use in the manufacture of die stamped parts from sheet metal. This hammer handles the classes of work which are ordinarily produced by a board drop hammer. The special object in designing this tool was to eliminate the board, friction rollers, gears, clutches, automatic trips and other parts of a somewhat complicated mechanism which are included in the design of many board drop hammers.

Cylinder Boring Machine: Barrett Machine Tool Co., Meadville, Pa. This machine is adapted for either belt or motor drive. The table is 71 by 66 inches in size and the tail pedestal can be adjusted on the bed from 0 up to 60 inches. The boring bar is 8 inches in diameter and has a continuous feed of 60 inches in either direction. Rapid power traverse in either direction is provided and the method of control is such that it may be handled with one hand when moving through short distances.

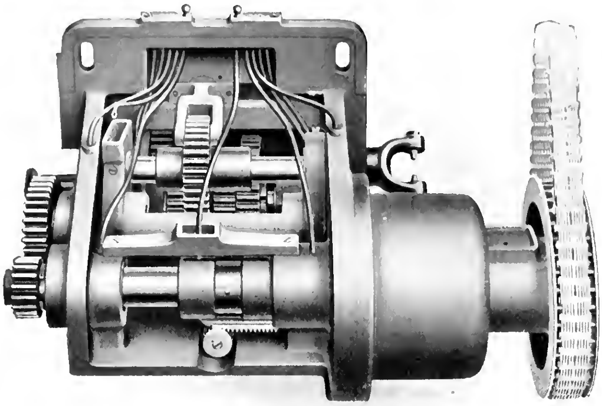
Spur Gear Testing Machine: Gleason Works, Rochester, N. Y. A machine equipped with power drive and a wood lined brake which may be adjusted for testing gears under various loads. The sliding heads of the machine are square gibbed and the spindle bearings are bronze bushed. The adjustment of the center distance is provided by a screw and handwheel graduated to 0.001 inch. The maximum distance between centers is 9 inches and the minimum distance 1¼ inch. The machine swings 16 inches.

Index Centers: Fred C. Dickow, 33 S. Desplaines St., Chicago, Ill. A set of universal index centers which swing 10 inches in diameter. The centers are made of tool steel, hardened and ground, and the spindle is equipped with a clamping device by means of which it can be locked during the cutting operation. This is the means of relieving the worm, wormwheel and index pin of all strain. The index plates provide for obtaining any number of divisions up to 50 and all even numbers from 50 to 100.

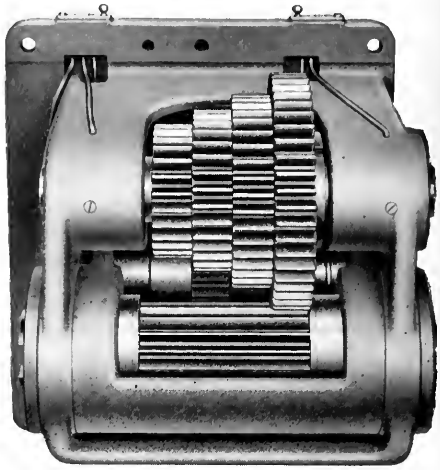
Nut Lock: O. K. Nut Lock Co., Providence, R. I. A nut lock consisting of a corrugated washer and a nut which is corrugated on the under side. The threaded section of the bolt has a slot in it which holds a split washer against turning. When the nut is screwed down, a lug on one end of the split washer engages with the corrugations in the washer, while a similar lug on the other end of the split washer engages the corrugations on the under side of the nut. In this way, the nut is prevented from turning.

Blueprint Machine: Revolute Machine Co., 417 E. 93rd St., New York City. A continuous blueprinting machine in which the light is obtained from two mercury vapor lamps. These lamps are contained in a revolving glass cylinder, and the blueprint paper passes between a belt and the tracing, the tracing being in contact with the glass cylinder. Printing is done while the paper revolves through three-fourths of a revolution of the cylinder. The machine is 32 inches wide and is designed for offices where the demand for blueprints is not large.

Length of Service is Determined



Interior of Feed Case



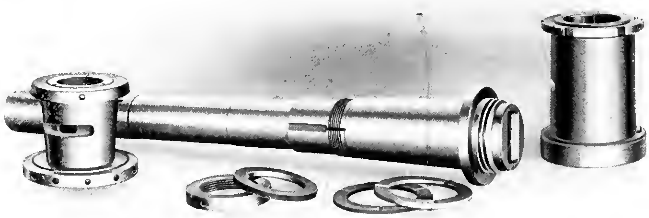
Interior of Speed Case

Bearings—the life of the Milling Machine—are easily overlooked in the general discussion of operating features and productive capacity when buying. Most of them are out of sight, yet their distribution, size and quality are the points which really determine length of service and the return on the investment.

The three cuts show examples of our attention to maintenance of accuracy in designing bearings. Note the heavy shafts mounted in massive housings in the feed and speed cases above. Each shaft is firmly supported close to the point of pressure.

Principal shafts are hardened and ground. All shafts run in long bronze boxes. The oiling system is simple and thoroughly efficient.

The spindle runs in long, heavy phosphor bronze boxes firmly mounted in thick walls. Simple and efficient means are provided to compensate for wear—front spindle bearing tapered, wear taken up by drawing spindle into taper—rear spindle bearing straight, wear taken up by clamping split box concentrically. End thrust taken by heavy hardened steel and babbitt washers.

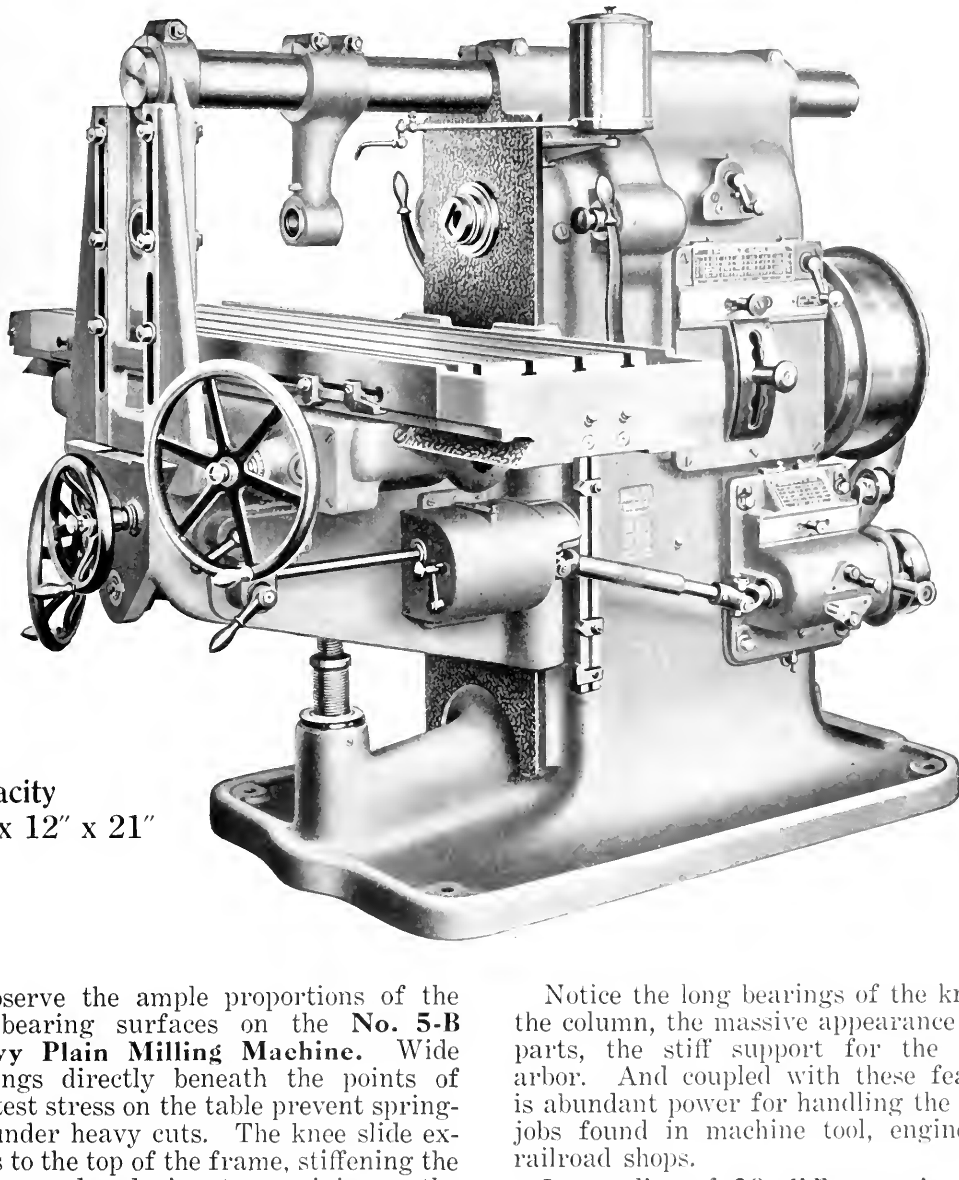


BROWN & SHARPE MFG. CO.

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626 630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419 University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

y the Durability of Bearings



Capacity
50″ x 12″ x 21″

Observe the ample proportions of the flat bearing surfaces on the **No. 5-B Heavy Plain Milling Machine.** Wide bearings directly beneath the points of greatest stress on the table prevent springing under heavy cuts. The knee slide extends to the top of the frame, stiffening the column and reducing to a minimum the possibility of any spring in the spindle bearings.

Notice the long bearings of the knee on the column, the massive appearance of all parts, the stiff support for the cutter arbor. And coupled with these features is abundant power for handling the heavy jobs found in machine tool, engine and railroad shops.

In our line of **39 different sizes and styles** of Milling Machines there are just the right machines for your purpose.

ROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Ottawa, W[illegible] St. J[illegible]
FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. [illegible] Frankfurt a. M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Sch[illegible] St. Petersb[illegible] Russia. F[illegible]k Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain. [illegible] Japan, L. A. Vall, Melbourne, Australia; F. L. Strong, Manila, P. I.

Read page 67

Vertical Slotting and Milling Attachments: Rockford Milling Machine Co., Rockford, Ill. These attachments are driven by a geared connection at the back end of the spindle. When it is desired to use the milling machine for standard operations, the intermediate gear of the attachment is readily removed, thus disconnecting the drive. The distance from the face of the column to the center of the spindle of the vertical attachment is 7 inches and the maximum distance from the nose of the spindle to the top of the table, 19 inches. The slotting attachment has a stroke of 2½ and 3½ inches.

Electric Furnace Regulator: Thwing Instrument Co., 445 N. 5th St., Philadelphia, Pa. A special type of automatic temperature recorder and regulator for use on electric furnaces. This instrument is particularly adapted for use in connection with furnaces employed for the heat-treatment of small tools, springs and similar parts. It can also be used in connection with an oil or gas fired furnace. A furnace equipped with this regulator enables the temperature to be held within close limits, thus providing for treating the work at exactly the right temperature and having all of the parts of uniform hardness.

Barrel Welding Machine: Davis-Bournonville Co., Jersey City, N. J. A machine for welding the side seam of barrel bodies made of steel plates 3/32 inch in thickness. The edges to be welded are brought together without lap and no metal is added in making the weld. Two torches are employed, one of which acts outside and one inside the barrel as they are fed over the work. A duplex work arm is provided which enables one barrel to be in the working position, and while this barrel is being welded a second barrel may be mounted in the clamps on the other arm, so that there is practically no loss of time between successive operations.

Electric Buffing Machine: United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. In the May, 1913, number of MACHINERY, two sizes of motor-driven grinding machines built by the United States Electrical Tool Co., Cincinnati, Ohio, were illustrated and described. Since that time this company has brought out a line of six sizes of buffing machines, which are of similar design except for the fact that the length of the spindles has been extended to provide the necessary clearance for buffing, and that the speed is increased to the required figure. These machines are made in ¼, ½, 1, 2, 3 and 5 horsepower sizes. Motors may be provided for use on 220-440 volt, 60-cycle, two or three phase alternating current, or for 110-220 volt, direct current.

Screw Plates: Russell Mfg. Co., Greenfield, Mass. To meet the demand for a simple, quick opening die for threading bolts by hand, this company has brought out a quick opening die screw plate. It is similar to the Russell Style B screw plate, except that it may be quickly opened by means of a small lever, thus disengaging the die from the work. This means a considerable saving of time, as when the thread has been cut to the required length the die is opened and lifted off the work. Another recent product of the Russell Mfg. Co. consists of a full mounted screw plate. This plate is evolved from the original adjustable die which was invented in 1871. The die may be adjusted to compensate for wear, or to make a tight or loose fit for the bolt and nut, by first loosening two outside binding screws and then adjusting two taper headed screws which control the position of the cutters. After the adjustment has been made, the binding screws are again tightened and the tool is ready for use. The dies in this plate and in all other Russell plates are made double, so that they will cut from either face.

Manufacturing Milling Machine: Potter & Johnston, Pawtucket, R. I. One of the most striking features of this machine consists of two parallel work tables. One of these tables is located under the cutter arbor while the other is out at the front of the machine. By this arrangement the cutter may be operating on the work on one table, and while this operation is in progress the mechanic may be setting up work on the other table. In this way, the time between operations is cut down to a trifle more than the time required to index the table. The work tables are mounted on a circular turntable which brings them alternately into the loading and cutting positions, and locates them accurately. The machine spindle is carried on a vertical slide on the column upon which its position may be adjusted. The column, in turn, is carried on a horizontal slide. A rigid arbor support is provided. There are twelve spindle speeds and sixteen independent feeds. The available spindle speeds are 20, 25, 30, 37, 44, 54, 66, 80, 99, 121, 147 and 180 revolutions per minute. The feeds which are available are 3/4, 7/8, 1 1/16, 1 5/16, 1 11/16, 2 1/16, 2 7/16, 2 15/16, 3 3/8, 4 1/8, 4 15/16, 5 15/16, 7 1/16, 8 9/16, 10 1/4, 12 1/4 inches per minute. The feed changes are independent of the changes of spindle speed.

PERSONALS

Otto Abrahamsen, treasurer of Beaudry & Co., Inc., Boston, Mass., has gone to Europe on a three months' trip.

R. C. Cole has joined the staff of the pneumatic tool department of the Ingersoll-Rand Co., and has been stationed at the Chicago office.

Ralph E. Flanders, general manager of the Jones & Lamson Machine Co., Springfield, Vt., sailed May 9 on the *Olympic* for a short business trip in Europe.

M. E. Towner has been appointed special representative of the Whitman & Barnes Mfg. Co., Akron, Ohio, with office at 113 N. Second St., St. Louis, Mo.

W. S. Dickson, representing the Cincinnati Planer Co., and the Acme Machine Tool Co., both of Cincinnati, Ohio, sailed for Europe the latter part of May for a business trip.

R. E. Ellis, formerly with the Chicago office of Manning, Maxwell & Moore, Inc., is now sales manager for the Steinle Turret Machine Co., Madison, Wis.

H. M. Waite, manager of the city of Dayton, Ohio, addressed the Engineers' Club of Cincinnati and the Cincinnati section of the American Society of Mechanical Engineers, Thursday evening, May 21, on "Municipal Government under the City Manager Plan."

A. H. Boyd, who has been with the Fort Wayne Electric Works of the General Electric Co. since 1898 and for the last four years has been acting as manager of the company's Philadelphia office, has resigned to become general manager and treasurer of the Santo Mfg. Co., Philadelphia, Pa.

* * *

OBITUARIES

W. G. Kirkaldy, a well-known British expert on the testing of engineering materials, died April 10, aged fifty-one years. He had contributed a number of papers to engineering societies recording the results of his investigations. He was a member of the firm of David Kirkaldy & Son, London.

* * *

The Baldwin Locomotive Works has built a new type of articulated locomotive for the Erie R. R. which is known as the "triplex compound." It is a development of the Mallet articulated type in which the weight of the tender is made available for tractive purposes, a third engine being under the tender. The total weight of the unit is 853,000 pounds, and the tractive power is 160,000 pounds. It has twelve driving wheels on each side arranged in three groups of four wheels each. A pony truck in front and at the rear makes the total number of wheels supporting the unit twenty-eight. The design, originated by G. R. Henderson, consulting engineer of the Baldwin Locomotive Works, makes 89 per cent of the total weight of engine and tender available for traction effort. High pressure, superheated steam is supplied to the high-pressure cylinders of the center unit. One of these cylinders exhausts to the pair of low-pressure cylinders in the rear and the other high-pressure cylinder exhausts to the pair of low-pressure cylinders in front. The firebox is nine by ten feet, the grate surface being 90 square feet. The tube heating surface is 6418 square feet and the total equivalent heating surface including tubes, firebox, combustion chamber and superheater is 9262 square feet.

* * *

The liner *Laconia*, of the Cunard Line, which was built three years ago, was provided with Frahm's anti-rolling tanks, and it has been shown beyond doubt that in the case of this 18,000-ton steamer the rolling of the vessel has been reduced, on an average, 60 per cent. The success with the *Laconia* in this respect has induced the Cunard Co. to provide the 50,000-ton *Aquitania*, just being completed, with anti-rolling tanks.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Business { Alex. Luchars, President	" " " " "
Managers { M. J. O'Neill, General Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock:—	
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
H. L. Brown	" " " " "
Erik Oberg	" " " " "

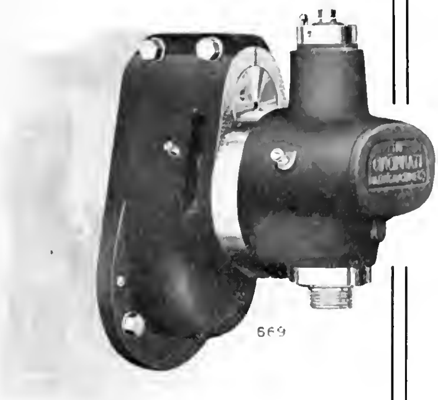
There are no bondholders, mortgagees, or other security holders.

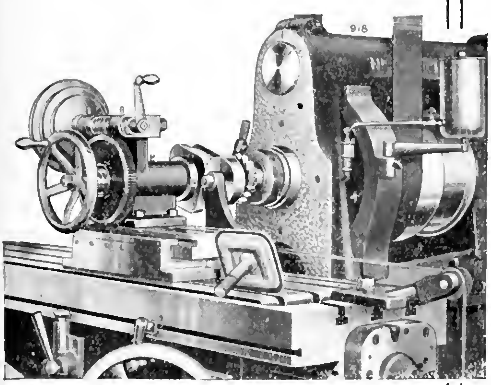
MATTHEW J. O'NEILL, General Manager.

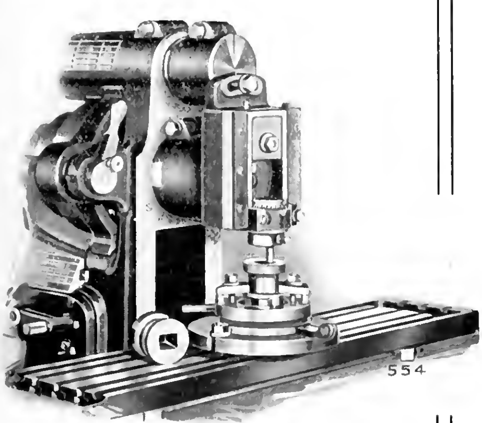
Sworn to and subscribed before me this 30th day of March, 1914.

HARRY B. HEALEY,
Notary Public No. 84, Kings County,
Certificate filed in New York County No. 74.

(SEAL) (My commission expires March 30, 1916.)







A Small Machine Shop

equipped with a

CINCINNATI UNIVERSAL Milling Machine

These three attachments and a sensitive drill can do every variety of milling—end, side and surface—a general line of die sinking, profiling and engraving, broaching, shaping, slotting, mill cams of every description, cut spur, bevel and spiral gears; in short, handle nearly everything within the range of the machine—rapidly and accurately.

Instead of tying up money in a lot of miscellaneous tools, the proprietor of a small shop should first buy a *Universal Milling Machine.*

No matter whether your shop is small or large, let us tell you how and why the prominent firms in America and Europe use Cincinnati Millers.

SEND FOR OUR NEW CATALOG

The Cincinnati Milling Machine Company

CINCINNATI OHIO, U. S. A.

COMING EVENTS

June 4.—Joint meeting of the Engineers' Club of Cincinnati, and the Cincinnati section of the A. S. M. E in McMicken Hall, University of Cincinnati, Cincinnati, Ohio, addressed by a representative of the National Tube Co. on the "Manufacture of Steel Tubes."

June 9-12.—Second convention of the National Association of Corporation Schools at Philadelphia, Pa. Arthur Williams, President, Irving Place and 15th St., New York City.

June 10-12.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill

June 15-17.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

June 16-19.—Spring meeting of the American Society of Mechanical Engineers, Minneapolis and St. Paul, Minn. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

June 30-July 4.—Annual meeting of the American Society for Testing Materials, Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Warburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 15-22.—Second International Congress of Consulting Engineers, to be held in Berne, Switzerland.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

University of South Carolina, Columbia, S. C. Catalogue 1913-1914.

Hebrew Technical Institute, 34 and 36 Stuyvesant St., New York City. Catalogue for 1914.

University of Nevada, Reno, Nev. Proceedings of the First Annual Industrial Safety Conference, held at the University of Nevada, January 26-27, 1914.

Columbia University, New York City. The summer session of the university extends from July 6 to August 14, not from June 3 to September 23, as erroneously stated in the May number of MACHINERY.

Technical League of America, 74 Cortlandt St., New York City, has issued a manifesto to the salaried members of the engineering profession which entreats them to unite to obtain that economic and social standing to which they are entitled by the services they render. The manifesto will strike a responsive chord in the hearts of every designer, draftsman and engineer who appreciates what their professions are doing for the world at large.

University of Wisconsin, Madison, Wis. Bulletin of the summer school extending from June 22 to July 31. The law course and certain courses in the College of Agriculture last until August 28. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shop work and surveying. Copies of the bulletin can be obtained from F. E. Turneaure, University of Wisconsin, Madison, Wis.

National Association of Corporation Schools, 124 W. 42nd St., New York City. Bulletins 1 and 2, containing "Report of Sub-Committee on Manufacturing and Transportation," by Mark B. Hughes; "Engineering Schools of Electrical Manufacturing Companies," by Dr. Charles P. Steinmetz; "Methods of Selecting Men in Business," by F. C. Henderschott; the president's address delivered at the banquet of the organizing convention, by Arthur Williams; "National Cash Register Schools for Salesmen," by R. H. Grant; and "Reasons for the Shortage of Skilled Mechanics," by A. F. Bardwell.

NEW BOOKS AND PAMPHLETS

American Water Works Association Proceedings, 1913. 749 pages, 6 by 9 inches. Published by the Association, John M. Diven, secretary, Troy, N. Y.

Testing the Hardness and Durability of Metals. Second edition. 40 pages, 6 by 9 inches. 19 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Safety and Sanitation. By Magnus W. Alexander, an address delivered at the seventeenth annual convention of the National Founders' Association, New York City, November, 1913.

Official Record of the First American National Fire Prevention Convention, held at Philadelphia, Pa., October 13-18. Compiled by Powell Evans, Philadelphia, Pa. 541 pages, 6 by 9 inches.

Critical Ranges A2 and A3 of Pure Iron. By G. K. Burgess and J. J. Crowe. 100 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 213 of the Bureau of Standards, Vol. 10.

Electric Switches for Use in Gaseous Mines. By H. H. Clark and R. W. Crocker. 36 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 68.

The Use of Iowa Gravel for Concrete. By T. R. Agg and C. S. Nichols. 31 pages, 6 by 9 inches. 9 illustrations. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin 34 of the Engineering Experiment Station, Good Roads Section.

The Sampling and Examination of Mine Gases and Natural Gas. By George A. Burrell and Frank M. Seibert. 116 pages, 5¾ by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 42.

The Utilization of Petroleum and Natural Gas in Wyoming. A preliminary report by W. R. Calvert. With a discussion of "The Suitability of Natural Gas for Making Gasoline," by George A. Burrell. 23 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical paper 57.

Caspar's Technical Dictionary of the English and German Languages. 272 pages, 4½ by 6 inches. Published by C. N. Caspar Co., Milwaukee, Wis. Price, $1 net.

This dictionary comprises the most important words and terms employed in technology, engineering, machinery, chemistry, navigation, shipbuilding, electro technics, "automobilism," aviation, etc. It is in two sections—English-German and German-English. The important technical words and phrases which have come into general use during the last decades are included.

Harper's Gasoline Engine Book. By A. Hyatt Verrill. 292 pages, 5¼ by 7¾ inches. Illustrated. Published by Harper & Brothers, New York City. Price, $1.

The extensive and growing use of the internal combustion motor has made it an object of general interest. This work, intended for boys and young people generally, treats of the gas engine, motor anatomy, marine and stationary motors, vehicle motors, troubles and repairs. It deals with both the two-stroke cycle and four-stroke cycle types and takes up construction features in detail.

Electric Furnaces for Making Iron and Steel. By Dorsey A. Lyon and Robert M. Keeney. 142 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of Interior, Washington, D. C., as Bulletin 67.

The bulletin is divided into two parts, the first treating of the electric furnace in pig-iron manufacture and the second on the electric furnace in steel manufacture. The growing importance of the electric furnace in iron and steel production should make this bulletin of unusual interest and value to iron and steel makers.

Harper's Aircraft Book. By A. Hyatt Verrill. 245 pages, 5¼ by 7¾ inches. Illustrated. Published by Harper & Brothers, New York City. Price, $1.

This work, intended for boys and others interested in making model aeroplanes, tells why aeroplanes fly, how to make models, and other interesting facts regarding heavier-than-air machines. It treats of motor-propelled and gliders, or non-propelled aeroplanes, hydro-aeroplanes and flying boats, the uses of the aeroplane, etc. Being profusely illustrated, the text should be readily understood by those who wish to follow the directions for making models.

Where and Why Public Ownership Has Failed. By Yves Guyot. Translated from the French by H. F. Baker. 459 pages, 5 by 7½ inches. Published by the MacMillan Co., New York City.

The work is divided into four parts as follows: Public and Private Trading Operations; Financial Results of Government and Municipal Ownership; Administrative Results; Political and Social Consequences of Public Operation. The author discusses the conditions of municipal activity in the United Kingdom, the United States, Germany, Russia, France, Austria-Hungary, Italy, Denmark, Switzerland, Netherlands, Belgium and Sweden.

Metal Coloring and Finishing. 39 pages, 6 by 9 inches. 14 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 123 of MACHINERY'S Reference Books, and deals with the methods of producing colors on iron, steel, copper, bronze, brass and aluminum, together with chapters on burnishing metals, including both lathe burnishing and ball-burnishing processes. The book deals with a subject on which no information is generally available except in large volumes containing formulas and recipes for all kinds of purposes. It gives descriptions of many processes for obtaining colors on metals and will be found valuable by those who are interested in this class of work.

Telephone Construction, Installation, Wiring, Operation and Maintenance. By W. H. Radcliffe and H. C. Cushing, Jr. 223 pages, 4 by 6½ inches. 132 illustrations. Published by Norman W. Henley & Son, New York City. Price, $1.

The first edition of this work was published in 1908. Considerable new matter has been added to the second revised edition to bring the work up to date. The work begins with the first principles, the assumption being that the reader knows nothing of telephony. It deals with the subject so thoroughly, however, that not only the amateur, but the wireman, the engineer and the contractor will find it useful. It treats of the construction, operation and installation of telephone instruments, inspection and maintenance of telephone instruments, testing telephone line wires and cables, wiring and operations of special telephone systems, etc.

Cold-heading. By Chester L. Lucas. 44 pages, 6 by 9 inches. 47 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 119 of MACHINERY'S Reference Books. It deals with the machines, methods and tools used for the cold-heading of screws, rivets and similar machine parts. The contents of the book are divided into three distinct parts: the first deals with principles of cold-heading, describing and illustrating the general methods employed; the second with cold-heading machines and operations, illustrating and describing the typical cold-heading machines manufactured and used in this country; and the third with cold-heading dies and tools, showing their construction and illustrating the methods used in making them. Mechanics will be particularly interested in this book, as it is the only one that has ever been published on the subject.

Machining Tapered and Spherical Surfaces. By Albert A. Dowd. 43 pages, 6 by 9 inches. 35 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

During the past year MACHINERY has published a number of valuable articles by the author of this book, relating to tools and devices used for machining operations. Two of these, describing taper boring and turning attachments and the machining of convex and concave surfaces, have been given permanent form in this book, which is No. 121 in MACHINERY'S Reference Books. The book shows a great number of devices illustrated by carefully made line-engravings and accompanied by concise descriptive text. All of the devices shown are taken from actual practice and have been designed for commercial purposes. The range covered is very extensive, passing from the simple to the complex devices used for the purposes mentioned. Tool designers, shop foremen, and those responsible for production in general will find much valuable material in this book.

National Association of Corporation Schools. Report of First Annual Convention including papers and discussions presented at Dayton, Ohio, September 16-19, 1913. Executive office, Irving Place and 15th St., New York City.

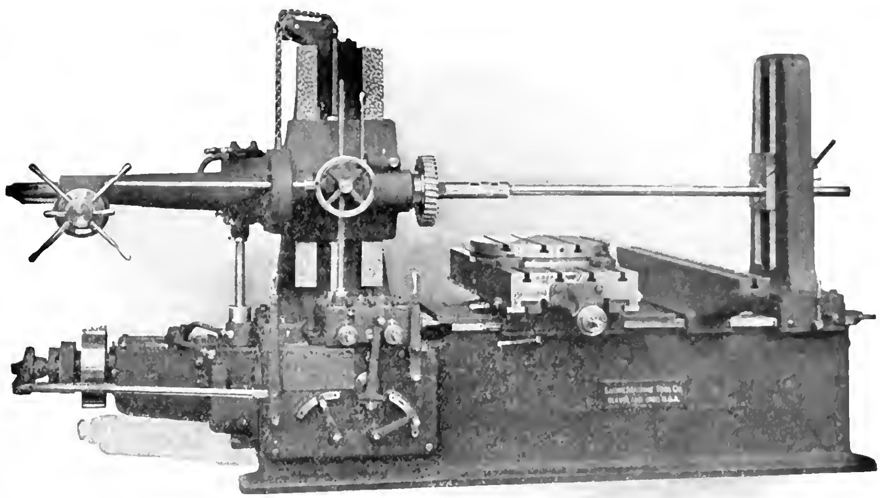
The National Association of Corporation Schools movement differs from any other in that it aims to carry specialized and general training to young men and women after they have actually entered upon their business or industrial careers. The work of the association does not enter into any of the established continuation schools, but is confined primarily to the establishment of what is practically a continuation school in industry, endeavoring through specialized training to replace the former, and now practically obsolete, apprenticeship training; and to bring as much as possible of a more general training and education to the industrial workers of our country. The membership of the association now includes nearly 150 in all classes, including thirty-two industries employing in the neighborhood of a million men and women.

Business Administration. By Edward D. Jones. 275 pages, 5 by 7¼ inches. Published by Engineering Magazine Co., New York City. Price, $2.

The Engineering Magazine Co. has published a number of well-known books on works management and this work is the latest addition to the list. Prof. Jones assumes that success in dealing with men and affairs depends upon certain laws which can be discovered in the work of successful administrators, but that the rules and methods followed by masters of business and finance are usually not open to investigation. The leaders in statecraft, war and science, however, are figures whose careers and practice are fully recorded and open to analysis. In the study of history and the biography of warriors, diplomats and scientists, he has found what he considers to be the elementary rules of success. In short, Prof. Jones derives the principles, motives and actions of successful business men by studying the careers of successful public men. The contents are as follows: The Rise of a New Profession; The Utility of the Study of History; Military History; Administrative Principles; The Pioneers of Science; System-makers of Science; The Application of Science; The Principles of Mental Efficiency; History of the Gentleman Administrator; Methods of the Gentleman Administrator; Ideals of the Gentleman Administrator.

Compressed Air. By Theodore Simons. 173 pages, 6 by 9 inches. Illustrated. Published by the McGraw-Hill Book Co., New York City. Price, $1.50.

This treatise on the production, transmission and use of compressed air treats of the natural laws and physical principles concerned. The endeavor has been made to produce a work suitable for the average technical student who has a sound knowledge of the elements of algebra, physics and mechanics. The contents comprise Production of Compressed Air; The Behavior of Air Undergoing Compression and Under the Application of Heat; The Compression of Air in Air Compressors; Theory of Air Compression; Clearance, Volumetric Efficiency, Capacity, Speed, Mechanical Efficiency of Compressors; Two-stage and Multi-stage Compressions or Compound Compression; Effect of Altitude on Air Compression; The Compressed Air Indicator Card; Cooling Water Required in Compression—Efficiency of Compressor Plant—Air Compressor Ex-



plosions; The Transmission of Compressed Air; Dimensions of Pipe Lines for Conveying Compressed Air; The Use of Compressed Air; Theory of Air Engines; Effective Heat Losses; Internal or Intrinsic Energy of Air; The Efficiency of a Compressed Air System; Reheating of Compressed Air; Air Compressors and Accessories; Examples of Modern Air Compressors of the Reciprocating Type; Important Mechanical Features of Air Compressors; Compressor Accessories.

Steam Turbines. By James A. Moyer. 376 pages, 6 by 9 inches. 225 illustrations. Published by John Wiley & Sons, New York City. Price, $3.50.

The first edition of Prof. Moyer's work was published in 1908. The additions made in the 1914 edition of this favorably known work on steam turbines have been mainly in the line of new applications. The chapter on low pressure turbines has been rewritten to include the latest developments and applications. The real important developments of the last few years have been in the construction of increasingly large sizes of steam turbines. The author mentions that the largest turbine generator now ready for installation is rated at 35,000 kilowatts, which is to be compared with a maximum size of 14,000 kilowatts of only three years ago. The contents by chapter heads are: The Elementary Theory of Heat; Nozzle Design; Steam Turbine Types and Blade Design; Mechanical Losses in Turbines; Method for Correcting Steam Turbine Tests; Commercial Types of Turbines, including De Laval, Parsons, Westinghouse, Allis-Chalmers, Curtis, Rateau, Wilkinson, Zoelly, Sturtevant, Riedler-Stumpf, Kerr, Terry Dake, etc.; Governing Steam Turbines; Low-pressure (Exhaust) Turbines; Mixed Pressure Turbines; Bleeder or Extraction Turbines; Marine Turbines; Tests of Turbines; Steam Turbine Economics; Stresses in Rings, Drums and Disks; Gas Turbines; Electric Generators for Turbines.

NEW CATALOGUES AND CIRCULARS

George P. Clark Co., Windsor Locks, Conn. Bulletin AC giving dimensions, prices, etc., of wheels and casters.

H. Bickford & Co., Lakeport, N. H. Leaflets illustrating boring and turning mills with motor drive and rapid power traverse, respectively.

Percy Pitman, 3 Willcott Road, Acton, London, W., England. Circular of the Pitman hydraulic governor for controlling the speed of water turbines, impulse wheels, etc.

Lutz-Webster Engineering Co., Philadelphia, Pa. Leaflet giving prices of the various sizes of compression wrenches, ratchets and bolt and nut sockets made by this company.

Sprague Electric Works of the General Electric Co., 531 W. 34th St., New York City. Circular 905 on Sprague electric hoists, illustrating a large number of designs suited to all kinds of hoisting service.

Millers Falls Co., Millers Falls, Mass. Pamphlet describing the Nos. 99, 99A, 100, 199, 199A, 200, 2100 and 2200 breast drills of this company's manufacture. Each style of drill is illustrated and its features briefly described.

David Maydole Hammer Co., Norwich, N. Y. Catalogue on the Maydole hammers, which are forged from solid crucible cast steel. The specifications for these hammers are printed in English, French, German and Spanish.

C. M. Smillie, 130 E. Larned St., Detroit, Mich. Circular of Smillie compensating turret chuck or drill holder for Fox lathes, turret lathes and screw machines. The chuck is made in three sizes, taking drills from No. 42 to 1 inch.

Laidlaw-Dunn-Gordon Co. (International Steam Pump Co., successor), Cincinnati, Ohio. Bulletin L-523-A, treating of the Cincinnati gear duplex Corliss steam driven air compressors, classes WA and XA. 24 pages, 6 by 9 inches.

Fred C. Dickow, 33 S. Desplaines St., Chicago, Ill. Leaflets illustrating double friction clutch countershaft and 10-inch universal index centers. The countershaft is provided with hollow set-screws which should commend it to those interested in "Safety First."

Ph. Bonvillain & E. Ronceray, 9-11 Rue des Envierges, Paris, France. Catalogue 6 in French on molding machinery, 104 pages, 8½ by 10¾ inches, containing descriptions of the line of up-to-date molding machines and accessories manufactured by this company.

Carroll-Jamieson Machine Tool Co., 257 Davis St., Batavia, Ohio. Bulletin on the Carroll-Jamieson "selective" sliding gear, single-belt drive 14-inch tool-room manufacturing lathe, illustrated. This lathe has a headstock designed to meet the demand for rapid production.

Lumen Bearing Co., Buffalo, N. Y. Booklet entitled "Bronze Alloys and Babbitts." The data given for each alloy is classified separately for a test bar cast in a chill and for a bar cast in sand; it includes tensile strength, elongation, Brinell hardness and specific gravity.

Diamond Clamp & Flask Co., Richmond, Ind. Circular of an "air spreader" or fan for use in machine shops, factories, etc. The fan is mounted in a bracket that is secured to the ceiling, and is driven by a belt from the lineshaft. A clutch is provided for throwing it in or out of action.

Baker Bros., Toledo, Ohio. Catalogue on Baker heavy pattern high-speed drills built in 5-inch, 4-inch, 3-inch and 2½ inch capacities. Illustrations of these machines with their various attachments are shown. The 1-inch by 6-inch automatic drill built by the Baker Bros. is also illustrated.

Consolidated Expanded Metal Companies, Architects Bldg., New York City. Pamphlet illustrating the use of "Steelcrete" guards for machine tools, lineshafts, chain drives, punch presses, stairways, etc. Expanded metal is well suited for machine guards, being light, strong and durable.

Monarch Mfg. Co., Dayton, Ohio. Circular of the Dayton welding and decarbonizing plants for use in repair shops, garages, etc. The company furnishes a welding outfit for $75 and a decarbonizing, welding and cutting outfit for $115. Directions are given for building acetylene generators at small cost.

Mesta Machine Co., Pittsburg, Pa. Catalogue O, giving the advantages of rope drives, among which may be mentioned smooth continuous action, low cost and high efficiency, noiselessness, freedom from shocks, etc. The catalogue also contains charts showing the length of life and horsepower transmitted by manilla ropes.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue D 1914, treating of "Brownhoist" tramrail systems, trolleys and electric hoists. A number of interesting installations of Brown hoists are shown, and the specifications are conveniently arranged in tabular form, capacity, dimensions, prices, etc., being given.

American Swiss File & Tool Co., 24 John St., New York City. Circular of a fourteen-inch file with a new cut called "Wavecut." This file removes metal in curled shavings instead of the ordinary granular filings. It has diagonal rows of cutting edges which give the file a wavy appearance that suggested the trade name, "Wavecut."

Sleeper & Hartley, Worcester, Mass. Bulletins 277 and 280 on spring hooking machines and spring coiling machines, respectively. The spring hooking machines produce any desired form of hook or loop on either right- or left-hand springs without waste of stock. The spring coiling machines produce either extension or compression springs.

Ransom Mfg. Co., Oshkosh, Wis. Bulletin SD1, showing the application of Ransom safety devices to abrasive wheels. These devices include steel and cast-iron wheel guards of the open and enclosed types, safety flanges, safety nuts, and the Ransom patent speed controller which obviates the possibility of over-speeding the wheel.

Hoggson & Pettis Mfg. Co., New Haven, Conn. Catalogue and price list 10 C of "Sweetland" lathe chucks, comprising combination chucks, universal chucks, car-wheel chucks, independent chucks, geared scroll chucks, planer chucks, drill chucks, etc. Information is also contained on the mounting and care of chucks, repairs and special chucks.

C. & E. Mfg. Co., Marshalltown, Iowa. Leaflet entitled "How do you do without the Marshalltown?", setting forth the advantages of the "Marshalltown" wrench—a ratchet wrench with only three working parts. Four detachable jaws are furnished for use on ⅜, 7/16, ½ and 9/16 inch nuts, and in addition there is one alligator jaw in the handle.

Munning-Loeb Co., Matawan, N. J. Bulletin 500 of plating and industrial brushes, comprising circular brushes, horse hair brushes, camel hair brushes, metal wire and cotton brushes, crinkled brass or steel wire brushes, hand polishing and scratch brushes, scouring brushes, etc. This line of brushes is made for electroplaters, buffers and other manufacturers of finished metal goods.

Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill. Circular E-1 of the new "Thor" electric drill equipped with universal motor for alternating and direct current, made in four sizes, the small size having capacity from 0 to ¼ inch; the second, 0 to 5/16 inch; the third, 0 to ⅜ inch and the fourth, ⅛ to 9/16 inch. These drills are equipped throughout with ball and roller bearings.

Betts Machine Co., Wilmington, Del. Catalogue 2614 on horizontal boring and drilling machines and attachments. 20 pages, 6¾ by 9¾ inches. The attachments that can be furnished for these machines at the desire of the purchaser are: additional circular table, extra facing head to facilitate machining both ends of a casting at the same time, threading attachment, power feeds to tables and electric drives.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin No. 61 on electric traveling cranes. 39 pages, 8½ by 11 inches. This book gives a complete description of the Shepard electric cranes and their various parts. Some of the basic features are: the balanced drive, complete enclosure of high-speed gearing, system of load brakes, and lubrication. A large number of installations of Shepard electric cranes are shown.

Van Dorn & Dutton Co., gear specialists, Cleveland, Ohio. Booklet treating of "V. D. & D." railway and mill motor gears and pinions. The gears are made from open-hearth steel castings in both solid and split types, with the exception of the forged or rolled gears which are furnished in the solid type only. Extreme care is taken both in the selection of material and in the manufacture of these gears.

Fitchburg Grinder Co., Fitchburg, Mass. Circular of the Fitchburg "Six-Fifteen" cylindrical grinding machine, styles A and B. The machine is of heavy proportions, being of 2- by 16-inch wheel capacity. It was designed especially to meet the demands for a simple machine suitable for grinding short cylindrical pieces in large quantities. Style A has an automatic traverse while style B is provided with hand traverse only.

Nazel Engineering & Machine Works, 4043 N. 5th St., Philadelphia, Pa., is issuing the "Nazel Hammer Book," which contains complete information concerning the Beche and Nazel hammers. These hammers are built in six sizes for either belt or motor drive. The Nazel-Beche hammer works on the same principle as the Beche hammer, but has a larger capacity and greater die area. The line of speed hammers produced by this company is also illustrated.

Oster Mfg. Co., 2107 E. 61st St., Cleveland, Ohio. Booklet entitled "Actual Pipe-Threading Experiences—II" containing information on average working times of Oster pipe-threading machines and showing installations of these machines in various parts of the country. All parts of Oster pipe-threading machines are standardized and interchangeable. The "facts and figures from the day's work" will be of much interest to those employing this class of machinery.

Gleason Works, Rochester, N. Y. Gear planer catalogue, 48 pages, 6 by 9 inches. This book includes descriptions and specifications of generating bevel gear planers(fully automatic), forming bevel gear planers (fully automatic), combination bevel and spur gear planer (semi-automatic), sixteen-foot bevel gear planer, bevel gear tempering machine and bevel gear testing machine. Each of these types of machines is illustrated by excellent half-tone engravings. The last section of the book illustrates mandrels for use on these machines.

National Machinery Co., Tiffin, Ohio, is issuing a series of folders entitled "National Forging Machine Talks." No. 2 takes up the bed frame as a potent factor in the efficiency of the forging machine, pointing out the necessity of providing stiffness and rigidity in this part of the machine. The halftone and line drawings illustrate the steel bed frame casting of the National heavy-pattern forging machine, showing the heavy under-ribbing and the improved form of gap which extends but one-third the depth of the bed.

Harrington Machine Co., Erie, Pa. Folder descriptive of "under" milling machines A and B. These machines derive their name from the fact that the cutter is mounted so as to be underneath the work, thus leaving the lines on the work always in plain view, the table being entirely unobstructed by spindle or housings. Type A is especially designed for milling trimming dies used in drop-forges and for all irregular open work. Type B is similar to A, but is much heavier and is not equipped with a tilting table.

Herman Bacharach, 14 Wood St., Pittsburg, Pa. Catalogue B descriptive of "Hydro" volume and pressure recorders, for measuring and recording the volume and pressure of gases. 16 pages, 6 by 9 inches. The velocity charts included will be found of value in determining the velocity of gases of any specific gravity. Some interesting curves obtained from "Hydro" volume meters are shown. These record the gas consumption of by-product coke ovens, the amount of blast furnace gas used for heating stoves and the amount of coke oven gas consumed in a steel mill.

Cullman Wheel Co., 1339 Greenwood Terrace, Chicago, Ill. Catalogue 9, 24 pages, 5¾ by 8¾ inches, giving price lists of sprockets for use with Coventry and Whitney noiseless chain. Noiseless chains and wheels are now being made in 8 and 10 millimeter pitches, to provide a light, compact and efficient drive. Tables of specifications giving dimensions, weight, strength, price, etc., of Coventry and Whitney noiseless chains of different pitches are among the material that will be of value to automobile manufacturers and others interested in this form of transmission.

Heald Machine Co., 20 New Bond St., Worcester, Mass. Catalogue illustrating the Heald line of internal cylinder, ring, and drill grinding machines and magnetic chucks. This catalogue was produced as a souvenir for the National Machine Tool Builders and National Metal Trades Associations' conventions, which probably accounts for the decided departure from the stereotyped style of machinery catalogue that it presents. The cover is light grey with silver lettering and deckled edges. The artistic touch is also shown in the arrangement of the type and cuts, the latter being printed on a fine grade of paper and pasted along the top edge to the japan stock used for the body of the book.

Crescent Machine Co., Leetonia, Ohio. New catalogue on Crescent wood-working machinery. 143 pages, 4 by 6 inches. This catalogue describes the Crescent bandsaws, special equipment, bandsaw blades, saw-tables, shapers, planers, matchers, surfacers, cut-off saws, disk grinders, wood-workers, etc. Special attention is called to the No. 101 to 112 "Universal" wood-worker illustrated and described on pages 108 to 125. This machine consists of a bandsaw, a jointer, saw-table, borer and shaper. Additional attachments may also be provided, adapting the machine for mortising, tenoning, making moldings, grinding tools, and sanding. Other new features include the remodeling of the 26 by 8 inch surfacer, which has now been equipped with variable friction feed, and improved fenders on bandsaws.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 3002-A, Section 3082 on motor-driven pumps, describing pumps of various kinds driven by electric motors. A number of installations of these pumps are shown. Tables are also included giving the frictional heat in wrought-iron pipe, horsepower for pumping, standard dimensions for pipe, and atmospheric pressures, equivalent heads and suction lifts. Leaflet 2364-A treats of Westinghouse electric direct-current Type K crane

MACHINERY

JULY, 1914

MANUFACTURE OF SAVAGE 0.22 CALIBER HIGH-POWER RIFLE*—1

EFFECTIVENESS OF A HIGH-POWER SMALL CALIBER RIFLE—MANUFACTURING AND TESTING METHODS AT THE FACTORY OF THE SAVAGE ARMS CO.

BY FRANKLIN D. JONES†

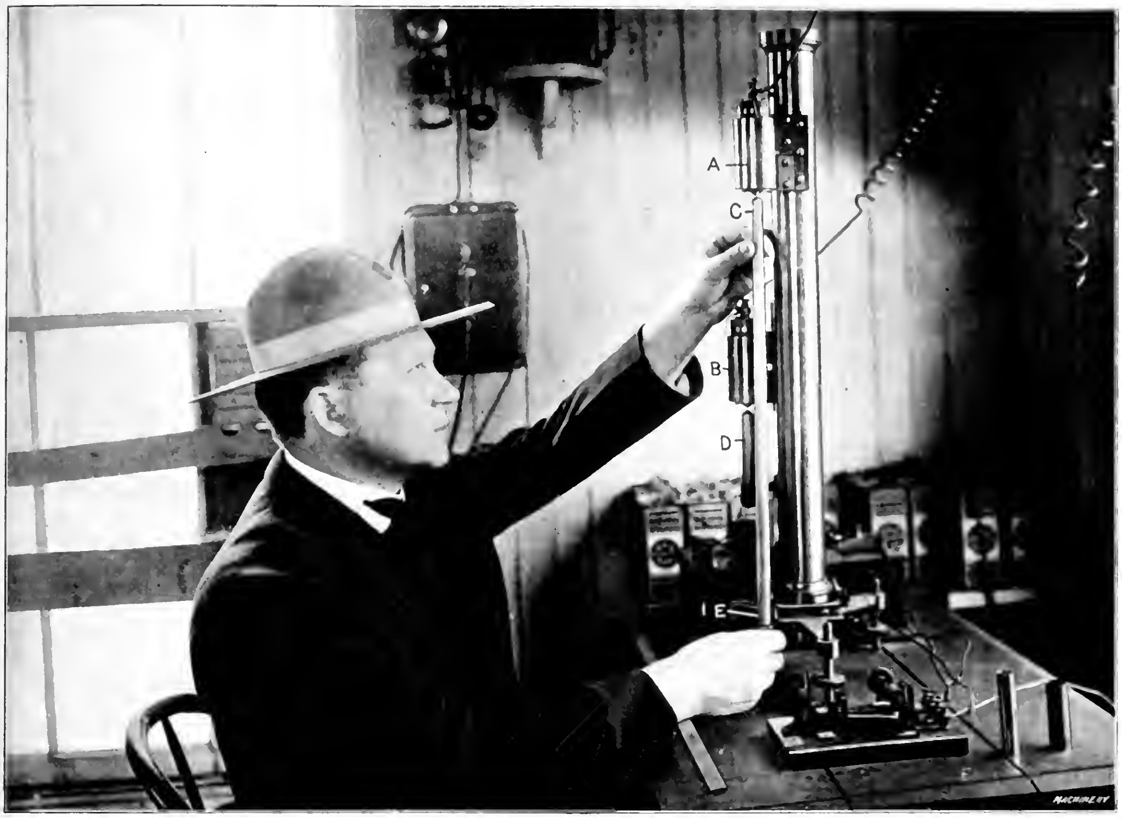


Fig. 1. The Chronograph, used to determine the Initial or Muzzle Velocity of a Rifle Bullet—The Instrument is being adjusted preparatory to making a Test

NOT many years ago the average sportsman prided himself on owning a rifle of large caliber, the idea being that a bullet must be large to be deadly. Modern gunmakers, however, have demonstrated that a small bullet may be much more effective and destructive than a large one, if it has the power behind it and is correctly shaped so that the average velocity during flight will be as high as possible, thus flattening the trajectory and increasing the accuracy as well as the striking energy of the bullet. The result has been that large calibers have been quite generally superseded by smaller ones, such as the 30-30 and other comparatively small bores, as those interested in firearms know.

One of the most wonderful developments of the small caliber high-power rifle has been made by the Savage Arms Co. of Utica, N. Y. We refer to the 0.22 caliber high-power rifle placed on the market by this company about a year ago. In many respects, this is the most remarkable firearm ever designed and manufactured, owing to the inverse relation between the size of the bullet and its destructive power. It is a hammerless repeater and is similar to the '99 model so far as the action is concerned. This rifle was originally intended for shooting wolves, coyotes, foxes, etc., but actual hunting experience has shown it to be powerful enough for deer, moose, caribou, mountain sheep, and even for such large game as Alaskan brown bear and American black bear.

Here are some figures which will show, in a general way, the performance of this rifle. The initial or muzzle velocity is 2800 feet per second and the theoretical striking energy over 1200 foot-pounds. The velocity is higher than that of any other firearm manufactured in this country and is 100 feet per second higher than that of the new Springfield United States Army rifle. Owing to this extreme velocity, the trajectory (or path followed by the bullet in its flight) is very flat, which increases the accuracy, especially at long ranges. The mid-range height of the trajectory for a range of 200 yards is only 2.99 inches and the rifle can be used for distances up to 350 yards without changing the point-blank adjustment of the sights. Under favorable weather conditions, this rifle (which only weighs $6\frac{1}{4}$ pounds) has done excellent work on a military target at 1000 yards range. It has scored twenty-five consecutive "bulls" on the 500-yard military target (20-inch bullseye), and has placed ten consecutive shots within a 10-inch circle at 500 yards. To those familiar with rifle shooting, these figures speak for themselves.

* For information on rifle manufacture previously published in MACHINERY see the series on "The Ross Rifle and Its Manufacture" in the October, November and December, 1911, and January, 1912, numbers of MACHINERY. See also articles referred to in connection with the first installment.

† Associate Editor of MACHINERY.

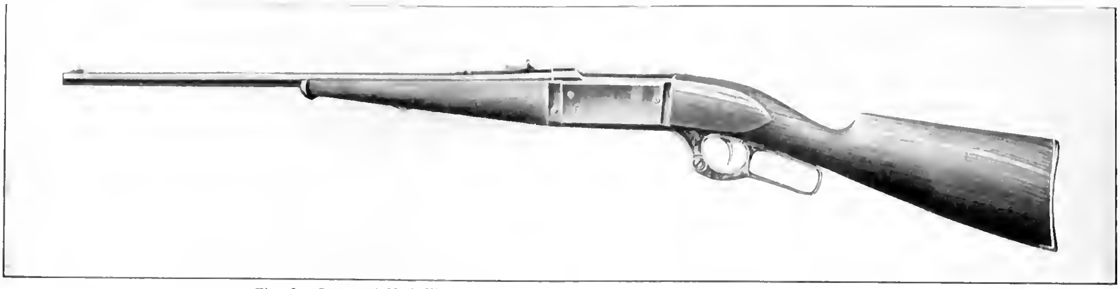


Fig. 2. Savage 0.22 Caliber High-power Rifle—Initial Velocity 2800 Feet per Second

The following data may also be of interest: The weight of the bullet is 70 grains; the diameter of the bullet, 0.228 inch; the diameter of the barrel from groove to groove, 0.2275 inch; the number of grooves, six; the lead of the rifling or the distance the bullet travels to complete one revolution, 12 inches. The pressure back of the bullet at the instant of discharge is 48,000 pounds per square inch. Incidentally, the pressure in a 14-inch gun, which is the largest now used in the United States Navy, is 35,000 pounds per square inch. These comparative figures are interesting, especially when we consider that the rifle can safely withstand this enormous pressure, although its weight is only 6¼ pounds. The bullet will penetrate a pine block in an endwise direction a distance of 7¾ inches, and it will pass through ½-inch chilled steel boiler plate.

The performance of this rifle at ranges varying from 100 to 1000 yards is given in the accompanying table, which was compiled by the ballistic department of the Savage Arms Co. The first horizontal column gives the ranges, and the second, the velocity in feet per second. As will be seen, the velocity at a distance of 700 yards is over 1000 feet per second. The mid-range trajectory or the vertical height of the path described by the bullet at a point midway between the rifle and target varies from 0.506 inch at a range of 100 yards to 248.5 inches at 1000 yards. The angle of departure represents the angle at which the rifle barrel must be elevated for a given range, to cause the bullet to strike at a point in the same horizontal plane as the muzzle of the rifle. By referring to the table, it will be seen that for 100 yards this angle is only 2 minutes 5 seconds, and for a long range of 500 yards, it is only 18 minutes 32 seconds, or less than one-third degree.

At the plant of the Savage Arms Co. new rifles are designed in the ballistic and experimental department. To develop a high-grade firearm not only requires a thorough knowledge of ballistics but a broad mechanical knowledge as well, in order to obtain a design that is not only accurate and effective, but mechanically perfect so that it can be manufactured on an economical basis. The designer begins with the cartridge and largely builds the rifle around it. He is confronted with many problems, all of which must be considered—and the problems are not solved in a day, but as the result of numerous experiments backed up by wide experience. The rifle designer has an interesting but difficult task; in fact, so difficult that no intelligent conception of the methods of procedure could be given here even though we were familiar with this science. So we shall leave the ballistic department and consider some of the methods and tools employed by the Savage Arms Co. in the manufacture of rifles, dealing particularly with the 0.22 caliber high-power design previously referred to.

Action of the Savage High-power Rifle

The action of the 0.22 caliber high-power rifle will be described first so that references in this and succeeding articles to specific parts will be intelligible. This action, which is the same as that used in the '99 model, is illustrated in Fig. 3. The upper view shows the action closed and the lower view shows it open. These two views illustrate a "cut-open action," the receiver having been cut away in several places to expose the interior parts. The operation of the mechanism for loading, firing, and reloading is as follows: When finger lever *A* is thrown down to the position illustrated in the lower view, it withdraws the breech-bolt *B*. A cartridge in the rotary magazine carrier *C* then jumps up in front of the breech-bolt and is held in position by a three-point contact between the carrier, the cartridge guide on the right side of the receiver, and the ejector or automatic cut-off *D* which is now forced out over the cartridge by a spring.

As lever *A* is pulled back to close the action, breech-bolt *B* moves forward, pressing ejector *D* back into its seat and pushing the cartridge forward into the barrel. When lever *A* is pulled back about half way, lug *E* on the hammer strikes against the sear *F* and the hammer is held back. As the forward movement of the breech-bolt is continued, the hammer spring is compressed, and when the breech-bolt is forced upward to its seat, the rifle is ready to fire, the action being in the position shown by the upper view, Fig. 3. When the trigger is pulled it turns sear *F* downward until the hammer is released; the hammer then flies forward and strikes the firing pin.

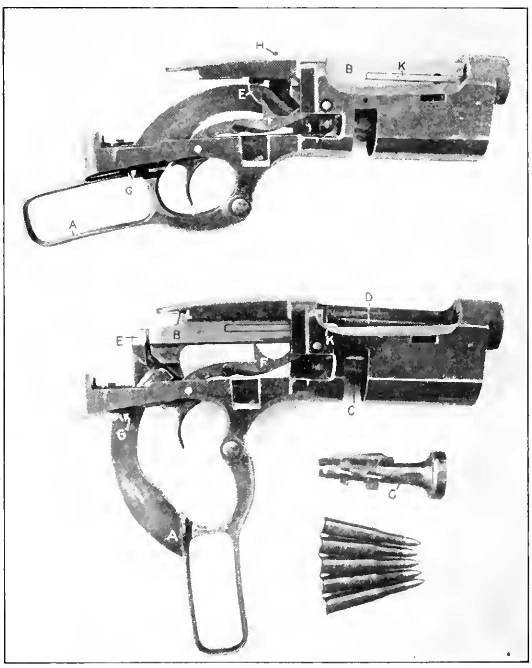


Fig. 3. Action used on 0.22 Caliber High-power Rifle—Sections of the Receiver are cut away to expose Mechanism

When lever *A* is again pushed forward, the extractor *K* (which is a latch shaped part at the end of the breech-bolt that hooks over the rim of the cartridge) withdraws the cartridge shell from the barrel. When the shell is back far enough to clear the forward end of the receiver, it strikes a small projection on the ejector *D* and is whirled around and out of the receiver. As the shell is thrown out, the ejector moves out over the next cartridge which is now in front of the bolt and in position for loading. The cycle of movements just described is repeated each time the rifle is fired.

The entire mechanism is very simple and positive in its movements. When the action is closed, the breech-bolt is forced upward to its seat by a cam surface on the inner end of lever *A*. The lower side of this inner end also bears on a

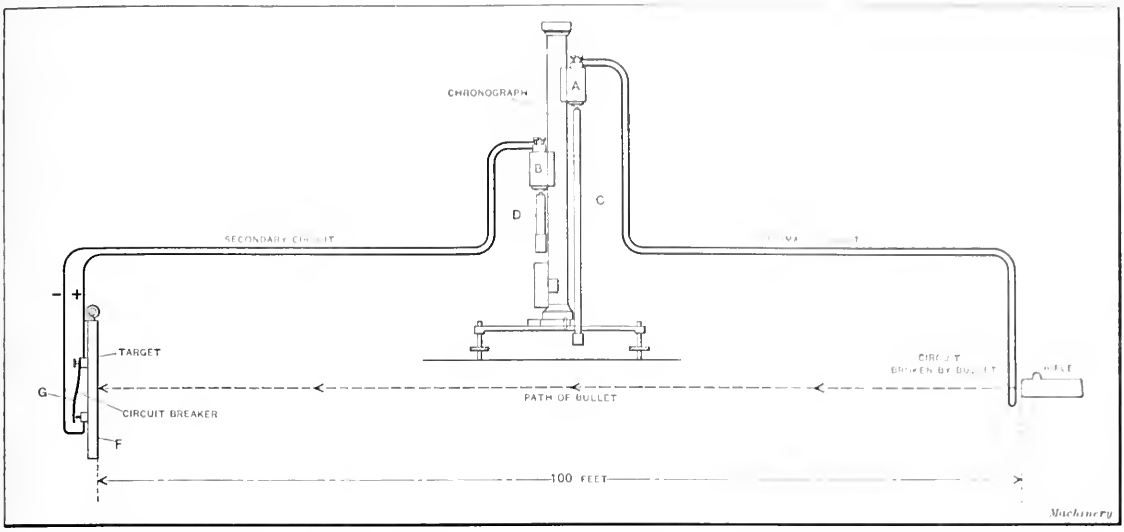


Fig. 4. Diagram showing how Primary and Secondary Circuits of the Chronograph are broken at Muzzle of Rifle and at Target by Bullet

projection on the bottom of the receiver, so that the breech-bolt is not only supported by the solid receiver frame at the rear, but has a positive support against downward thrust as well. In designing this action, particular attention was given to the matter of safety. By pushing the small slide *G* forward, the lever as well as the trigger is positively locked to prevent accidental discharge. The position of the hammer, that is whether cocked or uncocked, is shown by a small pin *H* which projects when the hammer is cocked.

As previously mentioned, the cartridges, when in the rifle, lie side by side around the circular, revolvable magazine carrier *C*. This arrangement prevents the bullet of one cartridge from bearing against the primer of another, thus making it impossible to discharge a cartridge while in the magazine by endwise shock. The forward end of the magazine carrier is in the form of a circular disk (see detail view) and is numbered from 0 to 5. These numbers are visible through a small aperture on the left side of the receiver and show the number of cartridges in the magazine.

General Process of Manufacture and Factory System

In this particular article, the manufacturing operations, as well as the inspection system, will be referred to in a general way, the idea being to present specific operations of interest in succeeding articles where the space will permit of detailed descriptions. Rifle manufacture is quite different from other lines of manufacture involving the use of metal-working tools. This is partly due to the irregular and intricate shapes of many of the parts, which makes it necessary to use many special tools and fixtures. The irregular shapes which must be machined, often with a considerable degree of accuracy, also greatly increase the number of operations required. For example, a receiver for the action illustrated in Fig. 3 requires 128 separate operations and the finger lever, 51. Most of these are machining operations. While in some cases there is a great deal of work on one part, this part is carefully designed to serve many purposes in a simple way.

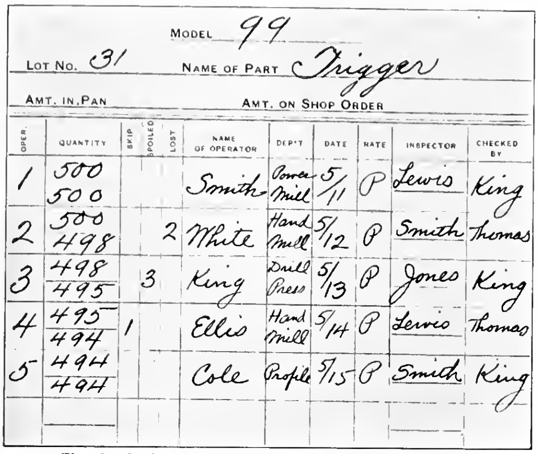
The manufacturing operations may be divided into the following general classes: Turning, drilling, reaming and rifling the barrel; machining the receiver and its attached parts which form the action or breech mechanism; turning, inletting and mortising the stock; polishing and finishing the various parts; assembling; inspecting. The inspection is referred to last, but this does not mean that there is but one final inspection. In fact, this system has been very carefully developed and will be explained later.

The barrel is made from alloy steel of special composition and of the same analysis as the steel used in the barrels of the new Springfield United States Army rifle. After the outside is rough-turned close to the finished size, the hole is drilled. The drilling, reaming and rifling is done in the well-known Pratt & Whitney machines which will be described in the second installment of this series. The work on the breech mechanism is done largely on Lincoln type milling machines or "power mills," profiling machines, hand milling machines, and drilling machines. Multiple-spindle, semi-automatic, combination drilling, reaming, and milling machines of special design are also used for machining the receivers. While many of the operations on the different rifle parts are common to those familiar with manufacturing methods, the Savage factory contains a great variety of special tools and fixtures, many of which are very ingenious and enable the work to

Fig. 5. General View of Lincoln or Power Milling Machine Department at Savage Arms Co.

be done rapidly and accurately. Some of the small parts of the action, especially for the lighter class of rifles, are blanked out and formed in dies.

Many thousands of parts are being machined continually in the factory of the Savage Arms Co., and in order to account for these parts without confusion and excessive waste of time, a very simple but effective system has been adopted which is utilized by the cost, inspection and manufacturing departments. The most important feature of this system is a card, such as the sample shown in Fig. 6, which accompanies each lot of parts that is to be machined and makes it possible to determine quickly the exact quantity of completed parts that is in stock. This card also serves other important purposes in connection with inspection, etc. When



MODEL 99

LOT NO. 31 NAME OF PART Trigger

AMT. IN PAN AMT. ON SHOP ORDER

OPER.	QUANTITY	SKIP	SPOILED	LOST	NAME OF OPERATOR	DEP'T	DATE	RATE	INSPECTOR	CHECKED BY
1	500 / 500				Smith	Power Mill	5/11	P	Lewis	King
2	500 / 498			2	White	Hand Mill	5/12	P	Smith	Thomas
3	498 / 495		3		King	Drill Press	5/13	P	Jones	King
4	495 / 494	1			Ellis	Hand Mill	5/14	P	Lewis	Thomas
5	494 / 494				Cole	Profile	5/15	P	Smith	King

Fig. 6. Card used at Savage Factory in connection with Manufacturing and Inspection Systems

a certain lot of parts is to be machined the tray containing them is accompanied by one of these cards. As will be seen, it gives the model of the rifle, the name of the part and the lot number. All operations are numbered, and the vertical column to the left contains the operation numbers for this particular part. In the next column is recorded the number of parts which are sent to each operator and also the number of good parts he returns. In this particular case, the card shows that 500 parts were sent out for the first operation and 500 were returned. For the second operation, 500 parts were sent out but only 498 were returned, two being lost; hence 498 are credited on the card and the operator is paid for the actual number returned. On the third operation three parts were spoiled and did not pass the inspector so that the number is now reduced to 495, and the final number after the fifth operation is 494, because, in this case, one part was "skipped" and came to the inspection department without being machined. When all the operations are finished and the parts are found to be up to the required standard of accuracy, the final number of completed parts, as shown by the card, is transferred to a card index so that the quantity on hand can be determined at any time. The card also gives the name of the operator, the department in which the work was done, the date upon which each operation was completed, the rate of pay for each operator, and the names of the inspectors.

System of Inspection

Each machine department has one or two inspectors who make frequent inspections while the work is being done, so that in case a machine is out of adjustment slightly or a cutter has worn excessively, the error will be detected before a large quantity of work is finished. From this it will be seen that the inspection is not only to detect inaccuracies but to prevent them. For instance, if the "outside" or department inspector finds that the cutter of a profiler is a little too high, the parts which were milled while the cutter spindle was incorrectly adjusted are run through again. These outside inspectors are constantly on the lookout for trouble and greatly reduce the number of parts rejected by the final inspection which is made in a centrally located inspection department.

The method of handling the various parts, while they are being transferred from one department to another, is worthy of note. Small pieces, such as triggers, sears, hammers, etc., are kept in plain metal trays, and the larger parts, such as rifle receivers or pistol frames, are placed in special trays in an orderly, convenient way. A number of these trays may be seen in the illustration Fig. 1. When the parts in one tray have been machined and are returned to the inspection department, another tray of rough parts is ready, so that there is no delay.

In addition to the careful inspection of the individual parts during the process of manufacture, the action of the rifle is thoroughly tested in the assembling department, and, finally, the operation and accuracy of the rifle by actual use. In connection with this final test, which is made by expert marksmen, the sights are carefully adjusted.

Determining Initial Velocity of Bullet with Chronograph

One of the most interesting instruments used in connection with rifle testing is the chronograph. By means of this instrument, which is illustrated in Fig. 1, the initial or muzzle velocity of a bullet is determined. The chronograph has two magnets, *A* and *B*, which have sufficient power to hold the bars *C* and *D* when the circuits are closed. Magnet *A* is fixed to the vertical column of the chronograph, whereas magnet *B* is adjustable vertically. (The purpose of this vertical adjustment will be referred to later.) Magnet *A* is energized by a primary circuit, and magnet *B* by a secondary circuit. The primary wire crosses the muzzle of the rifle and the secondary circuit connects with the target. When the rifle is fired the bullet cuts the primary circuit and the long bar *C* drops. Now when the bullet hits the target, which is located 100 feet from the rifle, the secondary circuit is momentarily broken, thus demagnetizing magnet *B*. The short bar *D* then drops and falls through a tube located just beneath it and onto a trip which releases a spring-actuated marking plunger at *E*, which is forced outward and instantaneously makes a mark on the long bar *C* as it drops. The distance from this mark to a standard datum line on bar *C* indicates the initial velocity of the bullet. That this dis-

PERFORMANCE OF SAVAGE 0.22 CALIBER HIGH-POWER RIFLE

Ballistic coefficient, 0.25 Weight of bullet, 70 grains

	Range in Yards										
	Muzzle	100	200	300	400	500	600	700	800	900	1000
Velocity, Ft. per Second	2800	2345	2103	1803	1542	1320	1152	1044	967	905	851
Mid-range Trajectory, Inches	......	0.506	2.998	7.325	15.289	28.515	48.037	77.502	120.787	172.51	248.576
Angle of Departure	......	2′ 5″	5′ 13″	8′ 36″	12′ 58″	18′ 32″	25′ 13″	33′ 44″	43′ 48″	55′ 48″	1° 10′ 42″
Time of Flight, Seconds	......	0.113	0.248	0.402	0.583	0.794	1.041	1.316	1.615	1.939	2.280
Energy in Foot pounds	1218	922	688	505	370	271	206	170	145	127	113

Machinery

tance will enable the velocity to be determined will be more apparent when we consider the fact that if both circuits were broken at the same instant, the mark made on bar C as it fell would exactly coincide with the datum line, provided magnet B were adjusted to the proper vertical height; but there is an interval between the breaking of the circuits which is equal to the time required for the bullet to travel from the rifle to the target, or 100 feet. Therefore, when the primary circuit is first broken by the bullet as it leaves the rifle, bar C begins to fall and when the secondary circuit is broken by the bullet as it hits the target, the mark made on bar C does not coincide with the datum line but is some distance from it, this distance determining the velocity of the bullet. The velocity is ascertained by measuring the distance between the lines with a special instrument which resembles an ordinary vernier caliper, except that it is longer and is graduated to give direct velocity readings in feet per second.

Before using the chronograph it must be "leveled," which means that the adjustable magnet B for holding the short bar must be moved vertically until the marker strikes the long bar exactly on the datum line when both primary and secondary circuits are broken at the same instant. The distance from the marker to the datum line on the bar is standard and if the instrument is properly adjusted, the marker should strike this line when both magnetic circuits are broken at the same time. The point, however, at which the mark is made when the circuits are broken simultaneously varies with the altitude and also because of different atmospheric conditions; hence, it is necessary to make this vertical adjustment of magnet B each time the chronograph is used, and on some days considerable time is required to get the adjustment exactly right. The holding power of the magnets must also be within certain standard limits. The energizing current is regulated by a rheostat until the magnet will hold the bar but will not hold it when a standard auxiliary weight is attached. These weights are in the form of tubes which are placed over the bars and are supported by shoulders at the lower end. The tubes are shown in the lower right-hand corner of Fig. 1. The method of breaking the circuit at the target the instant the bullet strikes is very simple but ingenious. The diagram Fig. 4 illustrates the principle. When the bullet strikes the steel target plate F, the impact causes the thin, flat spring G to jump off the binding post which momentarily breaks the secondary circuit and causes the short bar of the chronograph to fall and release the marker, as previously described. This diagram also shows how the primary circuit is broken by the bullet as it leaves the rifle. Of course it will be understood that the position of the chronograph relative to the rifle and target is immaterial.

In the next installment of this article some interesting machining operations on various rifle parts will be described in detail.

* * *

The following story is told about the early experiences of one of the leading men in the machine tool building field in America today. Some twenty-five years ago, when he arrived in the United States from across the sea, his knowledge of the English language was not all that might have been desired, and when he was first employed in a railway shop the foreman, for that reason, proportioned his compensation accordingly. This man, however, was a good mechanic and he soon satisfied himself that he was giving as much in return for his small wage as the native journeymen. He therefore promptly applied to the foreman for a raise, which was refused with the explanation that as the young man could not talk English very well, it was not possible to pay him any more. This explanation was quite unsatisfactory to the applicant, who quickly replied: "——— ——— it. I want to know whether you are keeping me here to talk or to work." He got the raise.

* * *

A light weight metal alloy known as "metal cork," considered superior to aluminum, is made from about 90 per cent magnesium, the remainder being zinc, sodium, aluminum and iron. The specific gravity of this alloy is said to be 1.76.

THE SYSTEMATIZER AND HIS SYSTEM

Perkins was an efficiency expert and systematizer. He had equipped the offices with innumerable card systems and blanks and report forms, and to save work and time in the writing and reading of long and cumbersome names, the men in the shop were all numbered. He installed various accounting machines and also a Hollerith tabulating machine, such as is used by the census office.

He was also a worker, and so it happened that one Thanksgiving day, in the afternoon, when everybody else was digesting turkey, he went down to the shop to plan some more systems and devise a few more blanks to be filled out when a stripped 3/8-inch nut had to be replaced with a new one on the machine known as "B-No. 36." It happened that a little later in the afternoon he found that he wanted to run the tabulating machine, but as the engine in the shop was not running and as he did not know that there was an emergency connection with the city supply, he was at a loss how to get current for the 1/4-horsepower motor of the machine; but as a great systematizer is never at a loss for long, he wandered down into the engine room, only to find that the engineer was properly celebrating Thanksgiving with his family, as every engineer ought to be given a chance to do. In the boiler room, however, he found a fireman, and he promptly ordered him to start the 200-horsepower high-speed engine that was direct-connected to the dynamo, in order that current might be produced for the 1/4-horsepower motor upstairs. The fireman, however, knew nothing about engines, nor about dynamos, and what is more—he knew that he did not know anything about them, and he said so. The systematizer went upstairs again and thought the matter over, and the more he thought about it the more thoroughly it was impressed on his mind that a fireman was inefficient if he did not know how to run an engine in an emergency case, and he went down again and told the fireman that it was up to him to start that engine or lose his job. Now, the fireman was used to doing the firing himself, and being fired by somebody else did not appeal to him, particularly as he had a wife and children depending upon him; so he took a chance, and after he had tried a number of handwheels on various valves, he got the big engine started.

Then there was another difficulty—the fireman did not know which switch to throw to connect with the 1/4-horsepower motor upstairs. The efficiency expert, however, quickly found a way out of this difficulty. He told the fireman to throw in one switch at a time, he himself, in the meanwhile, being upstairs to note the effect. When the fireman threw the proper switch, the motor would start, and he would then signal over the telephone.

So after all the 1/4-horsepower motor was running fine and cards passed through the tabulating machine at high speed, and the systematizer was delighted to add to his collections a few hundred more cards; but in about fifteen or twenty minutes the motor began to slow down, and then it stopped suddenly. The scientific systematizer rose in wrath; the fireman was playing a trick on him and had turned off the power. In about three jumps he found himself downstairs in front of a frightened fireman protesting his innocence, and then they both entered the engine room. To a great systematizer the sight was probably not so horrible, but we hate to think of the words that the engineer used when, disturbed by a hurry-up call in his Thanksgiving celebration, he came in and saw it. The engine had been running without oil—there being no card index indicating how often the engine should be oiled—and the babbitted main bearing next to the flywheel had become overheated. More than that, it had become so excessively overheated that it had partly melted away, and the flywheel was tipped at an angle as if it, too, had been celebrating Thanksgiving in an improper manner. At the other end, the rotor of the dynamo was dislocated and the armature had scraped against the pole pieces.

Just how much it cost to repair the damage is recorded only in the card index of the scientific systematizer, and what the general manager said to him the next morning, when the full details of the matter had been established, is not recorded anywhere.

CHUCKING METHODS FOR IRREGULAR PARTS*

FIXTURES FOR HOLDING UNUSUAL LATHE AND BORING MILL WORK

BY ALBERT A. DOWD†

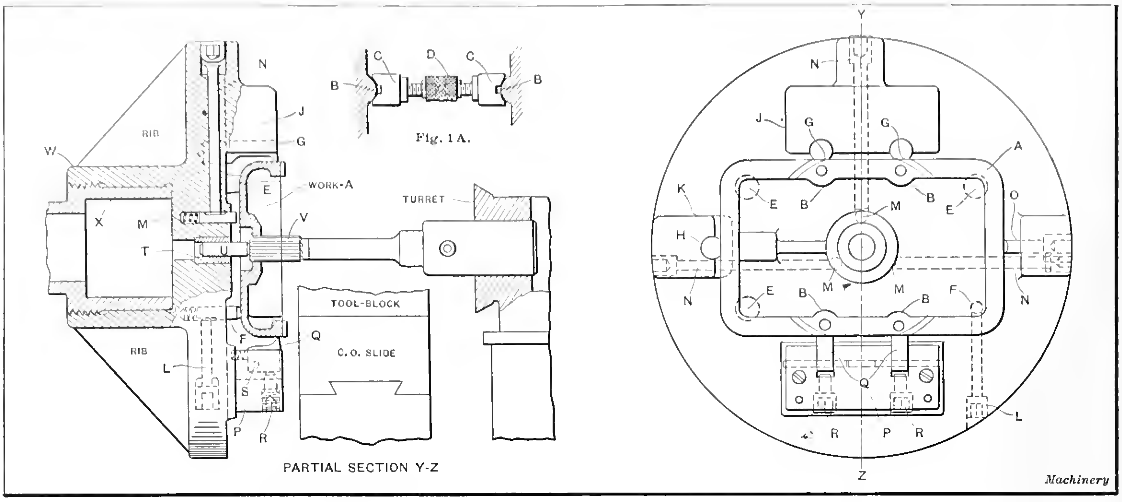


Fig. 1. Chuck for Rectangular Aluminum Castings used on Horizontal Turret Lathe

CASTINGS or forgings of irregular form usually require some method of holding (for the purpose of machining) other than chuck jaws, although there are many instances when the latter can be used to advantage. The form and size of the work have a great influence on the method of handling, and the accuracy required is also an important factor. The work itself may be in the rough state without any machining previous to the chucking operation or it may have been milled, planed or drilled. In the former case it is necessary to design a method of holding suited to the rough piece, and care must be exercised in selecting the surfaces best adapted for locating the work. It may even be necessary to have additional lugs or bosses cast or forged on the piece in order to facilitate holding it in position on the fixture. If walls are thin care must be used also in the method of clamping so that no distortion will take place. In case a previous operation of milling or planing has taken place, it is essential that the fixture be so designed that this surface be used for locating in order that accurate work may be assured. There are occasional instances when both milling and drilling operations have preceded the chucking. This may possibly complicate matters somewhat or it may simplify them depending on the conditions. Sometimes a series of holes has been drilled in a flange which has been surface milled, and in a case of this sort the holes may prove useful for clamping purposes. When a case is encountered with a milled surface and an angular hole, or some other condition of a similar nature, there may be more difficulty in designing the fixture.

The type of machine upon which the work is to be accomplished is also a factor which largely influences the design, and this matter should be decided positively before any attempt is made to draw up the device. The types of machines for which fixtures of this sort are most frequently designed

* For further information on the subject of work-holding devices and kindred subjects, see MACHINERY, October, 1913, "Work-holding Arbors and Methods for Turning Operations," and "Arbors for Second-operation Work"; November, 1913, "Holding Devices for First-operation Work"; June, 1914, "External Holding Devices for Second-operation Work." See also MACHINERY's Reference Book No. 120, "Arbors and Work-holding Devices."

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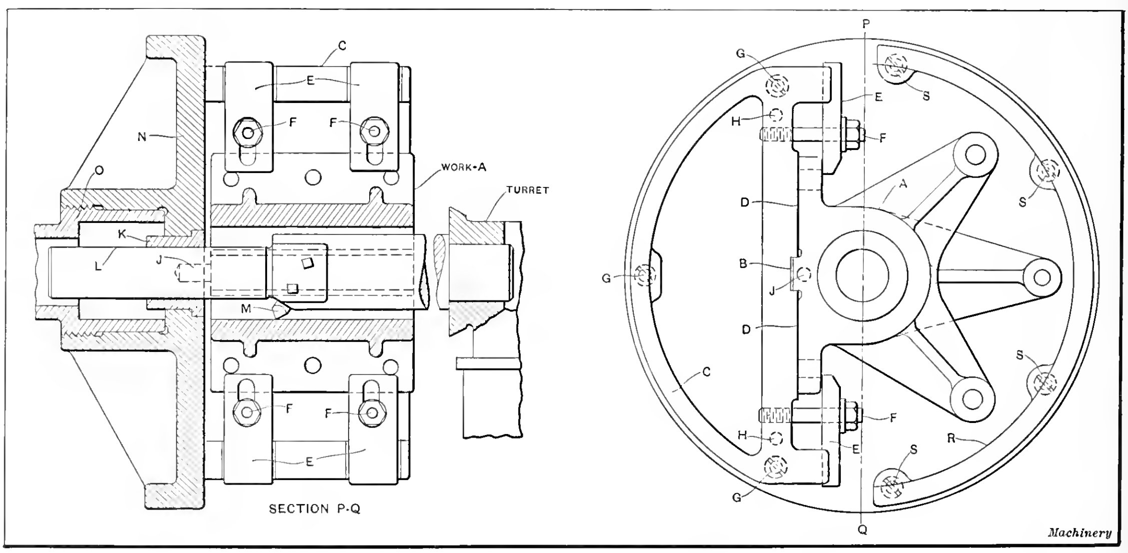


Fig. 2. Fixture for boring Irregular Castings on Horizontal Turret Lathe

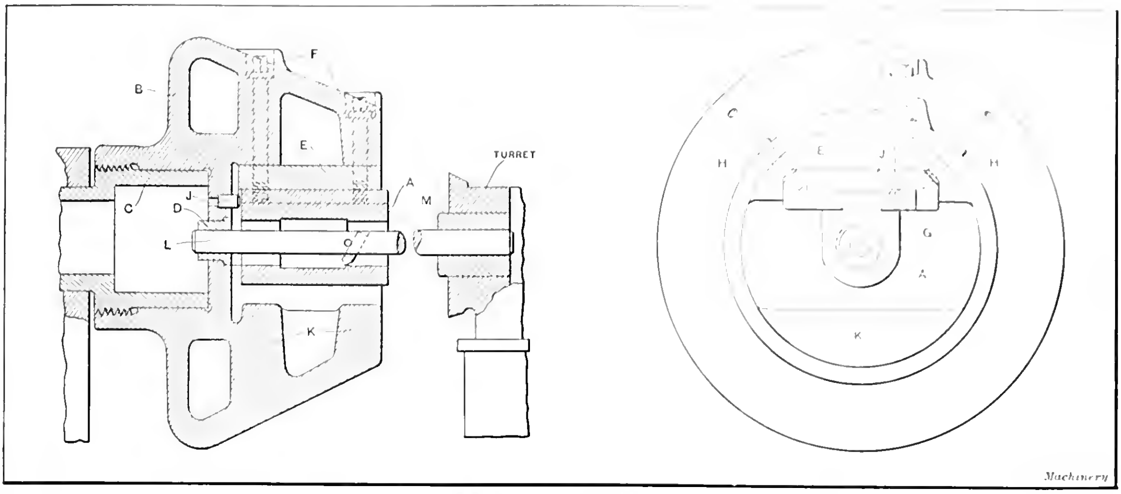


Fig. 3. Fixture for boring Small Bronze Castings on Horizontal Turret Lathe

are the horizontal and vertical turret lathes and the vertical boring mill. The engine lathe is also occasionally fitted with an arrangement for this kind of work, but as the construction of the fixtures is very similar to those used on the horizontal turret lathe it is not necessary to differentiate between the two in this article.

It is obviously out of the question to attempt to cover or describe all the conditions which may be encountered in the chucking of irregular work, but the examples here given represent a variety such as may prove of considerable value in elementary design. Adaptations to suit various conditions will suggest themselves to the progressive designer. Attention is called to a few of the important points in the design of fixtures of this character.

Important Points in Design

1.—*Locating points or surfaces.* These are very important and should be selected with care, having in mind any ribs, lugs or raised lettering on the casting, so that no trouble can be caused through faulty locating. Make use of the vee principle when the shape of the work will permit it. If four points are needed in the same plane for proper support or location of a rough surface, be sure that one of these points is movable to compensate for inequalities in the surface. If a finished surface is to be used for locating, the pads on which it rests should be as small as possible (consistent with sufficient surface for proper clamping) and should be easily accessible for cleaning.

2.—*Clearances around the casting.* These should be made ample to accommodate variations in the work. As a rule one-quarter inch on all sides of the rough piece is sufficient, on medium-sized work, such as that machined on horizontal turret lathes. On larger work for the vertical turret lathe or boring mill, one-half inch is none too much and even a little more than this is safer, for larger castings vary greatly in size and the writer has seen a fixture (within the last two years) which had to be machined to obtain sufficient clearance, although it was designed to give one-half inch clearance all around. Needless to say this was made for a large casting, and was used on a boring mill.

3.—*Clamping.* Methods of clamping are many but the plain strap is perhaps more used than any of the others, partly on account of its simplicity but also because it is very efficient. Hook-bolts are good if overhang is not too great, but they are worthless if not well backed up. They are also rather expensive. It is advisable to so design the clamping devices that they can be rapidly operated so that valuable time may not be lost in setting up or taking down the work. It is not considered good practice to use clamping screws which are tapped into a cast-iron body. It is much better to make these in the form of a stud with a nut and washer on the clamp. This brings the wear of the clamping action on steel instead of cast iron.

4.—*Chips.* Provision should be made for the removal of chips so that accumulations of these will not cause trouble. Accessibility to bearing or locating surfaces is important so that cleaning can be readily accomplished. When fixtures are of the pot variety cored openings may be arranged for this purpose. When fixtures are designed for use on vertical boring mills this point is of great importance and must be carefully considered in the design.

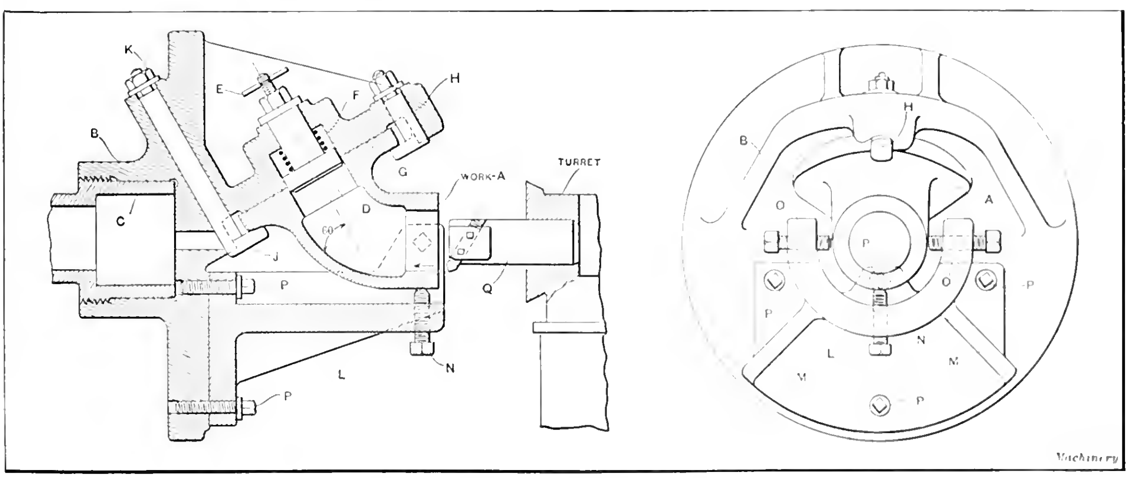


Fig. 4. Fixture for machining Angular Cast-iron Fitting

5.—*Rigidity.* On the horizontal type of machines this point is largely dependent on the overhang from the spindle. Therefore the fixture should be designed in such a way that this will be as short as possible. Ribbing may also be used when needed to give additional stiffness, especially around the clamps, as at these points the strains are excessive and changes may take place in the work itself unless provision is made to neutralize distortion. On the vertical type of machines fixtures should be made of generous proportions to resist the heavy cuts which these machines commonly take.

6.—*Safety.* The operator should be considered at the time the designing is done and not afterward. Projecting lugs, set-screws, etc., should be avoided as far as practicable, especially when their location is at the outer portion of the fixture. Lugs can be easily made so that they have round corners which will not catch in the operator's clothing, and set-screws of the hollow variety may now be obtained in many different forms suited to almost all conditions.

7.—*Cost.* This should be to a certain extent proportional to the accuracy required in the finished work and also to the number of pieces of one kind which are to be machined. A very elaborate and costly fixture should not be designed for a case calling for only a few pieces as this cost distributed on the work would greatly increase the cost of each piece.

The work was placed in the fixture so that it rested on the three fixed pads *E* located at the corners, and a spring pin *F* acted as an adjustable support at the other corner. The coil spring under the pin is just strong enough to insure positive contact with the work without danger of springing. The set-screw *L* is of the hollow type and serves to lock the pin securely in position. The side and end locations of the work are determined by the pins *G* and *H* which are flatted off to form a knife-edge where they touch the casting. This arrangement causes them to sink in and prevents any tendency to pull out of the fixture. It will be noted that these pins are set into the blocks *J* and *K* which form a solid backing and prevent springing. A steel block *P* is screwed to a finished pad on the fixture body and is doweled in place. Two knife-edged clamps *Q* fit slots in the block and are pivoted on the pins *S*. They are forced into the casting by means of the hollow set-screws *R*, and have coil springs for the purpose of keeping them back when not in use. In connection with these clamps, attention is called to the points on which they pivot; these are placed well back from the knife-edge so that the clamping action also has a pulling-in tendency. As a means of support for the center of the work, the three spring pins *M* are provided, these being arranged in the same manner as the pin *F*, and locked in position by the set-screws *N*. The

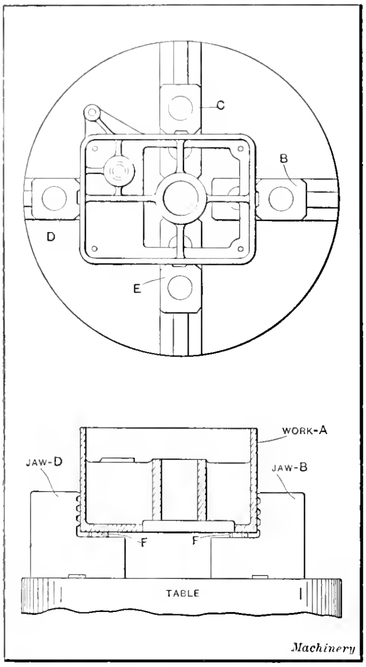


Fig. 5. Use of Four-jaw Chuck for holding Rectangular Work on a Vertical Lathe or Boring Mill

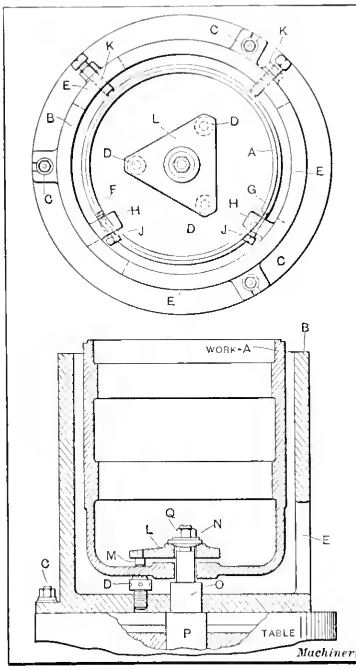


Fig. 6. Pot Casting Fixture for holding Steel Castings on Vertical Turret Lathe

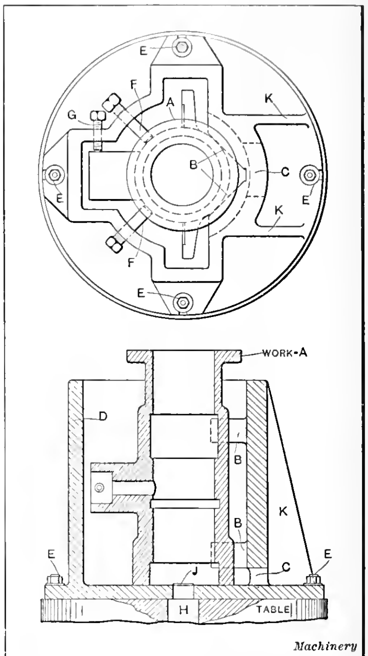


Fig. 7. Pot Casting Fixture for holding Irregular Steel Castings on Vertical Turret Lathe

When a large number of castings are to be handled, however, the first cost may be almost overlooked and every improvement used which will tend to decrease the production time.

In the examples given herewith attention will be called to some of the important points in design and construction, faults will be emphasized, and suggestions made. It should be borne in mind that the examples illustrated have been selected with a view to simplicity rather than complexity of design, so that basic principles will be readily grasped.

Chucking Fixture for a Rectangular Aluminum Casting

The work shown at *A* in Fig. 1 is an aluminum cap for an electric generator. The casting is somewhat rectangular with round corners and is of rather thin section with practically no reinforcement in the shape of ribs. No work has been done upon it previous to this setting so that the casting is in the rough. The machining necessary for this series of turret lathe operations consists of boring, reaming and facing the inner hub; facing the rim and sizing the segmental circular tongues on the face of the rim. An accurate job was required, and no distortion of the casting was permissible.

body of the fixture *W* is well ribbed up at the rear and is bored out and threaded to fit the spindle *X*. A tool steel, hardened and ground bushing *T* is forced into the center of the body, and acts as a guide for the boring and reaming bars. The pilot *U* of the floating reamer *V* is shown in position.

After this fixture had been completed it was tested and was found unsatisfactory, due to the spring of the work at the clamping points *B*. In order to remedy this defect, a pair of special supporting jacks were made such as shown in Fig. 1A. Two steel vee-blocks *C* were turned down and threaded with right- and left-hand threads, respectively, to fit the knurled collar *D*. These jacks were placed in position in the casting before it was placed in the fixture, and were tightened by the fingers, a piece of drill rod being used for the final pressure. By the use of this device a perfectly rigid effect was produced and the work obtained thereafter was entirely satisfactory. In the design of this fixture as a whole, attention is called to the freedom from projecting set-screws, and other protuberances likely to catch in the operator's clothing.

Special Fixture for a Bearing Bracket

The work A shown in Fig. 2 is a cast-iron bearing bracket of somewhat peculiar shape. This has been planed in a previous setting, on the base D, and the tongue B has also been machined to size. The body of the fixture N, made of cast iron, is screwed to the spindle O of a horizontal turret lathe. It was faced off in position on the machine so that the face would be perfectly square with the spindle. The semicircular pot casting C, carefully located on it by the dowels H, is held in place by the screws G which enter it from the rear. The work A is located on the face of this casting by the tongue B which fits a slot cut to receive it. The clamps E are of steel and are slotted so that they can be pulled back out of the way when placing the work in position or removing it. The studs F are threaded to a tight fit in the casting C, and are provided with nuts and washers which bear on the clamps. In this construction the wear due to the operation of the clamps all comes on the steel of the screw rather than on the cast iron, this tending to make the life much longer, and the up-keep better. The lugs on which the ends of the clamps bear are slotted in order to prevent twisting while they are being tightened. These slots are not machined but are cast and afterward smoothed out with a coarse file. The pin J in the body of the casting simply acts as a longitudinal stop.

Partly as a protection to the operator and partly as a counterbalance, the segmental piece R is screwed to the body by the four screws S. This arrangement is valuable because the work is revolving at a fairly good speed (120 R. P. M.) so that good balance is important, and danger to the operator is avoided on account of the guard over the projecting lugs on the work. Attention is called to the accessibility for cleaning the locating surfaces and also to the ease with which a wrench can be used on the clamping nuts. A point in the design which could be improved is the amount of surface used for locating. Small pads under the clamping surfaces and a rim on each side of the tongue would have been ample and could have been kept clean more easily. A tool steel bushing K is forced into the body of the fixture and acts as a guide for the pilot L of the boring-bar, which greatly assists in preventing chatter while the tool M is cutting. The work accomplished in this fixture was satisfactory.

High Speed Fixture for a Bronze Bearing

The bronze bearing shown at A in Fig. 3 has been previously machined on the dovetail portion, and it is of importance that the bearing should be in a fixed relation and parallel with this dovetail. As the hole is of small size and the work of bronze, it is necessary that the fixture should run at high speed in order to produce the work in a reasonable time. The body of the fixture B is made of cast iron and is fitted to the spindle C of a horizontal turret lathe. A steel locating block E is fitted to the dovetail of the work and is fastened into its seat in the body by the screws H. Two screws F are tapped into the dovetail gib G, so that they can be used to tighten the work in the fixture without chance of distortion. The pin J acts as a longitudinal stop. The lugs K are provided for the purpose of balancing the fixture so that it will run without vibration which might otherwise be caused by the high speed and spindle overhang. It will be noted that the outside of the fixture is smooth, thus offering no danger to the operator. Obviously a socket wrench is used to tighten the gibs which secure the work in position. A tool steel hardened and ground bushing is forced into the body at D and acts as a guide to the boring-bar L which is necessarily small and needs support. The other end of the bar is held by the bushing M in the turret hole. This fixture is quite simple but the method used is a little out of the ordinary. It should be noted that the clamping device is efficient and does not tend in any way to distort the work. Its action is in two directions on account of the angle of the dovetail and therefore makes a positive location, as it crowds the work into the dovetail and draws it back at the same time. The fixture was used with satisfaction.

Fixture for an Angular Cast-iron Fitting

The rather awkward piece of work shown at A in Fig. 4 is an angular cast-iron fitting which has been previously machined at G and had the hole at this end bored. The angle required between the two openings is sixty degrees. The machine to which this fixture is fitted was a horizontal turret lathe. The body of the fixture B is of cast iron and is screwed to the spindle C in the regular way. The angular pad which receives the finished portion G of the casting is machined to give the correct relation between the holes in the joint. A spring plunger D is located centrally in this pad, and serves to locate the work in relation to the previously bored hole. The pin E is used to pull the plunger back when placing the work in position. The hook bolts H and J grip the piece by the flange and hold it firmly against the locating pad. It will be noted that J passes through and is operated by the nut and washer at K on the back of the fixture. In order to insure rigidity to the forward portion of the piece where the work is being done, a segmental casting L is used, which is secured to the body by the four screws P. The set-screws N and O are cup-pointed, and greatly assist in keeping the work rigid at this end. It will be seen that the bracket is well ribbed up at the points M to secure additional stiffness. A plain boring-bar Q is held in the turret.

Simple Arrangement Using Four Jaws

The motor bracket casting shown in Fig. 5 is of cast steel and has been previously machined on one of its faces. Four jaws in a chuck of the independent type are used in this setting of the work, and the machine employed is a vertical turret lathe. The bracket which is to be machined is located by the two jaws B and C which are left set to fit the work. The function of these jaws is to take the place of a vee-block and the other jaws are used for the purpose of holding the work securely. The shape of this piece of work being rectangular, it is feasible to use this method for locating, by allowing them to act as a vee. In action, E and D are brought up alternately until the work is securely held. The surface of the work which has been previously machined is supported by the steel buttons F which are positively located in the jaws. This method is adaptable to work which comes along in small lots but it is open to objections. The principal one of these is the possibility of the operator's shifting one of the vee-jaws unconsciously thereby ruining valuable castings. Another is the possibility of variations in the squareness of the machined face with the gripping surface, which will naturally result in work which is not absolutely true. But as a makeshift method when only a few pieces are to be machined, it is satisfactory in the majority of cases unless a very careless workman is employed.

Pot Fixture for an Electrical Piece

The steel casting A in Fig. 6 is a piece of work which is handled in the rough, no previous machining having been done on it. This casting is of large size and being of steel is subject to variations in size and shape. As this is the case it is necessary to make suitable provision for these so that compensation may be obtained to suit the various conditions. The vee-principle is made use of in the locating device as far as the cylindrical portion is concerned, the set-screws K being adjusted to suit the casting, so that it is centered from the rough exterior. The pot casting B is of cast iron and is centered by the plug P in the center of the table. This plug is forced into the pot casting at O. The work is dropped into the fixture and forced over against the vee-screws K, by the square-head set-screws J which are tapped into the lugs H, and come against the open portion of the work at F and G. Support is obtained by the screws at the three points D, two of which are movable and the third fixed. The movable points are as shown in the lower view, and they are adjusted by means of a piece of drill rod so that the entire casting can be tipped one way or the other to compensate for inequalities in the rough casting. The steel triangular plate washer L is fitted with three clamping points M which bear on the inside of the rough casting and are equalized so that they all get the same amount of pressure, by the spherical washer N, operated by the nut Q. The entire fixture is held down on the table of the machine by the tee-bolts C which fit the table tee-slots. This fixture gave results which were satisfactory, but the setting-up time required was rather long. The openings E shown in the illustration permitted

access to the jack-screws and also allowed cleaning to be easily accomplished. The projecting set-screws are a rather bad feature, as they are dangerous to the operator, but as the speed was not excessive, no trouble was experienced with them. This defect could have been very easily remedied.

Fixture for a Piece of Hydraulic Work

The casting *A* shown in Fig. 7 is of steel and is handled in the rough, no previous machining having been done. This work could have been handled in a three-jaw chuck combination, had it not been for the projecting lugs on the casting, and even these could have been taken care of by cutting away the sides of the jaws. A pot casting method was decided upon instead of this, however, on account of the greater rigidity. The body *D* is of cast iron and is fastened to the table with the four tee-bolts *E*. On one side of this body are two pads *B* which are planed out to form a pair of vee-blocks in which the cylindrical portion of the casting locates. It is forced into position by the screws *F* in the wall of the pot casting. The entire fixture is located on the table by means of the steel plug *H* which fits the table center hole and is forced into the fixture at *J*. A driver is provided in the screw *G* which bears against the hub of the casting and takes the thrust of the cut. Although this is a very simple fixture it illustrates the principle of the vee-block to advantage and should therefore be carefully noted.

The examples illustrated in this article have been selected from a number of fixtures for irregular work, principally because they are of a simple nature and yet illustrate various conditions fully as well as if they were of a complicated structure.

* * *

"MOVIES" MEETING OF THE EFFICIENCY SOCIETY

On the evening of May 26 the Efficiency Society held its regular monthly meeting. This session was designated as a "Movies" meeting, because of the fact that motion pictures and their relation to greater efficiency in the manufacturing and selling interests were discussed. The meeting, which was preceded by a dinner, was held at the Aldine Club, New York City. Major Charles Hine, the presiding officer, stated that it was through the efforts of Fred Hawley, the chairman of the plan and scope committee, that the various films shown to demonstrate the greater efficiency in business that could be secured by the moving picture, were obtained. In connection with the showing of the films, the secretary of the society, Elihu C. Church, made explanatory remarks.

The films shown were divided into two classes, those of interest as efficiency promoters in the factory, and those of interest for promoting selling efficiency. The program under the first class included an interesting film made in the United States Steel Corporation's plant at Gary, Ind., vividly calling attention to accident prevention and self-development for workers in the industries. This was followed by a manufacturing descriptive film from the Ford Motor Co.'s plant; then by a demonstration of the oxygraph. After this followed several microscopic analysis films, in which the motions of a ball balanced on a column of water were analyzed, and the trajectory of a bullet was shown. Time and motion studies were also shown, illustrating the advantages to be gained by the efficiency engineer by analyzing motion through the medium of the moving picture.

As a promoter of selling efficiency, films were shown to illustrate the advantages to be gained by the farmer in using dynamite. In this film the tools and methods of procedure for blasting stumps and felling trees were shown. This was followed by a film showing the operations of a ditch digging machine, bringing out the point that even if impossible for a salesman to show his prospect the actual apparatus, the moving picture film formed a good substitute. The final film was a selling educational film to illustrate various electrical devices as used in the home.

The evening's program did much to demonstrate to the efficiency engineer that the moving picture, like the phonograph and similar inventions that were originally laboratory experiments and later entertainers, are finally evolving into valuable adjuncts to business.

A CONVENIENT TOOL COMPARTMENT

A convenient type of tool-holding compartment especially adapted for screw machine tools is in use in the plant of the DeVilbiss Mfg. Co., Toledo, Ohio, manufacturer of atomizers. This tool-holding compartment is of simple arrangement and keeps all the tools separate and all the tools for one job in one place. As shown in the accompanying illustration, it comprises five compartments, each of which contains sixty boxes. On the door of each compartment is a card which gives the job number, the number of tools used, and the number of the box in which these tools are contained.

The screw machine cams are numbered, as they cover several jobs, and are held on a separate rack provided with pins which fit into the large hole in the cam. All collets,

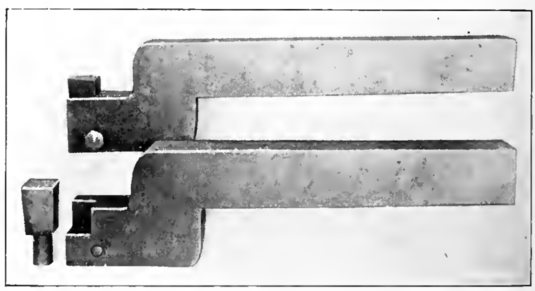
A Convenient Tool Compartment

spring fingers and standard tools are held in racks inclined at an angle of about 45 degrees, which form the last compartment of this row. These racks are arranged in shelf form and are spaced so as to give plenty of room for all the tools. There are spaces for six tools in a row. The special feed tubes are held on the rack shown to the left of the compartment. D. T. H.

* * *

A NON-CHATTER PLANER TOOL

To overcome the chattering encountered on a hard job of planing, the Stockbridge Machine Co. of Worcester, Mass., made a special planer tool with an inserted cutter, shown in the accompanying illustration. The illustration shows two of these tools, right- and left-hand; one has been disassembled and the other is shown with the cutter in place. The tool-holder is of the familiar gooseneck form and the cutter is held in by a clamping bolt at the side. The cutter



Right- and Left-hand Planer Tools made to obviate Chatter

is square in section and fits snugly in a machined section of the tool-holder, being supported on two sides. A round shank is provided that fits into a corresponding hole in the tool-holder. A section of the round hole extends through a slip bushing through which the clamping bolt passes. Thus, when the clamping bolt is tightened, it pulls against the shank of the tool and binds it firmly in place. In using this type of planer tool, there is not the slightest tendency to chatter.

C. L. L.

ELECTRIC ARC WELDING*

APPLICATION OF THE CARBON AND METALLIC ARC IN CUTTING AND WELDING

BY ALAN M. BENNETT†

ELECTRIC arc welding as a means of uniting metals—particularly iron and steel—has been rapidly developed in the past few years, and apparatus for doing this work is now a standard product with a number of manufacturing concerns. This process of welding is particularly applicable to certain classes of work encountered in foundries, railroad shops, tank and boiler shops, steel mills, locomotive shops, and shipyards; and the demand for welding apparatus from these sources is well established. In addition to the field covered by these industries, where the use of this process has become more or less standardized, there are countless other lines of manufacture, each representing a great variety of work to which arc welding is adapted.

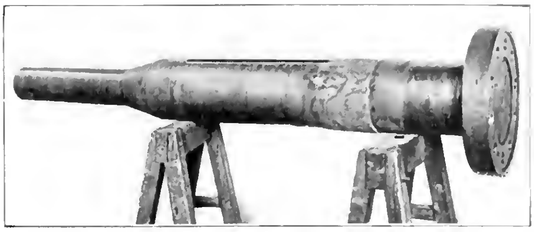


Fig. 1. A Built-up Fit on an Armature Shaft done with the Metallic Arc


Fig. 2. Head, Flange and Branches welded in a 42-inch Tank with the Metallic Arc

Various methods of using the arc for welding have been devised from time to time, the majority of which have met with indifferent success. At the present day practically all welding, in this country at least, is confined to the method in which an electrode and the object to be welded are connected in a simple electric circuit, and an arc of limited size is drawn between the two by bringing the electrode in contact with the work at the point at which the weld is to be made. The size of the arc is capable of adjustment to suit various classes and conditions of work.

The Carbon Arc

In practice there are two methods of applying this process to the making of welds and the cutting of metals. In the first, which makes use of the carbon arc, a rod of graphite forms the electrode; and the arc drawn between this rod and the work heats the latter to the point of fusion. This method is used for cutting or burning off metal, and is the simplest application of the arc. Its principal use is for reducing scrap material to sizes capable of being easily handled, and in foundries for cutting risers and fins from large castings. By extending this process of fusion and introducing pieces of metal within the influence of the arc, actual welding or building up of the work is accomplished. The metal supplied, which may be either in the form of small pieces of scrap material or a rod held in the operator's hand, is fused and unites with that part of the work already raised to a molten state by the heat of the arc, forming a solid mass of even structure upon cooling.


Fig. 3. Fractured Section of Locomotive Frame before repairing

The principal field for the use of the carbon arc is in foundries and steel mills, for the repair of broken and imperfect castings of large size. The loss from this source, which is always high, can be reduced to a very small percentage, as castings containing blow-holes, cracks, shorts, etc., can readily be repaired with a small expenditure for material and labor. For all work of this nature in which the carbon arc is used, comparatively heavy currents are required, ranging from 300 to 600 amperes. Owing to the ability to use these heavy currents, and to apply the heat quickly and concentrate it at the required point, the heat generated at any particular point is very intense and the process of cutting or welding becomes a very rapid one.

The Metallic Arc

The second method in this process of welding makes use of a metallic electrode—usually of a soft grade of iron or steel—which during the operation of welding is fused by the heat of the arc and carried over in the form of small globules that are deposited at the point on the work from which the arc rises. The work itself is raised to a state of incandescence at this point, and the fused metal unites with it as it flows from the electrode. The operation of welding by this method is very rapid, as the fusing of the electrode is continuous after the arc is started, the drops of molten metal following each other in close succession. This method is extensively used in all classes of repair and reclamation work, such as filling in cracks of broken castings, building up the worn parts of rolls and rails, repairing cracks in boilers, patching locomotive fireboxes, and in many industries as a manufacturing means in the process of getting out the finished product. Examples of this latter use are the welding of heads and branches to tanks, joining the seams of tanks and boilers, welding fireboxes, flue sheets, boiler tubes, etc., and all classes of pipe and sheet metal work.


Fig. 4. Section of Locomotive Frame after repairing

The current required for the metallic arc is small compared with that used in connection with the carbon arc, rarely exceeding 175 amperes for the heavier classes of work just described, and ranging from this down to as low as from 12 to 15 amperes for

* For other articles on electric welding which have appeared in MACHINERY, see "Point and Ridge Method of Electric Welding," September, 1911; "Electric Butt Welding," October, 1910; "Electric Welding of Copper, Brass and Aluminum," March, 1910; "Electric Welding," February, 1909; "Electric Welding of Tools," October, 1908; "Electric Welding of Dissimilar Metals," July, 1908; "Some Examples of Electric Welding," April, 1908; and "Notes on Electric Welding," April, 1903.

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thin sheet metal work. The size of the electrode used also varies with the nature of the work and current required, the average being from 3/32 to 1/8 inch in diameter. That it is necessary in every case to have a proper relation between the current strength and the size of the electrode can be seen, when it is considered that the heat of the arc must be sufficient to raise a spot on the work to the point of fusion, in order that there may be actual union of the metal from the electrode with the work. If this condition of right temperature does not obtain, there will be an imperfect union of the oncoming metal with the work, and a poor weld will be the result. On the other hand, if the metal is overheated there is danger of burning it. Oxidation also takes place more rapidly, thus impairing the weld, and heavier heating and cooling strains are set up in the metal. The current must, therefore, be regulated to bring about the condition of a proper temperature rise in the work, and the size of the electrode should be selected to carry this current without danger of its being overheated

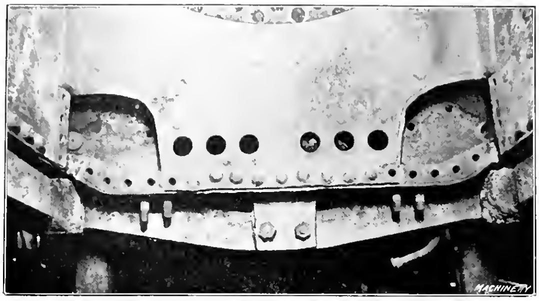


Fig. 5. Fractured Mud-ring of Locomotive Firebox prepared for making the Welds

and oxidized. On the other hand, the size of the electrode must not be too large for the current used, as this will result in slow and imperfect fusion, and equally slow and unsatisfactory welds.

Combined Use of Arc

In many cases, and more particularly in repair work, it frequently becomes necessary to remove parts of the metal at the place where the weld is to be made. For example, to widen out a crack in order that the metal from the electrode may be more readily deposited in it; or to cut out a burned, broken or worn spot for the insertion of new material. This operation of cutting is most readily performed by means of the carbon arc. In such work, therefore, the alternate use of the carbon and metallic arcs becomes desirable and to meet this requirement, as well as to make the outfit as general in its application as possible, means are usually provided whereby both classes of welding can be done from the same outfit. This feature also makes preheating possible, by which means work of large section is raised in temperature by use of the carbon arc, before the welding is actually done. The operation of welding on the hot metal results in the strains being more evenly distributed, both during the process of welding and when the work is cooling off. Welds of greater strength are thus obtained, and the structure of the metal in the weld is more homogeneous with that of the surrounding parts.

Description of Apparatus

The simplest possible outfit for welding would consist of a source of direct-current supply, an adjustable resistance for regulating the current, and an electrode holder. In practice, for reasons which will be explained later, the current is usually furnished by a low voltage generator which may be driven by a motor, engine or belt. In addition, the outfit usually includes a switchboard having on it the starting apparatus for the motor end of the outfit, if motor driven; the control and indicating apparatus for the generator, consisting of a field regulator, voltmeter, and ammeter; and the regulating apparatus for the arc circuits, consisting of a set of current regulating switches with resistance, and usually some form of automatic switch or contactor.

The generator should be compound wound in order that the voltage may be maintained constant under varying load. The need for close voltage regulation will be found to be greatest in connection with the metallic arc, and to increase as the size of the arc and the amount of current used decreases. The smaller arcs will be found to be very sensitive to even the slightest voltage variation, the direct result being an uneven deposit of metal, and burnt welds in the case of very light work. With the carbon arc, where the current used is generally large and where a certain amount of current regulation can be had by lengthening or shortening the arc, the need for close voltage regulation is not so great.

Of the resistance, a certain part is in circuit with the arc at all times when working, this resistance causing the difference between the voltage drop in the arc and the terminal voltage of the machine. It will vary with the amount of current required for welding, and is adjusted by the current regulating switch. When no contactor is employed in the arc circuit, the current at the time the arc is started is limited only by the resistance in that circuit, which is the amount required for welding. This may be of low value, particularly when using a heavy current. There is, therefore, danger of short-circuiting the generator until the arc is established and its resistance introduced into the circuit. The function of the contactor in the arc circuit is to cut out resistance after the arc is established, leaving in the circuit for welding that amount previously determined from the current to be used. By this means the chance for short-circuit is removed, and the apparatus made more automatic in its operation.

After the current is adjusted to give the size of arc needed, no further adjustment is necessary and the arc may be drawn and broken at will, the automatic character of the apparatus always insuring a return to normal conditions. By this means the operator is relieved of all concern as to current regulation, and his whole attention may be given to directing the arc over the work. The operation of welding by either of the methods described makes necessary the renewal of the electrode, though the rate at which the metallic electrode is consumed—owing to the fact that it constitutes the filling material—is much more rapid than that of the graphite rod. To facilitate the act of renewal or of feeding down as it is consumed, the rod forming the electrode is secured to a holder by some form of clamp that readily permits of its being released. The holder is designed to carry the current to the electrode with the least amount of heating of the operator's hand.

Fig. 6. The Completed Weld with Sections of the Throat Sheet replaced

Owing to the intense nature of the light and heat rays from the arc, the necessity for careful protection of the operator's hands, face and eyes is very important. This is particularly so in the case of the carbon arc, where the volume of light and heat is very great. Heavy gloves serve to protect the hands, while for the face, some form of shield held in the hand or supported from the head is generally used. This is provided with an opening filled with several thicknesses of ruby or blue glass, which afford protection to the eyes and still permit of the welding operation being closely followed.

Potential Required for Welding

The potential which has been found to give the most satisfactory results for welding varies from 65 to 75 volts. A

higher potential can, of course, be used, but as the drop in the arc rarely exceeds 65 volts, a potential in excess of this would have to be reduced by means of resistance in series with the arc. The wasteful effect of using a higher voltage, or of welding directly from shop or commercial circuits by means of resistance banks or water rheostats can be seen. The higher the voltage of the circuit from which welding is done, the greater the amount of resistance needed and the greater the energy loss due to this resistance. Assuming that 75 volts is the maximum required for all cases of ordinary welding, if a 220 volt circuit is used for this purpose the efficiency is seen to be approximately 33 per cent, while at 500 volts it is as low as 15 per cent. It will also be found that when heavy currents—such as are required for welding—are taken directly from the line, serious voltage fluctuations will result, with corresponding ill effects on the apparatus connected to the line.

Flexibility of the System

Any number of operators may weld from the same outfit, each working independently of the other and taking the amount of current required for his own particular work, the self-regulating feature of the generator insuring a constant voltage. All of the arc circuits may be taken from the one welding panel or they may be divided among several smaller panels, which may be located at various centers at which it may be desired to do welding, these panels being connected by leads through the shop to the main panel. The latter, in this case, would contain only the motor and generator control apparatus. This arrangement is particularly desirable in locomotive and railroad shops, where the majority of the work is of such a nature that it cannot be moved around conveniently for welding. For doing work of this nature, the electrode holder is often fitted with leads of sufficient length to allow the work to be reached.

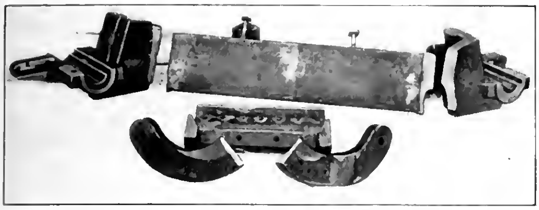


Fig. 7. Broken Casting from a Wood-working Machine

Welding can thus be done up to any distance from the outfit, the only limit being the allowable voltage drop in the lines to the work and the electrode. This, in turn, can be regulated to a certain extent by increasing the size of the cable as the distance increases. Beyond 500 or 600 feet, however, this method is hardly practicable for any work other than that which can be done with the metallic electrode, as the size of the cable required for carbon work with its large currents would increase to such an extent that its cost would be prohibitive and the handling of the cable exceedingly difficult. To meet conditions of this character a complete portable outfit consisting of generating and regulating apparatus, mounted on a truck that can be moved from place to place, is most appropriate. For land use the generator end of such an outfit is usually motor driven, while for marine work steam-driven outfits mounted on barges afford the most convenient arrangement.

Special Features

In connecting the work and the electrode in the welding circuit, the former should be connected to the positive side of the source of supply. There are two reasons for this, the first being that the positive side of the arc is by far the hotter of the two. The point on the work under the action of the arc is thus brought to the required fusing temperature in less time than if it were connected to the negative side of the circuit. A better distribution of heat between the electrode and the work is also secured by this means, as the electrode which is usually of small mass compared with the work should naturally be subjected to the less amount of heat. But a more important reason for this arrangement is that when the electrode is made positive the resulting arc is found to be very erratic and unstable, and its control becomes practically impossible.

It is not necessary that the operation of welding always take place in a downward direction. While work with the carbon arc has to be done in this position, due to the flowing of the metal in the weld, the metallic arc can be used as readily on vertical or overhead welds as on downward ones, the only difference being in the rate at which the metal is applied. Owing to the fact that in any position other than downward, the metal is applied against the force of gravity, its rate of flow from the electrode is necessarily slower. This feature of being able to weld with the work in any position occasions a great saving in the amount of handling which would have to be done were it necessary that all welding take place in a downward direction. The arc process of welding is thus seen to be exceedingly flexible in its application, covering work of practically all classes and degrees of accessibility, and this feature greatly facilitates the operation of welding. Handling of the work is reduced to a minimum, and welds are made with an ease and despatch not approached by any other method.

Character of Welds

A large measure of the success attained by this process is accounted for by the satisfactory character of the welds from the standpoint of efficiency. By a proper selection of the grade of filling metal, and the exercise of care in making the weld, it is possible to obtain a tensile strength in the weld of from 95 to 97 per cent of that of the original section. Welds made under the average conditions of everyday work show a tensile strength of from 80 to 90 per cent of the metal. It is possible by slightly reinforcing the welded section to make the strength of the weld even greater than that of the original section. This may be very desirable in many cases where a part has broken through having an undue strain put upon it. By a proper increase of section at this point, a repetition of the break may be avoided. Welds made by this process present a neat and finished appearance. With the metallic arc, the filling metal added from the electrode can be deposited exactly where it is wanted; and with the carbon arc, where the added material is reduced to a molten state in the weld, it may be run at pleasure, extra material being added where needed and the surplus metal being fused

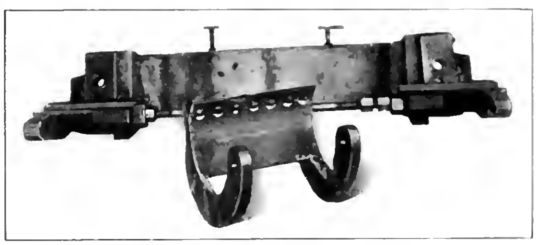


Fig. 8. Same Casting repaired with the Carbon Arc

down to the desired level. In either case, little or no trimming of the finished weld is necessary.

Examples of Work done by the Electric Arc

The illustrations show examples of electric arc welding. While these are of a varied character and show work done with both the carbon and metallic arcs—with a considerable range of current—they do not in any way represent the complete possibilities of the process of arc welding and cutting. Fig. 2 shows an example of tank welding, in which the head, flange and branches of a tank 42 inches in diameter were welded with the metallic arc. The current required was approximately 165 amperes at 70 volts. The finished appearance of the welds and the necessity for little subsequent trimming will be evident from this illustration. Figs. 3 and 4 show a fractured section of a locomotive frame before and after welding. In repairing a break of this nature the metal is cut away along the line of fracture, forming a V-shaped opening. This is filled with the repairing metal. The current required for work of this kind will vary from 500 to

600 amperes. It will be noted that the section has been reinforced where the metal was added.

An armature shaft that had been turned too small at the spider fit is shown in Fig. 1; to remedy this error metal was added by means of the metallic arc, thus increasing the diameter sufficiently to provide for refinishing the fit to the required size. This was done with the metallic arc, using current of approximately 160 amperes. Figs. 5 and 6 show the repair of a fractured mud ring of a locomotive firebox. It will be seen that part of the throat sheet has been cut away in Fig. 5 in order to give access to the mud ring. The fractures in the corners are first opened up with the carbon arc preparatory to welding, and after the weld is completed the sections of the throat sheet are replaced and welded as shown in Fig. 6. In this illustration, it will be noticed that the weld on the right-hand side has been dressed, while that on the left has not. The latter shows the appearance of the weld immediately after making a repair with the metallic arc. Figs. 7 and 8 show a broken casting of a wood planer before and after being repaired with the carbon arc. In cases of this kind the broken part is in use again in a short time, as the delay occasioned by having to replace it with a new casting is avoided.

Cost of Welding

The cost of making welds by this process can best be illustrated by examples covering operations of a common or familiar nature. The work capable of being done by arc welding is of such a varied character that it is not possible to give specific costs for each and every case that may present itself. The cost of generating current, the price paid for labor and the time required for doing any particular job will vary, and this will influence the cost of the weld. Of these three factors the first will be found to vary between the widest limits, the price of labor for the various classes of welding being fairly well standardized, and the time required for making welds not varying greatly where expert welders are employed. The cost of producing the following welds is figured on the basis of labor at 30 cents per hour, and current at 2 cents per kilowatt hour, the voltage in each case being approximately seventy.

A broken shaft 2 inches in diameter was welded and ready for refinishing in one hour; the current used was 350 amperes and the total cost 79 cents. A crack in the back sheet of a locomotive boiler 12 inches long was welded in nine hours, the current used was 175 amperes and the total cost $4.90. The risers on steel casting, 4 by 4 inches in size, were cut off in four minutes; the current used was 350 amperes and the total cost 5.2 cents. A cast-steel tender frame broken in three places was welded in twenty-seven hours; the current used was 300 amperes and the total cost $19.44. The journals of a worn 2-inch armature shaft were built up in three hours; the current used was 165 amperes and the cost $1.59. As an example of straight welding on sheet-metal work, seams on 1/8-inch steel can be welded at the rate of from 15 to 16 feet per hour, and on 1/4-inch steel at the rate of from 12 to 13 feet per hour.

Conclusion

From a consideration of the foregoing the principal reasons for the popularity and success of electric arc welding—both as a repair means and as a manufacturing means—will be readily appreciated. They may be briefly summarized as follows: The adaptability of the process to work of an exceedingly varied character, practically all cases in which iron or steel have to be united being covered by the two methods of using the arc. To this may be added the opposite case, or that of cutting, where the arc is equally effective. The fact that vertical or overhead welds can be made as readily as downward welds greatly increases the availability of the process for certain classes of work, and reduces to a minimum the labor which would otherwise be required for handling. The low cost of welding by this process, as seen when comparison is made with like results obtained by other methods, is a decided argument in its favor. In many cases of repair work, where the electric process is not available, the entire replacing of the broken or worn part would be necessary at a cost many times greater than that required for welding.

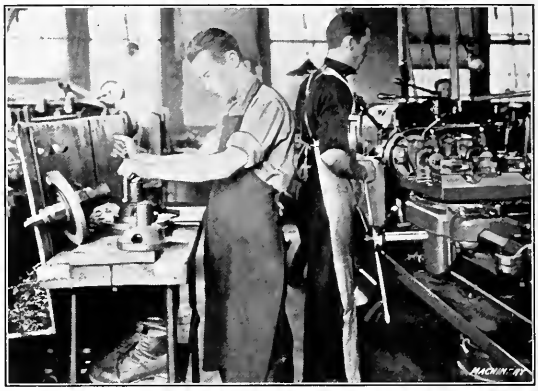
Any number of operators may work from the same outfit up to its capacity. They may be doing different classes of work, and at any distance from the outfit up to limits fixed by the allowable voltage drop in the lines. This feature is particularly effective in those cases where the job is large enough to permit of several operators working at one time. The low voltage used for welding precludes all chance of accident to the operator from contact with current-carrying parts of the apparatus. Welds made by the electric arc possess a degree of strength only slightly below that of the original section, and by reinforcing this can be increased to any desired amount. They present a neat and finished appearance, are homogeneous in structure and may be easily machined. From every standpoint they are of a highly satisfactory character.

* * *

EFFICIENCY IN THE TURRET LATHE DEPARTMENT

The ordinary machine tool represents an investment of several hundred dollars capital, and it would seem that one of the first steps in efficiency would be to keep the machine running as nearly full time as possible. And yet in many shops the operator spends half of his time in preparing work for the machine.

The management of the Brown-Lipe-Chapin Co. at Syracuse, N. Y., has applied efficiency methods in the turret lathe department to Jones & Lamson double-spindle flat turret lathe operation, as shown in the illustration. The work consists



The Boy chucks the Work and the Operator runs the Machine

in machining two diameters, the sides of two flanges and the end of a differential gear housing casting. In chucking the work, the pieces are first put on a faceplate and thus held on the spindle of the machine. To save the operator's time, who is a specialist on this machine, a boy is employed to chuck and unchuck the work. He works back to back with the operator and as soon as one piece is finished the operator passes it to the boy who in exchange gives the operator a piece chucked and ready for the machine. The proficiency that these two men display in working together on this job is remarkable. Notwithstanding the fact that the length is held to within 0.005 inch and the diameter to 0.0005 inch, these operators regularly produce two finished castings in four minutes. In a recent test for speed they turned out forty of the housings in thirty minutes. C. L. L.

* * *

Copper can be welded by the oxy-hydrogen blowpipe by placing two pieces of copper in position so that they can be heated at the proper point by the blowpipe until the requisite degree of softness is attained. Complete reduction is then effected in the flame by the use of purified hydrogen, and the welding is completed by hammering. The joint is said to be invisible and the metal at the weld is claimed to be as homogeneous in every way as the remainder of the metal welded.

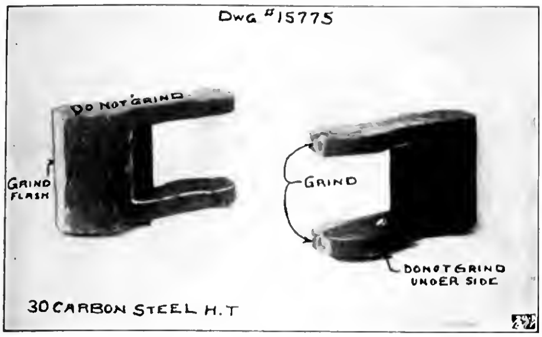


Fig. 1. Forging with "Do Not Grind" Surfaces to be finished in a Subsequent Operation

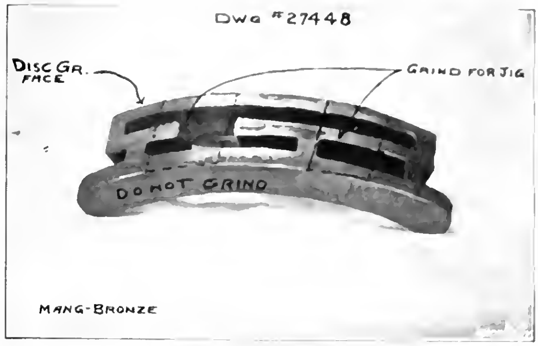


Fig. 2. Surfaces subsequently machined, which are ground to meet the Requirements of the Jig

THE USE OF PHOTOGRAPHS IN GRINDING AND POLISHING DEPARTMENTS

BY GEORGE B. MORRIS*

Marking up photographs of the finished parts is a unique method of instructing foremen and inspectors that is used in the grinding and polishing departments at the Pierce-Arrow Motor Car Co., Buffalo, N. Y. The photographs are on extra heavy Azo paper (requiring no mounting) 5 by 8 inches in size, the same as the operations cards, and the photographs and cards are filed together. The cost of prints per thousand is surprisingly low. The greatest expense is the preparing of parts for photographing, and right here is the great advantage of the system. It is necessary to study each piece carefully; learn its function and location; determine just what surfaces should be ground or polished, and how much; and cut out needless grinding where surfaces are later machined, as in Fig. 1, where the "Do not grind" surfaces are machined in the next operation. In many cases, even surfaces that are later machined have to be ground, as shown in Fig 2, because of jigs and fixtures. It is not expected of a foreman or inspector to look after these points.

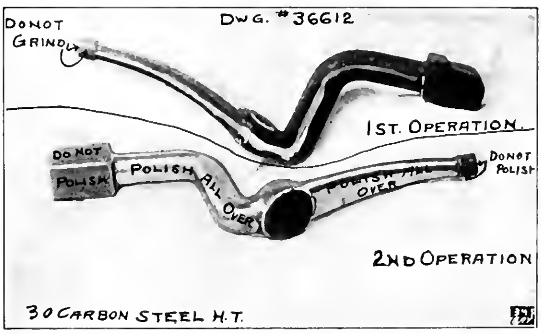


Fig. 3. Instructions for Two Operations included on a Single Card

As a record, the photograph system is excellent; and should a foreman leave, the new man would be greatly assisted by it. Furthermore, there would be no excuse for over- or under-doing a job. As a means of instruction to the workman, the simple words, "John, make like picture" are enough for a new man. The lettering is all done on the photograph, not on the negative, making it possible to use the same negative for several similar parts. A change is also easily made, without exposing another plate, by simply re-marking a new print. The photograph system is being extended to other departments, where one, two or more photographs give instructions in assembling for cases when printed instructions are not clear.

Before taking up this system we outlined two other methods, which were subsequently discarded. The first of these consisted of marking up blueprints for use in the grinding department, while the second was to supply finished samples of the pieces to be ground to serve as a guide in finishing similar pieces of work. Both of these methods were unsatisfactory, and the latter had the further disadvantage of the expense which it involved. A surprising reduction in manufacturing costs has been brought about by the adoption of the photograph system of issuing instructions, and as this method is capable of quite general application, it would appear that many manufacturing companies would do well to adopt it.

* Safety Engineer, Pierce-Arrow Motor Car Co., 1695 Elmwood Ave., Buffalo, N. Y.

* * *

ALLOYS OF ALUMINUM AND ZINC

Experiments undertaken by Dr. W. Rosenheim and S. L. Archbutt indicate that alloys of aluminum and zinc may be made to resist corrosion very effectively by using zinc free from impurities. The addition of zinc to aluminum facilitates the production of good castings. An alloy containing 25 per cent of zinc can be rolled into bars and drawn into wire. The addition of a small percentage of copper to these aluminum-zinc alloys greatly increases the tensile strength. In general, the alloys should contain not less than 15 per cent of zinc, and if dynamic as well as tensile strength is considered, the alloy should contain not less than 20 per cent zinc. Aluminum-zinc alloys lose strength rapidly as the temperature rises. Even 100 degrees F. produces a very marked effect. Alloys containing from 10 to 30 per cent of zinc can be easily worked by machine tools of all descriptions, and in most cases without the use of cutting lubricants.

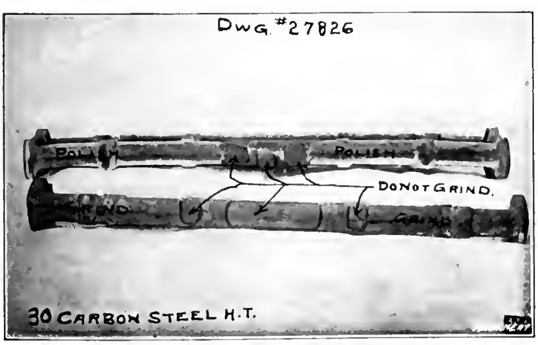


Fig. 4. Simple but Complete Instructions regarding Surfaces to grind, those to polish and those to leave Rough

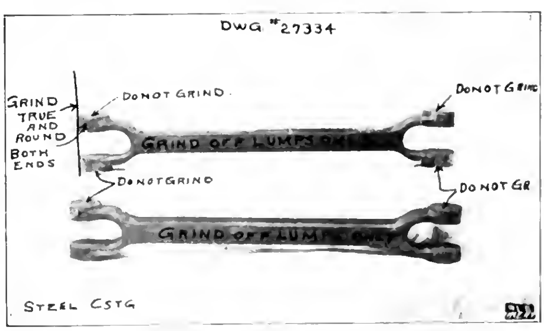


Fig. 5. Instructions that are so Explicit that a New Man cannot misunderstand them

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GRINDING MULTIPLE DIAMETERS

A curious and interesting development of grinding practice is going forward which apparently will make still greater the revolution effected in machine shop practice by the cylindrical grinding machine. This is grinding to size without lateral traverse of the wheel or work. A few years ago it would have been considered rank heresy to advocate the grinding of work to close limits by feeding the wheel in to the required depth without traversing it back and forth over the work. Now it is the accepted practice for shouldered shafts, crankshafts and other parts having bearings or other cylindrical portions not exceeding five inches in length.

The practice was developed in grinding multiple-throw crankshafts for automobile engines. The bearings between the crank cheeks were short, and very short traverse only was possible. The operation of grinding crank-pins was slow and costly. Cylindrical grinding machines sufficiently heavy and powerful to drive grinding wheels of the full width of the bearings were built, and the practice of grinding crankshafts without lateral traverse was soon recognized as a quick and low-cost method of machining a difficult part.

Now the practice of grinding motor shafts without lateral traverse is accepted as being a practicable and rapid method, quickly acquired by the operator and very satisfactory in results. A further development makes possible the grinding of two or more diameters simultaneously, the wheel having been turned with a diamond to the required diameters.

The limitations of this method are the practicable width of the grinding wheel and the strength and rigidity of the machine. One well-known expert places the limitation of wheel width as being perhaps one foot. The possibilities of rapid production with a stepped wheel one foot wide on electric motor shafts, for instance, are startling. Evidently if three or four diameters on the shaft can be ground simultaneously in about the time now required for one, the grinding time will be cut to one-third or one-fourth what it now is.

* * *

ON GETTING JOBBING WORK

Builders of special machinery often find it difficult to convince prospective customers by mail that they have the skill and equipment to produce the desired apparatus. A booklet illustrating the machine tool equipment and showing a number of examples of machines built will be found one of the best means of pulling business from a doubtful prospect. Every concern looking to do high-grade special work should make a point of photographing every job done, and in time it can easily compile a booklet to slip into letters answering inquiries, that will prove a very effective business getter.

Let these concerns also advertise in the trade papers that they are builders of special machinery and offer to send booklets on application and they will soon find themselves in touch with many who want work done. There is no better way of getting employment at anything than by showing what you have done. The fact that you have done certain things well is pretty good evidence that you can do other things acceptably to those who want them done.

* * *

UNIFICATION OF WEIGHTS AND MEASURES

Some of our English contemporaries have of late devoted considerable space to the metric system, and conservative minds have tried to improve upon the existing English system of weights and measures, so that—while retaining the old names and main units—the benefits of a decimal system could be realized. This seems futile and serves no purpose whatever.

Nor do mere academic discussions of the advantages or defects of the metric system, on the one hand, and the English system, on the other, serve any useful purpose. A uniform system of weights and measures for the whole civilized world is greatly to be desired, and there is little doubt that it will ultimately be achieved. The longer the work of unification is put off, however, the more difficult will it be to accomplish the change. As it is hardly reasonable to expect that the part of the world which uses the metric system will change back to the system used by the English-speaking nations, it seems inevitable that the English-speaking nations must ultimately conform in this matter to the rest of the world, especially as such a change in the opinion of many is in the line of progress.

This editorial is not an argument in favor of the metric system as such, but it is an argument in favor of a *uniform* system of weights and measures which would be a great boon to the industries and to the trade of all nations. When the importance of such a uniform system is recognized, the adoption of the metric system is a foregone conclusion, simply because it is already used by three-fourths of the civilized world.

* * *

DRAWING AND FORMING DIES

Comparatively little definite information has been published in the mechanical journals relating to the drawing of metals in presses. Numerous examples of practical press work are shown every month, but the fundamental principles governing the work have yet to be worked out. In fact, the art of drawing and forming may still be considered, in some respects, to be in its infancy. While an enormous amount of this kind of work is done daily in hundreds of shops in the country, there is still a scarcity of definite information as to the principles involved. Some day this subject will be taken up and thoroughly investigated, as F. W. Taylor investigated the art of cutting metals, and then exact rules and formulas may be worked out governing the drawing of metal sheets into shells. At present the mechanic interested in this work must content himself with studying a few general principles based upon practical experience.

It is possible, however, that even with the knowledge at present available on this subject, it could be treated for publication purposes in a far more comprehensive and analytical manner than has heretofore been done, and right here is an opportunity for men of practical experience, with ability to analyze principles and express themselves in clear language, to contribute to the engineering literature of the day information that would be of great value, because it would be original, practical and in constant demand.

It is a curious fact that on nearly every other mechanical subject there are books dealing with fundamental principles. In punch and die work writers seem to be satisfied with merely showing examples of work that has been done.

THE COEFFICIENT OF MECHANICAL FRICTION

When the surfaces of two bodies are in contact and under pressure, there is resistance to motion of one body on the other, due to the mutual interlocking of the minute projections on the two surfaces. Hence, to obtain relative motion, these projections must be disengaged, abraded or overridden and their resistance to these actions causes sliding friction. Thurston says: "The greatest force with which relative motion is resisted by friction is obtained by multiplying this total pressure (on the contact surfaces) by a *constant* coefficient (of friction) to be determined experimentally for every pair of surfaces of definite character"; and in citing the so-called "laws" of sliding friction, he states that this resisting force is dependent only on the nature of the surfaces and the normal force with which they are pressed together, and is independent of their area of contact, of the velocity of rubbing and of any other conditions than those noted above.

Thurston wrote thirty years ago and his statements were justified by the meager information then available. While later experience and experiment have shown that they are in many respects inaccurate with regard to machine bearings, his broad conclusions still find a place in some text and reference books in which the subject is treated very briefly, and hence they may deceive the young and inexperienced engineer. As a matter of fact, they are true, as a whole, only for surfaces whose normal pressure is low, whose velocity is very moderate and which have little, if any, lubrication—all conditions which are, in general, the reverse of those which the machine designer must meet.

For any two metals of the same character of surface, lubricant and normal pressure, the coefficient of friction is very far from being a constant—as Thurston states—in bearings of different types. On the contrary, it is one of the most variable factors to be found within the whole range of machine design. Take a familiar example: in a high-speed, reciprocating engine, the customary pressures per square inch of projected areas of the bearings may be taken in pounds as, roughly: crosshead guides, 100; shaft bearings, 400; crank-pin, 800; crosshead pin, 2200. Now, the metals in contact in all of the bearings are usually the same and the character of the surfaces is identical, but the allowable normal pressure differs in each case. Why? The only answer is that, for each case, there is a different coefficient of friction. A bearing is so proportioned that at its maximum pressure and velocity its temperature shall not rise above a "working heat" so that "seizing" shall not occur. Now, as the coefficient of friction varies inversely as the normal pressure, it is evident that the less the allowable pressure to prevent heating, the greater the coefficient of friction in that bearing must be—which, broadly, is the reason for the wide variations in normal pressure shown in the foregoing examples.

For machinery in general, the coefficient of friction for the same pair of metals depends upon a large number of conditions. Its value is affected not only by the nature of and the pressure upon the surfaces, but by their temperature and relative velocity, the latter having sometimes a marked effect. Again, the character of the motion and the steadiness or intermittent nature of the pressure influence it. For example, in a shaft bearing, the motion is continuous and the general direction of the pressure is steady; in a crank-pin journal the motion is also continuous, but the pressure changes from one side to the other; and with a crosshead pin, the motion is reciprocating and the pressure intermittent. The steadiness of pressure and the nature of the motion have much influence on the effectiveness of the lubrication. Again, the form of the surfaces—flat or cylindrical—and the character of their contact—through a surface or a line—are both factors of moment. Finally, the nature of the lubricant and the effectiveness of the lubrication are all important; every journal should run on a film of oil.

It is apparent that, for given metals, the coefficient of friction is not a constant, but rather a frequently changing factor or ratio.

NOTES AND COMMENT

The popularity of that type of automobile which has been termed the "cycle car" is on the increase, according to the *Scientific American*. There are now said to be nearly thirty companies building cycle cars in Detroit. Many of these find a ready sale for their products in Great Britain, and one maker has just announced the signing of contracts for 10,000 cars for England. As yet these cars are not very frequently seen on this side of the Atlantic.

A cheap material for making concrete waterproof, which is being used with success in some parts of the country, consists of finely divided iron filings, borings, turnings, etc. The iron has the property of making concrete waterproof because of rusting; the rust fills the pores and seals them up tightly. This simple means of making concrete waterproof has been sold as a trade secret with considerable profit to the promoters. The cost of the process is not as high as of some other waterproofing methods not as effective.

Rifles have been used to punch holes in iron wagon tires in emergencies, but it remained for F. A. Robarge of South Milwaukee, Wis., to use a rifle for the first time to cut down a chimney. A steel chimney of the Rundle Mfg. Co., Milwaukee, composed of sheets about 3/16 inch thick had been broken off by the wind about twenty-five feet from the top, and the broken part hung suspended from the stump. It was considered too dangerous for a steeple jack to climb and cut the part loose, so the rifle man was called on the job. Five or six shots through the supporting shred were sufficient to loosen the hanging piece and send it crashing down to the ground.

Cast iron is a common material of construction that has many characteristics little understood. It can be made glass hard by casting it in contact with chills—that is, cast iron forms of sufficient mass to cool the metal quickly. But if poured in cast-iron molds and removed as soon as the surface has solidified, the casting will be soft and easily machined. It even possesses a slightly malleable property. A still more interesting characteristic is its capacity for hardening when heated and quenched. Lathe and planer tools have been made from permanent mold castings, it is claimed, which, under favorable conditions, equalled the best high-speed steels in cutting performance.

Another giant hydro-aeroplane, rivaling in size the Sikorsky machine, has been built by Messrs. Jeanson and Collieux, in France. The machine is provided with a single boat having a length of 28 feet 6 inches and a beam of 8 feet 6 inches. The aeroplane portion consists of two sets of biplanes arranged in tandem. The span of the wings is 88 feet 6 inches and the total lifting surface, 1560 square feet. The boat body is provided with two 200-horsepower motors, connected with a single air propeller, 16 feet 6 inches in diameter. The total weight of the machine with pilot, assistant pilot and two passengers, and fuel for a thousand-mile (fifteen hours) trip, is slightly over 10,000 pounds.

A German contemporary states that the setting of Portland cement is assumed to be due to the formation of a gel, which ultimately hardens to a lime-aluminate-silicate mass and forms a close-fitting network around any embedded inert material. With concrete, such a network surrounding angular gravel or sand would be stronger than one enclosing rounded grains, and the strength attained with washed sand would be greater than with unwashed, since, in the latter case, the intervening layer of soft clay prevents the surrounding network from directly gripping the grains of sand. Similarly, with ferroconcrete, rust is detrimental as it prevents close contact between the iron and the surrounding gel.

Signs in shops prohibiting workmen from doing something they are likely to do are to be deplored unless means are conveniently provided for doing it in the prescribed way. Then they are not likely to do it in the prohibited way if it is

understood to be contrary to the practice of the shop and signs will not be needed. "Workmen will be discharged who use this grinder without wearing goggles," posted over a grinder used in common is a poor means of discipline if the goggles are not kept close at hand. In practice, the injunction will be ignored. If ignored with impunity, the probability is that cautionary regulations, in general, will not be observed when the convenience of the workmen dictates otherwise.

One of the difficulties with moving picture cameras is that they must be supported by a firm stand while the picture is being taken, in order to prevent vibration. A hand camera for taking moving pictures, however, has been developed in Europe, the front of the camera containing a rapidly rotating gyrostatic wheel which keeps the camera steady in any desired position. The motive power for driving the film and the gyrostat is obtained from cylinders containing compressed air fitted at the back of the camera. A paper describing the device has been read before the Royal Photographic Society in England, and the excellent results obtained by it were also demonstrated at the same time.

Experiments have been made to determine whether lubricating oil "wears out" or not in long-continued service. These tests were made by Professors Carpenter and Sawdon at Cornell University. The tests indicated that oil gains in specific gravity by continued use, as would be expected on account of the loss of volatile constituents. The used oil shows a higher viscosity than new, indicating that it gains in "body" with use. Friction tests showed that new oil has a slightly lower coefficient of friction at low bearing pressures, but the reverse is true for high pressures. The differences, however, are so small that for all practical purposes the coefficient of friction may be taken as being equal for new and old oils.

Germany now uses between forty and fifty million gallons of denatured alcohol a year, of which over thirty million gallons is sold to the general public for burning purposes. France uses about eighteen million gallons, the United States about ten million gallons and the United Kingdom only four million gallons. Denatured alcohol is gaining in favor for general burning purposes, and efforts are being made to use it as a substitute for motor fuel in place of high-priced gasoline. A monograph by Charles A. Crampton entitled, "Production and Use of Denatured Alcohol in Principal Countries," has been published by the United States Government and copies may be obtained from the superintendent of documents, Government Printing Office, Washington, D. C., at 5 cents each.

Wheel spindles of cylindrical grinding machines run up to as much as 1500 feet per minute peripheral speed. The bearings are plain bushings provided with means for collapsing to fit the spindle closely. The rule is to give only 0.001 inch clearance, that is the bearing is only 0.001 inch larger than the grinder spindle. The space for oil film then is only 0.0005 inch around the spindle and thin oil must necessarily be used. Spindles will run without appreciable shake in bearings 0.005 inch larger than the spindle but will run out of true if the running parts are not in perfect dynamic balance. The unbalanced part tends to rotate about the center of gravity, thus making the oil film thicker on one side than on the other. But the eccentric oil film does not remain in the same relation, the result being that the wheel runs out of true.

Vanadium has been used to some extent in brass, having been added in the form of cupro-vanadium. The resulting brass is generally known as "vanadium-bronze." The mechanical properties of this alloy are superior to those of ordinary brasses. The elastic limit is raised and the alloy is harder. At the same time the ductility is not affected to any appreciable extent. Published results of tests of vanadium brasses indicate quite a considerable increase in strength, and it is also stated that cupro-vanadium additions to brass reduce the tendency to corrosion. It is probable that the beneficial effect of vanadium is largely due to its deoxidizing action, but it is difficult to determine the exact effect of vanadium, owing to the comparatively large amounts of aluminum and other metals present in most samples of commercial cupro-vanadium.

The great change that has come in the business of steam engine building is indicated by the experience of one of the well-known concerns in this line. After having enjoyed a deserved reputation as a builder of high-grade automatic steam engines for many years, its business declined in the face of competition to the point that made necessary its discontinuance. The president has seen the work of a lifetime vanish in the march of progress. A melancholy aspect of the case is that he is one who has done much to promote better methods and ideals and to encourage the putting off of the old in favor of the new when the new is better. A large user of the company's engines recently sold it several discarded engines, still in first-class condition, at the price of scrap iron! To find customers for these engines, even at an absurdly low price, apparently will not be easy. The steam turbine, the gas engine and the electric motor have come to stay.

Roller rests for heavy lathe work are used much more abroad than in the United States, and they are used for good and sufficient reasons that should command our adoption of the idea. A roller rest will stand much use with little wear. The work revolves freely and is held up to the same height from start to finish of long jobs. This is an important consideration on gun lathes that may carry a gun weighing a hundred tons for weeks. The plain rests used in American shops generally are cheap and that is about the only merit they have. They oppose the movement of the work with unnecessary frictional resistance and wear considerably when supporting heavy parts in motion for several days. The work drops out of line with the lathe centers and the boring tools are affected. Improved steadyrests are greatly needed on heavy lathes. They require all the care in designing and making that any other important part of the lathe receives.

In a summary of the waterpower of various countries, the *Mechanical World* gives the possible horsepower of France as 4,500,000, of which only 800,000 is utilized. About an equal amount of power is available in Italy, but only 30,000 horsepower is utilized. The estimate for Switzerland is incomplete, but about 300,000 horsepower is in use. Germany has 700,000 horsepower available with 100,000 applied. Norway has 900,000 horsepower available, with a large part already developed. In Sweden there is 763,000 horsepower available, but mostly at a considerable distance from any industrial center. In Great Britain 70,000 horsepower is already utilized, and an equal amount in Spain. The resources of Russia are estimated at 11,000,000 horsepower, of which only 85,000 has been developed. The United States is credited with 1,500,000 horsepower, while Japan has 1,000,000, of which 70,000 has been exploited; in India 50,000 horsepower has already been developed.

A leading machine tool builder once solved a problem in screw cutting in an ingenious manner. He was required to cut a large long lead-screw to a metric pitch. The limits of tolerance were so narrow that the common translating gears, including a 127-tooth gear, would not exactly produce the required pitch when working under normal shop conditions. The difficulty was overcome by expanding the lead-screw of the lathe which is about sixty feet long, by heating it with a steam coil. The shop temperature was maintained equable night and day, while the screw was being cut, and the lead-screw was kept several degrees warmer by the steam coil boxed in with the screw as far as possible. A multiplying indicator on the end of the bed showed the amount of expansion obtained, and this was maintained as uniformly as possible. In this way the screw was chased to a very close approximation of the desired metric pitch. Its diameter was six inches and length about forty feet.

FLUTING HOBS

BY GUY H. GARDNER*

I recently received a letter asking for information relative to the fluting of hobs. The text ran as follows: "I have turned and threaded a hob of 2.125 inches pitch diameter and 15 degrees 30 minutes thread angle. I intended to mill twelve spiral flutes in the hob at right angles to the thread. I found the lead for these flutes by multiplying the pitch circumference by the cotangent of 15 degrees 30 minutes, which gives 24.0622 inches for the lead. Gearing the milling machine for a lead of 24 inches, and trying the job with a scriber in place of the cutter, I found that there are neither 12 nor 13 teeth in one complete turn of the hob thread; I judge that there are approximately 12 15/16 teeth to each turn. I can set my relieving attachment for 12 teeth or for 13 teeth, but not for any intermediate number. I am anxious to do a good job; how can I do it?"

The writer of the letter quoted has met with a difficulty which is practically unknown in large shops where hobs constitute one of the regular products, as such shops have skilled designers to make the necessary calculations, and in some cases, at least, relieving machines are available which are equipped with special differential gearing to enable them to handle teeth of fractional pitch. For men like my correspondent who only make a hob occasionally, the problem is somewhat difficult; and if one may judge from the hobs seen in use, it would appear that a satisfactory solution of the problem is not always arrived at. The purpose of this article is to point out one simple way in which work of this nature may be done on an ordinary relieving lathe.

It is first necessary to find the number of teeth that would be formed in each turn of the hob thread if the flutes were milled at right angles to the threads. Any one who can use a table of logarithms can easily ascertain this number by dividing the number of flutes in the hob by the square of the cosine of the thread angle, *i. e.*, the angle which the thread makes with a line perpendicular to the axis of the hob. The

FACTORS FOR DETERMINING NUMBER OF TEETH FOR VARIOUS THREAD ANGLES

Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor
5	1.0076	27	1.2596	44	1.9326	49¾	2.3953	55	3.0396
6	1.0110	28	1.2827	44½	1.9657	50	2.4203	55¼	3.0779
7	1.0150	29	1.3073	45	2	50¼	2.4457	55½	3.1170
8	1.0198	30	1⅓	45¼	2.0176	50½	2.4716	55¾	3.1571
9	1.0251	31	1.3612	45½	2.0356	50¾	2.4980	56	3.1980
10	1.0310	32	1.3905	45¾	2.0538	51	2.5250	56¼	3.2398
11	1.0378	33	1.4217	46	2.0723	51¼	2.5525	56½	3.2826
12	1.0452	34	1.4550	46¼	2.0912	51½	2.5805	56¾	3.3264
13	1.0533	35	1.4903	46½	2.1105	51¾	2.6091	57	3.3712
14	1.0622	36	1.5279	46¾	2.1300	52	2.6383	57¼	3.4170
15	1.0718	37	1.5678	47	2.1500	52¼	2.6680	57½	3.4639
16	1.0822	38	1.6104	47¼	2.1703	52½	2.6984	57¾	3.5119
17	1.0936	39	1.6558	47½	2.1910	52¾	2.7294	58	3.5611
18	1.1057	40	1.7041	47¾	2.2120	53	2.7611	58¼	3.6114
19	1.1186	40½	1.7295	48	2.2335	53¼	2.7934	58½	3.6629
20	1.1326	41	1.7557	48¼	2.2553	53½	2.8263	58¾	3.7147
21	1.1474	41½	1.7827	48½	2.2766	53¾	2.8600	59	3.7698
22	1.1632	42	1.8107	48¾	2.3002	54	2.8944	59¼	3.8253
23	1.1802	42½	1.8397	49	2.3233	54¼	2.9297	59½	3.8821
24	1.1982	43	1.8696	49¼	2.3469	54½	2.9655	59¾	3.9403
25	1.2174	43½	1.9006	49½	2.3709	54¾	3.0021	60	4
26	1.2379	...	......	...	......	...	......	...	......

Machinery

table presented in this connection provides an even easier method of determining the number of teeth for the angles given. In using it, it is only necessary to find the number corresponding to the thread angle and multiply it by the number of flutes. For the present case the result would be $1.0769 \times 12 = 12.9228$.

An ordinary relieving attachment cannot be set for this number of teeth, but by making a slight change in the lead of the spiral flutes, we can make them give 13 teeth in each turn of the hob thread. The accompanying illustration shows the method of procedure in determining the necessary change in the lead of the flutes. AB is the pitch circumference of the hob, BC is the lead of the hob thread and AC represents the length of one turn of the thread. Calling F the number of flutes milled in the hob, it has already been explained that the number of teeth produced in the length of one turn of the thread AC is $\frac{F}{\cos^2 \alpha}$. The line BD represents the direction of flutes milled at right angles to the threads AC, and BE represents the required direction of the flutes to produce exactly 13 teeth in each turn of the hob threads. It will be seen that the flutes BE are at an angle β to BG. Let N represent the number of teeth in a turn of the thread AC cut by the flutes having the direction BE.

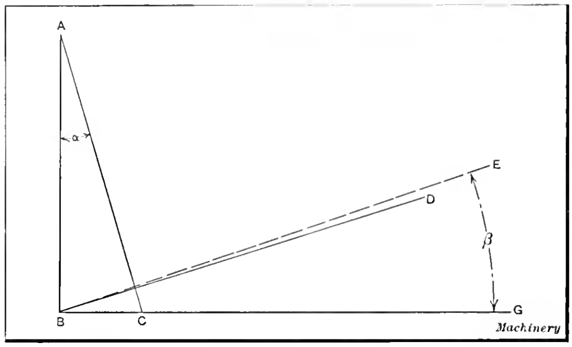

Diagram showing Method of adjusting Flute Angle to give a Whole Number of Teeth

In order to calculate the changed lead of the spiral flutes due to the alteration in their direction, the lead of the hob thread is required; this is usually known or can be found by multiplying the pitch circumference of the hob by the tangent of the thread angle α. In the present case, the lead of the hob thread is represented by BC in the accompanying illustration and has a value of 1.8513 inch. The changed lead of the spiral flutes is then found by multiplying the lead of the hob by the number of flutes in the hob and dividing the product by the desired number of teeth minus the number of flutes. Presented in the form of a formula this result would be given by the following:

$$\frac{BC \times F}{N - F} = \frac{1.8513 \times 12}{13 - 12} = 22.2156 \text{ inches.}$$

As 22¼ inches is the nearest available approximation, the milling machine is geared for this lead and the 12 flutes are milled. To find the angle EBD by which the direction of the flutes differs from that of the line BD which is perpendicular to AC, we divide the pitch circumference by the changed lead, the quotient being the value of tangent β. For the present case, β is found to have a value of 16 degrees 42 minutes. Subtracting from this the value of the thread angle α, which is 15 degrees 30 minutes, we find that the flutes are not at right angles to the hob threads by 1 degree 12 minutes. It will be noticed that no alteration of the lead is required when the thread angle α is either 45 or 60 degrees. The same is true when the thread angle is 30 degrees if the number of teeth F may be divided by 3 without leaving a remainder.

* * *

The possibilities of cost reduction of manufactured products are not fully grasped by many manufacturers who have been in the business for years. Where a single standardized machine is made in large numbers, special machinery and methods can be introduced with telling effect. The claim is made that the Ford motor car costs the company when ready to turn over to the agents less than $200. Compare this with the alleged costs of the higher priced cars selling for $2000 to $3000. There must be either great inefficiency of production or great profit in the business. As a matter of fact, the average maker's methods are inefficient but his profit is large.

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SUB-PRESS DIES FOR ARMATURE MANUFACTURE

SECTIONAL DIES FOR FIELD AND POLE PUNCHINGS, AND FOR ARMATURE DISKS

BY FRED K. HUDSON*

IN the January, 1914, number of MACHINERY, Douglas T. Hamilton described the making and use of one-piece armature-disk dies that are used in the factory of the Robbins & Myers Co., Springfield, Ohio. It is the purpose of the present article to describe the methods for making two interesting sectional sub-press dies that are used in the manufacture of armature disks and field and pole punchings. Fig. 1 shows the punchings and also the 0.025 inch sheet steel from which they are made. Fig. 3 shows the assembled punch and die used for making the field and pole punchings, and Fig. 6 shows the assembled punch and die for blanking and notching the armature disks. The other illustrations show parts of these punches and dies from which the construction will be readily understood. The parts A, B, C and D are produced at one stroke of the press. The parts E and F are scrap; and the disk G is stamped from the piece D in a subsequent operation.

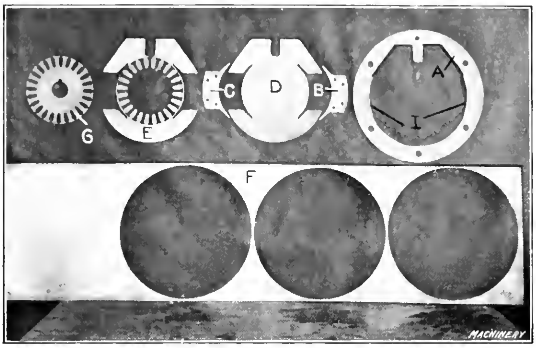

Fig. 1. Field, Pole and Disk Punchings and the Stock from which they are made

The assembled punch and die for making the parts A, B, C and D is illustrated in Fig. 2, and Fig. 3 shows this punch and die taken apart in order that a better idea of the construction may be obtained. In Fig. 4 the lower half of the die is shown with the strippers removed. This illustration also shows the templets for the field and pole punches and the templet drill jig used for drilling the pole punches. The punch for making the field (shown at A in Fig. 1) is made of six sections, comprising one each of parts shown at J and K in Fig. 4 and two each of parts L and M. These sections have flanges on the outside, fastened to a tool steel ring 5/8 inch thick, fillister-head screws and dowel pins being used for this purpose. The ring and flanges are ground to fit into a recess in die-holder N. The pole punches O and P are made 1/8 inch higher than the cutting edge of the field punch and have a flange on the inside. They are screwed and doweled onto a tool steel plate Q, 5/8 inch in thickness, this plate being a sliding fit in the ring on which the sections of the field punch are mounted. Both the ring and plate are doweled to the die-holder N and held in position by fillister-head screws which extend through from the back of the die-holder.

To facilitate grinding the die when it becomes dull, the

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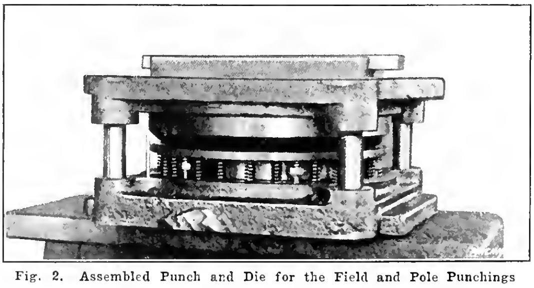


Fig. 2. Assembled Punch and Die for the Field and Pole Punchings

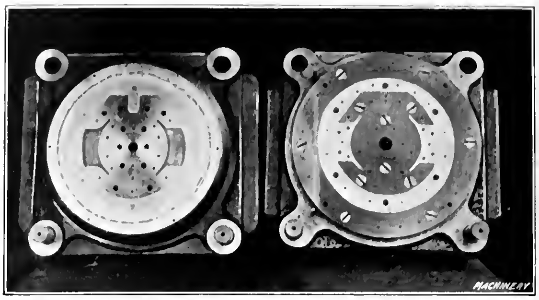


Fig. 3. Field and Pole Die taken apart

screws holding the field punch plate are loosened and the field punch raised to the level of the pole punches, four adjusting screws being provided for this purpose. The dies for the round holes in the field and poles are bushed in the punch sections. This makes replacement an easy matter and the scrap from the holes is allowed to pass down through the die-holder. The spring plate strippers are shown at R and S in Fig. 4. They are held in position by flat-headed screws which have nuts in counterbored holes in the back of the die-holder. Dowel pins are put into the holes to keep the nuts from turning, the method being clearly shown in Fig. 7. Short springs and nuts shown in Fig. 4 are used to prevent the screws from loosening up when the die is in operation.

Fig. 5 shows the upper half of the die used for producing the field and pole punchings. In this illustration the outside die ring, the solid stripper, the knockouts, and the templets for the sections of the punch are clearly shown. The punch is composed of one each of sections T, U, V and W and two of section X. These sections are doweled onto a tool steel plate Y, the plate and 1/8 inch at the bottom of the sections being ground on the outside to fit a circular recess

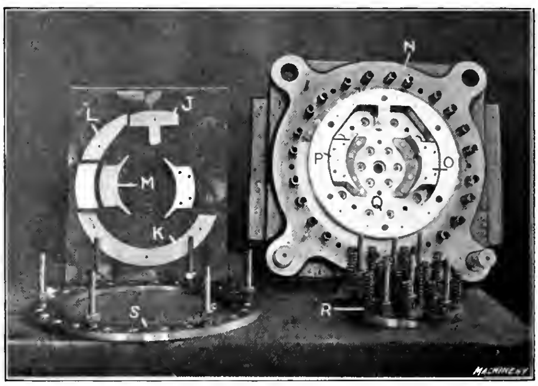


Fig. 4. Lower Half of Die with Strippers removed; also Templets for the Punch Sections

in the holder Z, to which the plate is held by dowel pins and fillister-head screws. The solid stripper a is made of tool steel with two hardened dovetailed sections inserted. These sections sever the pole punchings from the field at the points marked I in Fig. 1. The springs shown in the die-holder Z, Fig. 5, take the thrust of the cut, and as the pole punches are 1/8 inch higher than the field punches—as previously explained—the pole punchings are blanked before the field punchings. The stripper serves as a support for the punches which pierce the small holes in the field, constitutes the cutting edge for the pole dies and also acts as an ejector for the field punching shown at A in Fig. 1. The die ring b is recessed into the holder Z; and the flange on the bottom of the stripper a, which fits into a recess in the blanking ring b, keeps the cutting edge flush with the rest of the die.

As a is ground to a close sliding fit with the inside of the die ring and the outside of the sectional pieces on the plate Y, perfect alignment is always maintained. The knock-outs c, for ejecting the pole punchings B and C in Fig. 1, are fastened to the bar d, which is worked automatically by the punch press.

All cutting members of this die are hardened and accurately ground so that there is absolutely no variation in the size of the blanks. A tolerance of 0.002 inch is allowed, but the dies are made to maintain the maximum size. The punches are made 0.003 inch smaller than the die, thus affording a cutting clearance of 0.0015 inch. A run of from 35,000 to 40,000 blanks is obtained between grindings, the number of pieces produced varying according to the grade of steel from which the work is being produced. Counting the three separate punchings produced at each stroke, this would mean a total production of from 105,000 to 120,000 finished blanks. The height of the punch and die above the holders is $1\frac{3}{4}$ inch. This affords $1\frac{3}{8}$ inch of wearing surface, which corresponds to a total production of from 4,007,500 to 4,580,000 blanks, after which the strippers and flanges can be reduced

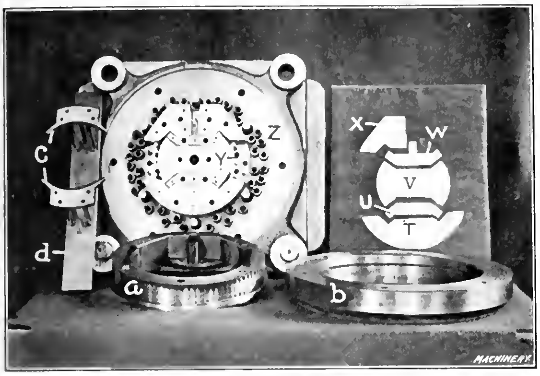


Fig. 5. Upper Half of Die, Solid Stripper, Outside Die Ring, and Templets for Sections

in thickness to give at least $\frac{1}{8}$ inch more of wearing surface.

Fig. 6 shows the assembled die which is used for blanking and notching the armature disks, and also one of the finished disks and the scrap left in making it. It will be seen that the disks are produced from the scrap formed by the die used for making the field and pole punchings, this scrap being shown at D in Fig. 1. The blank for the armature disk is located on the die by means of a nest of spring pins which are shown at e in Fig. 6. The spring stripper plate is recessed to allow the operator to handle the blanks quickly with a pair of pliers. Fig. 8 shows the die taken apart, the lower half being shown at the right-hand side of the illustration. This part of the die is made up of sections having a flange on the bottom, the design of one section being shown in detail in Fig. 9. These sections are accurately fitted together and built around a tool steel plug which is bushed to receive the center hole and keyway die. The assembled sections are fitted into a recess in a tool steel plate and securely fastened by means of screws and dowel

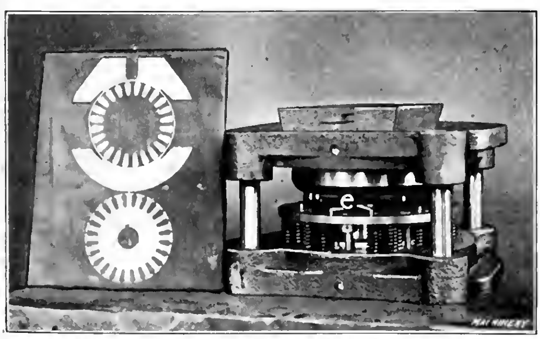


Fig. 6. Assembled Punch and Die for blanking and notching Armature Disks

pins. The plate itself is held in a recess in the die-holder f, and the scrap from the center hole goes down through the die.

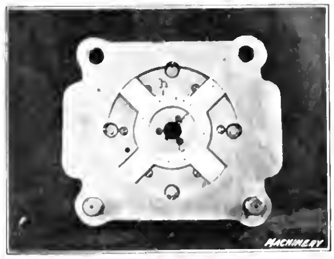


Fig. 7. Back of Lower Half of Die showing Method of securing Strippers

The part marked g is a spring stripper plate; the strippers for the slots are made separate and they are a close sliding fit in the slots, thus helping to support the die sections. Studs threaded on one end are screwed into the bottom of the strippers and the opposite ends of these studs pass through the die-holder and are secured in the ring shown at h in Fig. 7. This ring is fastened to the stripper plate g (Fig. 8) by means of four flat-headed screws and the springs under the plate g operate all of the strippers. One of the punches for the upper part of the die, shown at the left-hand side in Fig. 8, is illustrated in detail in Fig. 10. These punches have a flange on the bottom and are accurately fitted together at the correct angle to obtain accurate spacing and alignment with the lower die sections. The punches are assembled on a tool steel plate and ground on the outside to a snug fit in a tool steel ring which constitutes the cutting edge for the outside diameter of the blank. The knock-out i in Fig. 8 is $\frac{1}{2}$ inch thick; it is made a sliding fit on the slot punches and is connected by three studs to a plate in the head block. This knock-out is worked automatically by the press. The punch for making the keyway is dovetailed into the center hole punch j, the shank of which is made a driving fit in the holder k. The sections of these dies are milled to size so that no filing or fitting is necessary after the parts have left the milling machine. The final finish is obtained by grinding between the joints and this grinding is only necessary when the steel has expanded in the hardening process, the expansion never amounting to

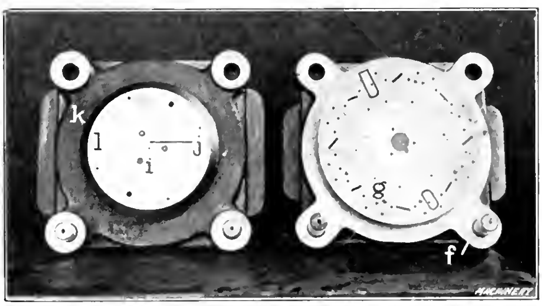
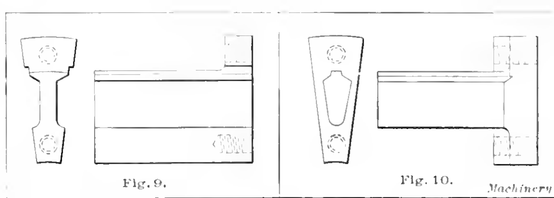


Fig. 8. Upper and Lower Halves of Die shown in Fig. 6

more than from 0.001 to 0.002 inch. The outside cutting edge of the die sections is ground to the correct diameter to give a clearance of 0.0015 inch between them and the ring l in Fig. 8. The center die and punch and the ring l are ground all over, the punches being 0.0015 inch smaller than the dies. The center die j has a tapered hole through it which allows the scrap to drop down.



Figs. 9 and 10. Design of Sections for the Punch and Die shown in Fig. 8

The average number of pieces produced in this die between grindings is 35,000 and at least $1\frac{1}{2}$ inch of the die can be used up. This corresponds to a total production of 4,375,000 blanks. This number of blanks produced from

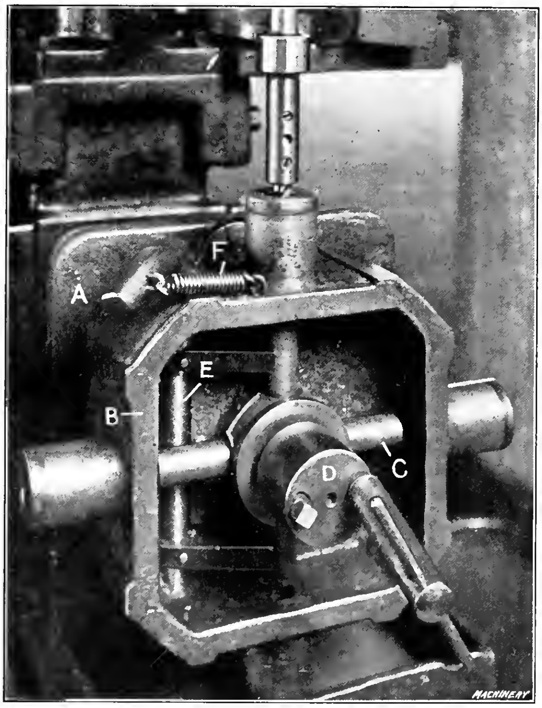
sectional dies is not unusual and we have some dies that have stood up under this rate of production without requiring any repairs during a period of three or four years. The stock used is Crucible Steel Co.'s 1.25 per cent carbon steel which is hardened so that it cannot be scratched with a file. The first cost of the sectional dies is considered by many to be higher than that of solid dies, but in the opinion of the writer, considering the life of the dies, they are cheaper in the end, providing the number of parts to be produced is large enough to warrant the increase in first cost.

* * *

INDEXING JIG FOR COUNTERSINKING DIFFERENTIAL SPIDER ARMS

The ordinary way of making a differential spider is to center the ends of the arms, rough-turn the forgings, harden the spider and grind the arms to the finished size. The Brown-Lipe-Chapin Co. of Syracuse, N. Y., has a better way, however, of finishing the spider. The forging is chucked and rough-turned, including the arms and then, without centering the ends of the arms, the piece is casehardened as it is. A row of hardened spiders is then strung on an arbor and sufficient metal is ground from the ends of the arms to remove the hardened case. This leaves the soft cores exposed for center drilling. By drilling after hardening a better working center is obtained, and one that is not full of scale; moreover the centers are not influenced by any distortion that might occur in hardening.

The jig upon which the center drilling is done is of more than ordinary interest. As shown in the illustration, it consists of the angle-iron base *A*, upon which is swiveled the jig section *B*. The spider, which is indicated at *C*, is slipped over the swiveling stud *D*. In order to locate the spider centrally in the jig, that is, so that the arms will come in average alignment with the four bushings, the centering dog *E* is employed. By means of a spring *F*, whose end is attached to the bent end of the dog, the two aligning fingers are brought to bear simultaneously against opposite arms of the spider. Thus the spider is located evenly in the jig. After this it is a simple matter to drill and countersink the spider arms one after another, indexing the jig by hand for each arm.



Indexing Jig for countersinking Differential Spider Arms

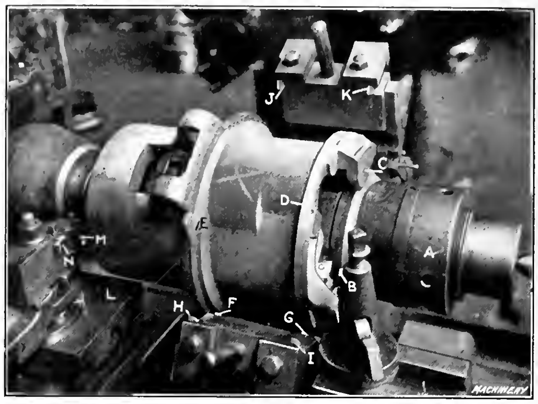
An idea of the facility with which this jig is operated can be gathered from the fact that five hundred of these spiders are drilled and countersunk in a day of nine hours, making a total of two thousand holes per day. The most important part, however, is the fact that the method insures that the centering is done with reference to the *hardened* spider arms, thus insuring that the amount of metal removed in grinding will be practically equal at all points.

C. L. L.

* * *

A MULTIPLE TURNING JOB ON AN ENGINE LATHE

Given an old engine lathe, almost ready for the scrap heap as far as general work is concerned, and a very accurate turning job, one would hardly expect to see the two combined harmoniously. Yet this combination was effectively accomplished at the Ritter Dental Mfg. Co.'s factory in Rochester, N. Y.



Multiple-turning on an Engine Lathe

The turning job was the machining of a cylinder for the base of a dental chair, an operation that consumed a great deal of time when done by ordinary turning methods, and it was desired to make a special turning fixture for the work. The illustration accompanying this article shows how the cylinder casting was held on the expansion arbor *A*, which in turn was held on the centers of the lathe. The only change required in the lathe was to make sure that the spindle had no shake and that it would turn straight, and also to put on the special carriage attachments shown. A facing tool *B* is held in the toolpost of the lathe and used for facing the ends of the base. The face that tool *B* machines is indicated at *C*. The most particular part of the work, that of facing off sections *D* and *E*, is well handled by special tooling on a separate carriage with which the lathe is fitted. As each of these sections is only approximately ½ inch wide, by using the two special roughing tools *F* and *G* mounted in fixed positions, only a very short travel of the carriage is required.

After these two surfaces were roughed they were semi-finished by the two tools *H* and *I*. These tools are on a separate swinging latch that the operator swings up to a stop and allows to make the cut. This leaves the two surfaces in a semi-finished condition and the final light chip is taken by tools *J* and *K* on a similar latch block at the top, mounted at the reverse side of the carriage. The latch mechanism that holds the tool-block down while making the cut may be seen at the side of the upper left block. While these cuts are taking place, the operator uses the special auxiliary slide *L* on the carriage, on which are mounted tools *M* and *N*. Tool *M* is a boring tool for facing out a small section within the casting, and tool *N* is a chamfering tool that serves to face and round the corner of this end of the casting.

The limit on this job is 0.002 inch on all measurements. The production is eighty-five cylinder bases in eight and one-half hours. Owing to the complication of the tool set-up, the lathe is kept set ready for this job at all times. Instead of being sent to the scrap heap it has been made an effective machine for this job.

C. L. L.

BULLDOZER DIES FOR FORMING STEEL STIRRUPS

BY P. P. FENAUX*

In certain of its products, the General Electric Co. uses steel stirrups of the form shown in Fig. 1. These stirrups are made of high carbon steel of approximately $\frac{3}{4}$ by $\frac{3}{8}$ inch in cross-section. As the quantity of these parts that are required is rather large and as no forging machine was available, it was decided to makes dies in which these stirrups could be produced on a standard bulldozer. As the dimensions are required to be within 1/64 inch of uniform, it was necessary to make dies that would produce work within these limits without requiring any subsequent forging which would leave hammer marks.

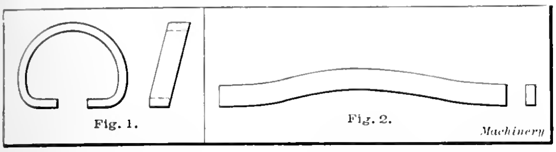


Fig. 1. The Finished Stirrup　　Fig. 2. Blank after the First Operation has been performed

The sequence of operations involved in making these stirrups is as follows: A bar of steel is sheared into blanks of the required size, which are first bent to the form shown in detail in Fig. 2, this form being a development of the finished stirrup. Suitable allowance is made for the spring of the steel in order to obtain the required dimensions. The blanks are bent to the form shown in Fig. 2 between the dies *A* and *B*, which are shown in the operating position, and also in cross-section in order to illustrate the construction more clearly. The die *A* is fastened to the stationary base *C*, which is, in turn, bolted to the ways of the bulldozer and backed up by adjusting screws *D*. It will be seen that the plates *A* and *B* overlap in order to prevent distortion of the work while it is being bent into shape. The die *B* is bolted to a supporting plate *E* which is carried by a second plate *F* bolted to the ram of the bulldozer. The gage *G* provides for locating the blanks in the proper position.

The next step is to complete bending the work to bring it to the form shown in Fig. 1. When the ram recedes after performing the preliminary operation between the dies *A* and *B*, the work is taken out and laid edgewise on the shelves *H* and *J* of die *K*. The gage *X* provides for locating the work in the required position. When the ram comes forward, it pushes the wedge *L* against the slide *M* which travels on ways provided in the block *N*. During the first part of the operation performed in this die, the block *N* is held stationary by a locking-pin; but after the slide *M* has completed its travel, the locking-pin is released and the block *N* moves forward. A more complete explanation of this part of the work will be given in a subsequent paragraph. The slide *M* carries a form *P*, and as the slide moves to the right this form comes into contact with the work and forces it into the die *K*, thus bending the piece to a U-shape.

When the operation has proceeded to this point, the wedge *Q* located on the under side of the base *C* pulls out the locking-pin *R*, thus leaving the block *N* free to move. As the ram continues its forward movement, the die *S*, which is fastened to the ram, comes into contact with one arm of the U-shaped piece on the form *P* and bends it around the form. At the same time the ram continues to move forward and pushes the slide *M* and the block *N* with it. In so doing, the other arm of the U-shaped work is pushed into the stationary die *T*, which bends it around the form *P*. At the end of the forward movement of the ram, both the dies *S* and *T* come in contact with the wedge-shaped end of the slide *M*, which forces the dies against the form *P*, thus setting the work onto the form. The dies *S* and *T* are pivoted at the points *V* and *W*, respectively, to enable the dies to be moved by the tapered surfaces on the slide *M*. While this forming operation is being performed, the work is pushed against a stamping device *Y* set in the die *K*, which produces the necessary marking on the part. When the ram returns, the die is released and the slide *M* is pushed back by the springs in the block *N*; then the link A_1 draws the block *N* back, the pin B_1 being provided in the block for this purpose.

The form *P* is now taken out of the slide with the work in place around it. The third operation consists of setting the work in the dies C_1 and D_1. The purpose of this operation is to overcome the elastic limit of the material so that the piece will be set to exactly the required form. After this final operation has been completed, the form is pushed out of the work by means of the ejecting-pin E_1, leaving it in the shape shown in Fig. 1.

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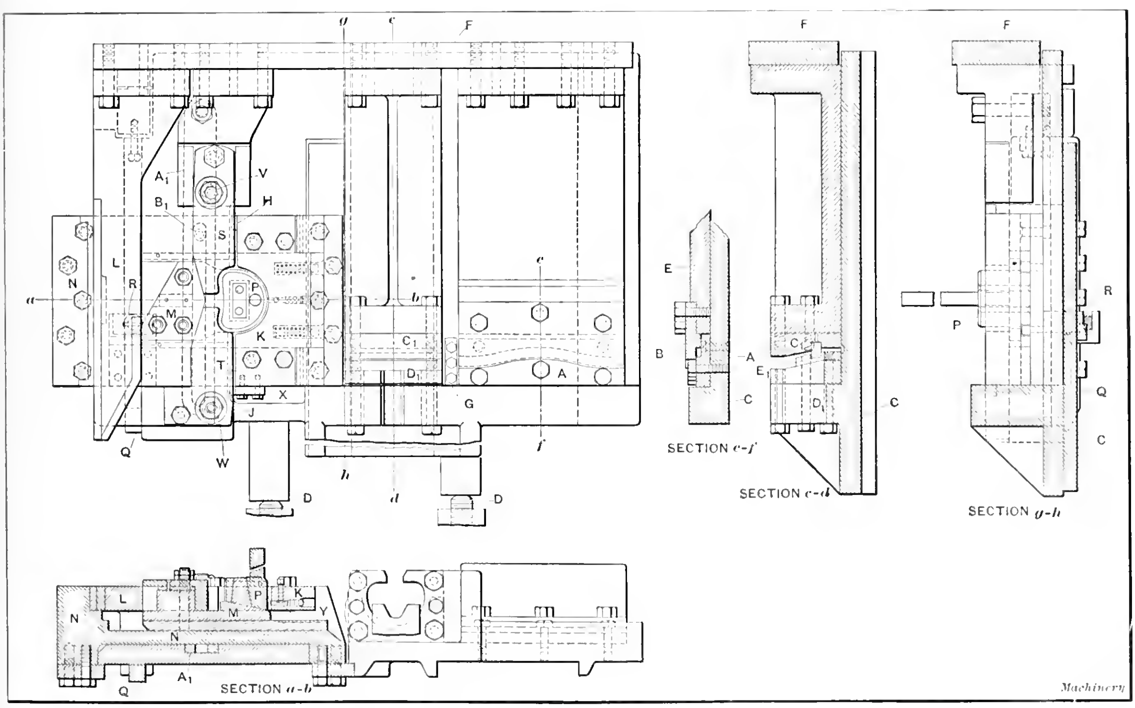
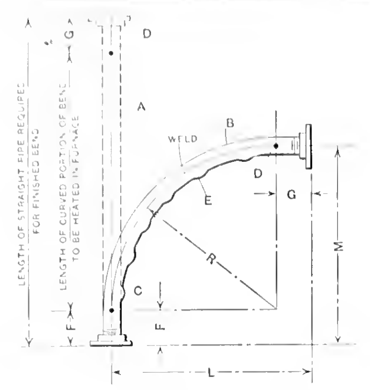


Fig. 3. An Interesting Set of Bulldozer Dies for forming Stirrups of the Form shown in Fig. 1

STEAM POWER PLANT PIPING DETAILS—9*

THE DESIGN OF WROUGHT IRON AND STEEL PIPE BENDS

BY WILLIAM F. FISCHER†



Length of straight pipe required = F + 1.57 R + G.

Machinery

Fig. 68. A 90-degree Bend and the Straight Pipe required to make it

In a previous number of MACHINERY rules, tables and formulas were given for estimating the amount of expansion cared for by expansion bends of different types. In this installment, rules and formulas will be given for the design of wrought iron and steel pipe bends in general. When used to convey steam at high pressure, wrought iron and steel pipe bends 4 inches and over in size are usually made up with "rolled" or Van Stone joints, or in some cases the flanges are welded direct to the pipe. In making rolled or Van Stone joints, the end of the pipe is heated in a furnace and then rolled over the face of the flange and finished off to a true bearing surface in a pipe lathe. When pipe bends are ordered with rolled, Van Stone, or welded flanges, it is always advisable to attach the flanges to the pipe and roll or finish the flange faces true in a pipe lathe before bending the pipe to the required form. Therefore it becomes necessary, in cases of this kind, to determine the length of straight pipe that will be required to make the bend to the given dimensions. After the length of the straight and curved portions of the bend have been determined by the designer, the general dimensions are noted on sketch sheets and sent to the pipe shop. A piece of pipe is cut to the proper length and the flanges attached and finished to a true bearing surface, after which the pipe is sent to the bender, who lays off on it the length of straight and curved portions of the bend (see Fig. 68) and places the pipe in the furnace to be heated to the proper bending temperature. The pipe is then removed from the furnace and placed on a bending table, where it is curved to the required dimensions.

In case the designer makes an error in calculating the length of straight pipe required for the finished bend, it will be readily understood that when the bend is made up and curved to shape it will be either too long or too short, as the case may be. Furthermore, unless the error is a slight one it may be impossible to make the bend to the desired dimensions without first cutting a new piece of pipe to the proper length, rolling or flanging new joints and finishing them true in a lathe. Errors of this kind are necessarily expensive and cause considerable delay in getting the piping material ready for erection. As a general rule, after the sketch sheets leave the drafting-room, an error in the length of straight pipe required for the finished bend is discovered only when the bend has been completed and is being checked up for dimensions on the bending table, in which case the material and workmanship represent a total loss to the manufacturer unless the bend can be used on some other job. For this reason, all calculations pertaining to pipe bends should be carefully checked in the drafting-room before the detail sheets are sent to the pipe shop. In the following article, the writer has prepared simple rules, tables and formulas which will enable the reader to determine all of the necessary dimensions required for pipe bends of the types illustrated below. These represent about all of the standard shaped bends ordinarily used in steam power plant work; therefore, the designer should be able to choose the type best suited to his purpose and figure the important dimensions accordingly. As a further guide in choosing the proper bend to use for a given service, the reader is referred to the second, third, sixth and eighth installments of this series, which appeared in earlier numbers of MACHINERY.

TABLE XIV. RADII FOR PIPE BENDS OF WROUGHT IRON AND STEEL PIPE*

Size of Pipe	Actual Outside Diameter of Pipe	Minimum Radius for Bends of Extra Heavy Pipe		Minimum Radius for Bends of Standard or Full Weight Type		Advisable Radius for Bends of Standard or Full Weight Type		Advisable Minimum Radius for Bends used to Take Care of Expansion and Contraction		Length of Straight required at Each End for Flange or Fitting	
Inches	Inches	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.
1	1.315		2½		4		5		8		2½
1¼	1.660		3		5		6		10		2¾
1½	1.900		4		6		8	1	0		3
2	2.375		5		7		10	1	3		3½
2½	2.875		6		8	1	0	1	6		4
3	3.500		8		10	1	3	1	9		4½
3½	4.000		10	1	0	1	6	2	0		5
4	4.500	1	0	1	3	1	9	2	3		5½
4½	5.000	1	2	1	6	2	0	2	6		6
5	5.563	1	3	1	9	2	3	2	9		6½
6	6.625	1	9	2	0	2	6	3	3		7
7	7.625	2	0	2	3	2	9	3	9		8
8	8.625	2	3	2	9	3	3	4	3		9
9	9.625	2	9	3	3	3	9	4	9		10
10	10.75	3	3	3	9	4	3	5	6	1	0
11	11.75	3	9	4	3	4	9	6	0	1	1
12	12.75	4	3	4	9	5	3	6	6	1	2
14	14	5	6	6	0	6	6	7	6	1	4
15	15	6	0	6	6	7	0	8	6	1	5
16	16	6	6	7	0	7	6	9	0	1	6
18	18	7	3	7	9	8	3	.....		1	6
20	20	8	3	9	0	9	6	.....		1	6
22	22	9	3	.....		.....		.....		1	6
24	24	10	0	.....		.....		.....		1	6

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* Note.—Pipe 14 inches and larger is known as O. D. pipe, meaning outside diameter pipe.

Fig. 68 is a typical example of the method employed in laying off or marking straight pipe in the shop when used for bending purposes. The dotted lines *A* show the straight pipe flanged and marked, ready for the bender; and the full lines show the completed bend, true to dimensions. Take, for example, a 6-inch 90-degree bend of the form shown in Figs. 68 and 69, to be made to minimum dimensions *L* and *M*, using extra strong or extra heavy pipe for the bend. By referring to Table XIV, we find the minimum radius *R* for a 6-inch bend of extra strong pipe is 1 foot 9 inches or 21 inches; and the minimum length of the straight sections *F* and *G* to be employed at each end of the bend is 7 inches, making minimum dimensions *L* and *M* in Fig. 68, 1 foot 9 inches +

* The eighth installment of this series was published in the May number of MACHINERY.

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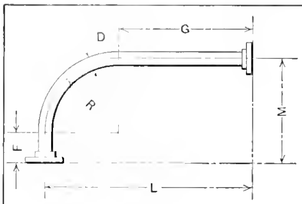


Fig. 69.

Length of straight pipe required = F + 1.57 R + G. Dimensions M, L, and R should be given when ordering the bend.

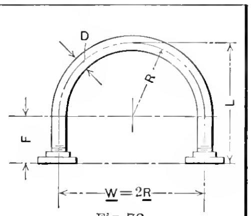


Fig. 70.

Length of straight pipe required = 2F + 3.14 R. Dimensions L, W and R should be given when ordering the bend.

Machinery

Figs. 69 and 70. A 90-degree or Square Bend and a U-bend

7 inches = 2 feet 4 inches from center to face. In Fig. 69, we find the length of the 90-degree circular arc = 1.57 × radius $R = 1.57 \times 21 = 32.97$ or say 33 inches. Therefore, the total length of straight pipe required for the finished bend = $33 + 7 + G = 40 + G$ inches or 3 feet 4 inches + G from face to face of the flanges. The length of the curved portion of bend (33 inches) is marked off, as indicated by the dotted lines in Fig. 68, and that portion of the pipe is heated in the furnace ready for bending. If no error has been made in calculating and laying off the dimensions on the straight pipe, the bend will be true to dimensions when curved to shape as indicated by the full lines.

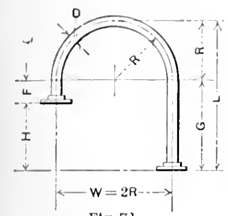


Fig. 71.

Length of straight pipe required=F+3.14 R+G. Dimensions L, W, H and R should be given when ordering the bend.

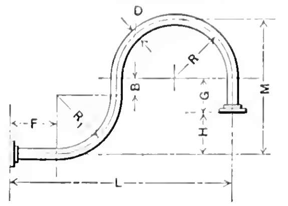


Fig. 72.

Length of straight pipe required = F + 1.57 R_1 + B + 3.14 R + G. Dimensions L, M, H, R and R_1 should be given when ordering the bend.

Machinery

Figs. 71 and 72. A Gooseneck U-bend and a Combination Square and U-bend

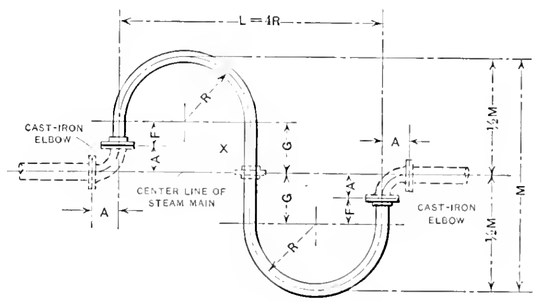
In order to prevent strains on the welded joint of the pipe when bending it to shape, the weld should be placed either up or down, *i.e.*, over the neutral axis of the pipe where it is neither in tension nor compression. The tension side of the bend is indicated by B and the compression side by E, Fig. 68, which also shows the proper position for the weld in bending. If the welded joint is placed either on the tension or compression side of the bend, the seam is very likely to spread or open up, due to the severe bending strains at these points. If the radius R is made less than the values indicated in the third and fourth columns of Table XIV, the pipe is likely to buckle on the compression side of the bend, as shown at E; and it will assume an oval shape in cross-section at these points, thus decreasing the effective area and destroying the general appearance of the bend. Pipe bends curved to a very large radius are also likely to buckle on the compression side of the bend, due to the bender having to take short heats, *i.e.*, heat the pipe two or more times in order to complete the curve. Lap welded wrought iron or steel pipe is to be preferred to butt welded pipe for bending purposes, as the weld is more secure and less likely to spread or open up when bending.

Pipe Bends with Screwed Joints

Although pipe bends having threaded ends and screwed flanges may be cut, threaded, and flanged after bending, it is rather difficult to perform this work satisfactorily by machine, especially if the pipe is of large diameter. In all cases, it is advisable to flange the pipe and finish the flanges true in a lathe before bending to the desired shape. Pipe bends having threaded ends and screwed flanges are frequently made up as "fillers" or closing pieces; these bends are made with long ends, which are cut off by the steam fitter to suit the closing dimensions of the line. In a case of this kind it is, of course, necessary to cut, thread and flange the pipe in the field after the bend is made. In all cases where bends can be made to correct dimensions in the shop, however, much time and expense can be saved by cutting, threading and flanging the pipe before it is curved to shape on the bending table.

Minimum Standard and Maximum Radii for Pipe Bends

Steel or wrought iron pipe bends made up of "standard" or "full weight" pipe (*i.e.*, standard weight pipe not under 5 per cent of card weight, as listed in the manufacturers' catalogues) should not be bent or curved to a radius less than that listed in the fourth column of Table XIV, as these are considered the minimum safe radii to employ for standard light weight pipe, when perfect bends are desired. Although it is possible to bend standard weight pipe to a smaller radius than listed in this table, it is not advisable to do so, owing to the danger of the pipe buckling on the compression side of the bend, as shown in Fig. 68. When bends of a shorter radius are desired, they should be made of extra strong or extra heavy pipe, having approximately twice the thickness of a standard or full weight pipe of the same outside diameter. The dimensions in the third column of the table are the minimum radii to be employed for pipe bends of extra strong pipe. In the fifth column of the table is given the advisable radii to use for bends of standard or full weight pipe. In the sixth column of the table is given the advisable minimum radius to employ for bends which are to be used as expansion bends for relieving the expansion and contraction strains in a long line of piping, as explained in an earlier number of MACHINERY. In this respect, it should be understood that any increase in the radius of an expansion bend adds considerably to its flexibility (see the eighth installment of this series published in the May number).



Length of straight pipe required, if made in one piece without flanges at X = 2F + 2G + 2 x 3.14 R. Dimensions F, G and R should be given when ordering the bend.

Machinery

Fig. 75. Special S-type of Expansion Bend

The maximum radius of curvature for a pipe bend of any description is governed by the character of the bend, the length of pipe required to make the bend to the given dimensions, and the space available for erection, rather than by the design of the bend. If the radius of the bend is too large, however, the bender may find it necessary to take more than one heat for each circular arc, in which case there is always more or less danger of the pipe buckling on the compression side, as previously mentioned. The minimum length of straight pipe to be allowed at

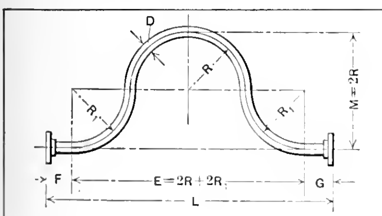


Fig. 73.

Length of straight pipe required=F + 3.14 R_1+ 3.14 R+G. Dimensions L, M, R and R_1 should be given when ordering the bend.

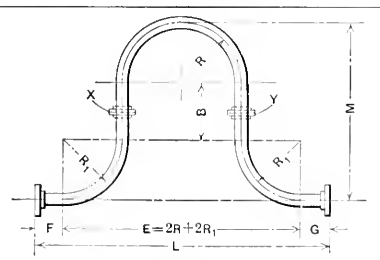
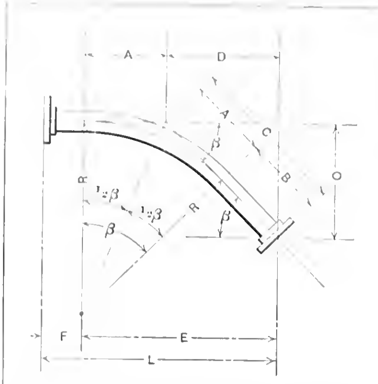


Fig. 74.

Length of straight pipe required=F + 3.14 R_1 + 2B + 3.14 R + G. Dimensions L, M, R and R_1 should be given when ordering the bend.

Machinery

Figs. 73 and 74. Expansion Bends with and without Straight Sections between the Arcs



Length of straight pipe required,= F + 0.01745 Rβ + B. Dimensions L, O, R and angle β should be given when ordering the bend. A = R × tan ½β, D = O × cot β and E = A + D. Then F = L − E, C = O ÷ sin β and B = C − A. The length of the circular arc of angle β = 0.01745 Rβ.

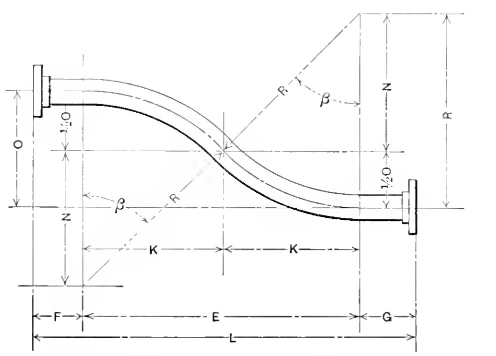
Machinery

Fig. 76. Angle Bend

each end of a bend for the attachment of flanges, or to screw into pipe fittings, is given in the last column of Table XIV. If the length of straight pipe at each end of a bend is made less than given in the table, there is always more or less danger of the pipe flattening or assuming an oval shape at the end while it is being bent, especially on bends of short radius, in which case there is danger of leakage occurring between the body of the pipe and the flange. The dimensions listed in Table XIV are a fair average of those recommended by several of the large manufacturers making a specialty of pipe bending, and may be considered safe figures to work to in all cases.

Rules and Formulas for Determining the Dimensions of Pipe Bends

The 90-degree or square bend illustrated in Fig. 69 is probably the most common type in use today. Bends of this kind are frequently used in place of 90-degree elbows, wherever it is required to take branches off at right angles to the main header. The U-bend shown in Fig. 70 may be used either as a return bend or a cross-over bend between two headers or



Length of straight pipe required,= F + 2 × 0.01745 Rβ + G. Dimensions L, F, O and R should be given when ordering the bend. N = R − ½O and cos $\beta = \frac{N}{R}$, from which the angle β is obtained. K = N × tan β and E = 2K. Then G = L − (E + F). The length of each circular arc of angle β = 0.01745 Rβ.

Machinery

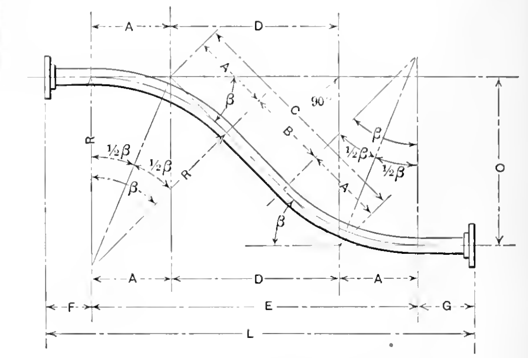
Fig. 77. Offset Bend with no Straight Section between the Arcs

mains; or it may be used in connection with two 90-degree bends or elbows as an expansion bend, similar to the arrangement shown in Fig. 74. The gooseneck U-bend illustrated in Fig. 71 is similar in all respects to the U-bend in Fig. 70, except that one leg of the bend is longer than the other, offsetting the flanges as shown at *H*. The bend shown in Fig. 72 is a combination of a U-bend (Fig. 70) and a 90-degree or square bend (Fig. 69). The expansion bends shown in Figs. 73, 74 and 75, as the name implies, are used for the purpose of taking up or relieving the expansion and contraction strains in a system of steam piping, as described. The length of straight pipe required to make any of the bends illustrated in Figs. 69 to 75, inclusive, may be found by adding together the length of the straight and curved portions of the bend, as described for each case. As these bends are either curved to an arc of 90 or 180 degrees, or to a combination of the two, it is a very simple matter to determine the dimensions indicated on the drawings. The length of each circular arc is readily determined as follows:

Length of 90-degree circular arc = 1.57 *R*.

Length of 180-degree circular arc = 3.1416 *R*.

Owing to the long length of pipe required to make the finished bends illustrated in Figs. 74 and 75 in one piece, it may be necessary—especially in the larger sizes—to make these bends in two or more pieces by adding the flanges as shown dotted at *X* and *Y*. Standard steel and wrought iron pipe may be obtained from the mills in random lengths up to 22 feet, and special welded pipe, for bending purposes, in lengths up to 40 feet. Lengths up to 22 feet are usually kept in stock, but if longer lengths are required they may have to be ordered, in which case it may be necessary to wait some time for delivery. Most of the larger manufacturers of piping materials are equipped with welding outfits and make a practice of welding pipe in suitable lengths for especially



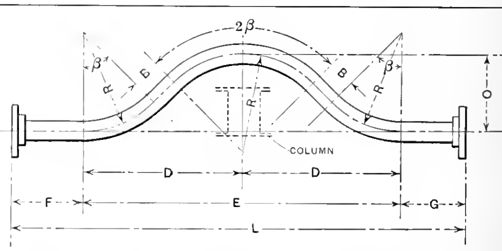
Length of straight pipe required = F + 2 × 0.01745 Rβ + B + G. Dimensions L, F, O, R and angle β should be given when ordering the bend. A=R × tan ½β, D=O × cot β and E=2A+D. Then G=L−E−F. C = O ÷ sin β and B = C−2A. Length of each circular arc of angle β = 0.01745 Rβ.

Machinery

Fig. 78. Offset Bend with a Short Straight Section between the Arcs

long bends. In many cases, large bends made in one piece are no more expensive than those made in two or more pieces, as the cost of rolling the extra joints and attaching flanges will about even up in each case. In order to facilitate shipment and erection of the piping, however, it may be advisable to design the large bends so they can be made in two pieces if so desired.

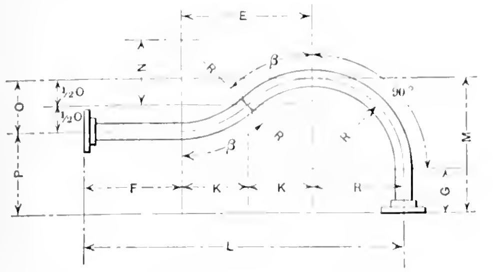
The bends illustrated in Figs. 76 to 84, inclusive, are more difficult to make and measure up than those illustrated in Figs. 69 to 75. The formula for figuring the length of straight pipe required for each type of bend under consideration is given under the illustration. The length of the circular arcs of angle β may be obtained as indicated for each particular case. For example, assume the angle β to be 45 degrees 50 minutes or 45 50/60 degrees, and radius *R* 4 feet 6 inches or 54 inches. Then, the length of the circular arc of angle β = 0.01745 × *R* × angle β = 0.01745 × 54 × 45 50/60 = 43.19



Length of straight pipe required = F + 4 × 0.01745 Rβ + 2B+G. Dimensions L, F, O, R and angle β should be given when ordering the bend. The dimensions B and D may be obtained as explained in Fig. 78. Then E = 2D and G = L − F − E. The length of each circular arc of angle β = 0.01745 Rβ.

Machinery

Fig. 79. Double Offset or Cross-over Bend

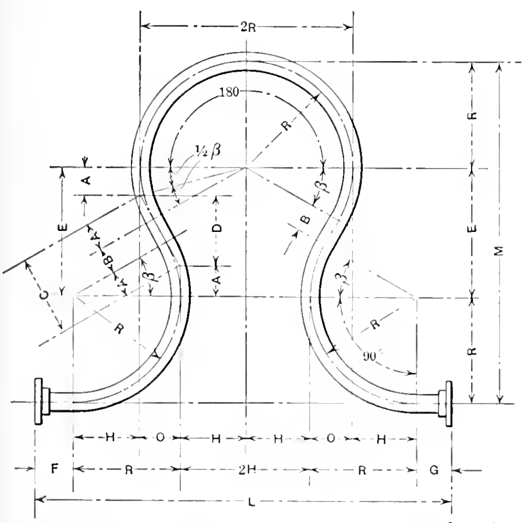


Length of straight pipe required = F + 2 × 0.01745 Rβ + 1.57 R + G. Dimensions L, R, P and G should be given when ordering the bend. M = G + R, O = M − P and N = R − ½O. Cos β = N ÷ R, from which angle β may be obtained. K = N × tan β and E = 2K. Then F = L − E − R. Length of the 90-degree circular arc is 1.57 R and of each circular arc of angle β it is 0.01745 Rβ

Machinery

Fig. 80. Single Offset Quarter Bend without a Straight Section between the Arcs

inches = 43 3/16 inches. If the angle β were exactly 45 degrees, the length of circular arc of angle β would be 0.01745 × 54 × 45 = 42.4 = 42 3/8 inches. The length of any circular arc can be found in a similar manner, and will be determined accurately enough for all practical purposes if angle β is read to degrees and the nearest minute in each particular case. That is, if angle β were actually 45 degrees 49 minutes 43 seconds, it would be close enough for all practical purposes to assume 45 degrees 50 minutes, or 45 50/60 degrees, expressed as a fraction. Having found the length of the curved portion, or portions, of the bend, it is only necessary to add the length of the straight portions in order to obtain the length of straight pipe (from face to face of flanges) required to make the bend.



Length of straight pipe required = F + 4 × 1.57 R + 4 × 0.01745 Rβ + 2B + G. Dimensions L, M, F, G, R and angle β should be given when ordering the bend. A = R × tan ½ β, D = O × cot β and C = O ÷ sin β. Then E = 2A + D, B = C − 2A and H = R − O. Length of each 90-degree circular arc is 1.57 R and of each of the circular arcs of angle β it is 0.01745 Rβ.

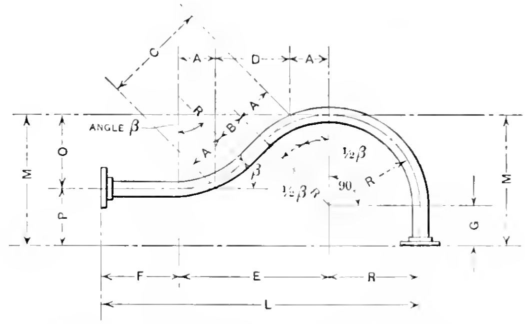
Machinery

Fig. 81. Double Offset Type of Expansion Bend

Examples Showing Method of Figuring Dimensions of Pipe Bends

As an example showing the method of figuring the dimensions of an angle bend, similar to that shown in Fig. 76, assume the following conditions: Size of pipe, 6 inches; radius R, 30 inches; distance L, 8 feet 6 inches = 102 inches; distance O, 3 feet, 4 inches = 40 inches; and angle β, 30 degrees 40 minutes.

Dimension $A = R \times \tan \frac{1}{2}\beta$. $\frac{1}{2}\beta$ = 15 degrees 20 minutes and the tangent of $\frac{1}{2}\beta$ = 0.2742. Therefore, dimension $A = R \times 0.2742 = 30 \times 0.2742 = 8.226$ inches. Dimension $D = O \times \cot \beta$. Cot 30 degrees 40 minutes = 1.6864 and O = 40 inches. Therefore $D = 40 \times 1.6864 = 67.456$ inches. Dimension $E = A + D = 8.226 + 67.456 = 75.68$ inches. Dimension L = 102 inches. Dimension $F = L - E$. Therefore, $F = 102 - 75.68 = 26.32$ inches = 26 5/16 inches. Dimension $C = O \div \sin \beta$. O = 40 inches, and sin 30 degrees 40 minutes = 0.51. Therefore $C = 40 \div 0.51 = 78.431$ inches. Dimension $B = C - A = 78.431 - 8.226 = 70.205$ or 70 3/16 inches. Length of circular arc β (curved portion of bend) = 0.01745 $R\beta$. R = 30 inches and β = 30 degrees 40 minutes = 30 40/60 or 30 2/3 degrees. Therefore, the length of the circular arc of angle β = 0.01745 × 30 × 30 2/3 = 16.054 inches. Then the length of the straight pipe (from face to face of flanges) required for the finished bend = length of circular arc of angle $\beta + F + B$ = 16.054 + 26.32 + 70.205 = 112.579 inches, or 9 feet 4 9/16 inches.



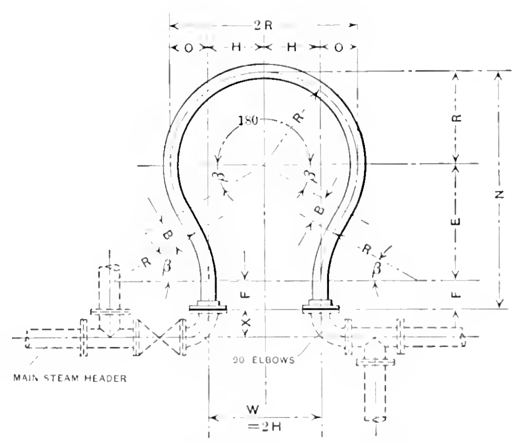
Length of straight pipe required = F + 2 × 0.01745 Rβ + B + 1.57 R + G. Dimensions L, P, G, R and angle β should be given when ordering the bend. M = G + R, O = M − P, A = R × tan ½β, D = O × cot β and C = O ÷ sin β. Then E = 2A + D, B = C − 2A and F = L − E − R. Length of the 90-degree circular arc is 1.57 R and of each of the circular arcs of angle β it is 0.01745 Rβ.

Machinery

Fig. 82. Single Offset Quarter Bend with Short Straight Section between the Arcs

Offset Bend with No Straight Section Between the Arcs

As an example showing the method of figuring the dimensions of an offset bend similar to that shown in Fig. 77, assume the following conditions: Full weight pipe 12 inches in size to be used. Given dimensions are G, F, O and R. The angle β is fixed by the specified offset O and radius R. It is required to make the dimension L as short as possible, using

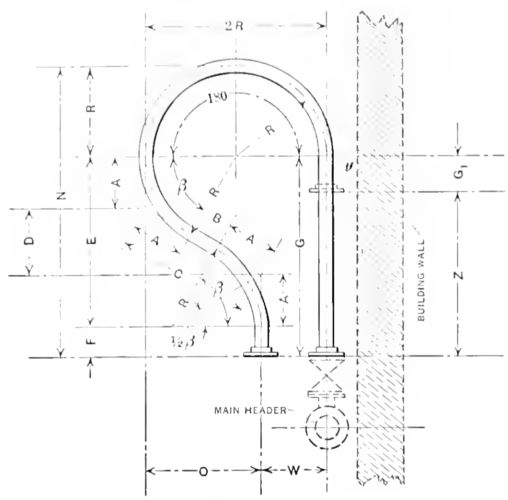


Length of straight pipe required = 2F + 4 × 0.01745 Rβ + 2B + 2 × 1.57 R. Dimensions W, N, R, F and angle β should be given when ordering the bend. The dimensions O, B and E may be obtained as explained in Fig. 82. H = R − O. The length of each 90-degree circular arc is 1.57 R and of each circular arc of angle β it is 0.01745 Rβ.

Machinery

Fig. 83. Double Offset Type of U-bend

minimum dimensions for F, G, and R. Looking in Table XIV, in the fourth and last columns, and opposite 12-inch pipe we find the minimum radius R equals 4 feet 9 inches or 57 inches, and the minimum dimension for F and G equals 1 foot 2 inches or 14 inches. If we assume the offset O as 14⅜ inches, $\frac{1}{2}\ O = 7\ 3/16$ inches. Dimension $N = R - \frac{1}{2}\ O = 57 - 7\ 3/16 = 49\ 13/16$ or 49.8125 inches. Cos $\beta = N \div R = 49.8125 \div 57 = 0.8731$. From a table of natural trigonometric functions, we find that the cosine of 0.8731 corresponds to an angle of 29 degrees 11 minutes. Therefore angle $\beta = 29$ degrees 11 minutes. Dimension $K = N \times \tan \beta$. $N = 49.8125$ and tan 29 degrees 11 minutes $= 0.5585$. Therefore $K = 49.8125 \times 0.5585 = 27.82$ inches. Dimension $E = 2\ K = 2 \times 27.82 = 55.64$ inches. Therefore minimum dimension $L = F + E + G = 14 + 55.64 + 14 = 83.64$ inches $=$ 83⅝ inches or 6 feet 11⅝ inches. The length of each circular arc of angle $\beta = 0.01745\ R\beta$, or length of both circular arcs (curved portion of bend) $= 2 \times 0.01745\ R\beta = 0.0349\ R\beta = 0.0349 \times 57 \times 29\ 11/60 = 58.054$ or 58 1/16 inches. Thus the length of the straight pipe (from face to face of the flanges) required for producing the finished bend $= 58\ 1/16 + 14 + 14 = 86\ 1/16$ inches or 7 feet 2 1/16 inches.



Length of straight pipe required $= F + 2 \times 0.01745\ R\beta + B + 2 \times 1.57\ R + G$. Dimensions W, N, R, F and angle β should be given when ordering the bend. The dimensions O, B and E may be obtained as explained in Fig. 82. $G = E + F$. The length of each 90-degree circular arc is $1.57\ R$ and of each circular arc of angle β it is $0.01745\ R\beta$.

Machinery

Fig. 84. Single Offset Type of U-bend

Offset Bend with Straight Between Arcs

As an example showing the method of computing the dimensions of an offset bend with a straight section between the arcs, as shown in Fig. 78, assume the following conditions: In this case L, F, O, R and the angle β are the given dimensions and should be determined by the designer when laying out the piping system to scale on the drawing board. Assume that a 6-inch pipe is to be used; $L = 9$ feet or 108 inches; $F = 18$ inches; $O = 42$ inches; $R = 36$ inches; and angle $\beta = 45$ degrees. Dimension $A = R \times \tan\ \frac{1}{2}\ \beta = R \times \tan$ 22 degrees 30 minutes $= 36 \times 0.41421 = 14.91$ inches. Dimension $D = O \times \cot\ \beta = O \times \cot$ 45 degrees $= 42 \times 1 = 42$ inches. Dimension $E = 2A + D = 2 \times 14.91 + 42 = 71.82$ inches. Dimension $G = L - (E + F) = 108 - (71.82 + 18) = 108 - 89.82 = 18.18$ or 18 3/16 inches (approximately). Dimension $C = O \div \sin\ \beta = O \div \sin$ 45 degrees $= 42 \div 0.7071 = 59.40$ inches. Dimension $B = C - 2A = 59.40 - 29.82 = 29.58$ or 29 9/16 inches (approximately). The length of each circular arc of angle $\beta = 0.01745\ R\beta$, or the length of both circular arcs $= 2 \times 0.01745\ R\beta = 0.0349\ R\beta = 0.0349 \times 36 \times 45 = 56.538$ inches. The length of the straight pipe (from face to face of flanges) required for the finished bend $=$ length of both circular arcs $+ F + B + G = 56.538 + 18 + 29.58 + 18.18 = 122.298$ or 122¼ inches $=$ 10 feet 2¼ inches. The double offset bend shown in Fig. 79 is figured exactly the same as the above.

Double Offset Expansion Bend

As an example showing the method of computing the dimensions of a double offset expansion bend, as illustrated in Fig. 81, assume the use of an 8-inch pipe with the following given dimensions: Radius $R = 4$ feet 3 inches $= 51$ inches; angle $\beta = 30$ degrees; length of straight pipe between arcs at $B = 12$ inches; $F = 9$ inches; and $G = 9$ inches (see Table XIV). The other dimensions are to be computed as follows:

$A = R \times$ tangent $\frac{1}{2}\ \beta = 51 \times$ tangent 15 degrees $= 51 \times 0.26795 = 13.665$ inches; $C = 2A + B = 2 \times 13.665 + 12 = 39.33$ inches; $O = C \times \sin\ \beta = C \times \sin$ 30 degrees $= 39.33 \times 0.5 = 19.665$ or 19⅝ inches (approximately); $D = C \times$ cosin $\beta = C \times$ cosin 30 degrees $= 39.33 \times 0.866 = 34$ inches; $E = 2A + D = 2 \times 13.665 + 34 = 61.33 = 61\ 5/16$ inches or 5 feet 1 5/16 inch; $M = 2R + E = 2 \times 51 + 61\ 5/16 = 163\ 5/16$ inches, or 13 feet 7 5/16 inches; $H = R - O = 51 - 19\ 5/8 = 31\ 3/8$ inches, or 2 feet 7⅜ inches; and $L = F + G + (2R) + (2H) = 9 + 9 + (2 \times 51) + (2 \times 31⅜) = 182¾$ inches or 15 feet 2¾ inches. The length of each 90-degree circular arc $= 1.57\ R = 1.57 \times 51 = 80.1$ inches, or approximately 6 feet 8⅛ inches. The length of the 180-degree circular arc $= 3.1416\ R = 3.1416 \times 51 = 160.2$ inches, or approximately 13 feet 4 3/16 inches. The length of each 15-degree circular arc of angle $\frac{1}{2}\beta = 0.01745 \times R \times \frac{1}{2}\beta = 0.01745 \times 51 \times 15 = 13.349$ or 13⅜ inches (approximately). The length of each circular arc should be computed separately, as explained above, in order to mark off on the straight pipe the different lengths to be heated for bending. When computing the total length of straight pipe required for the finished bend, however, it is more accurate and more convenient to compute the curved portions of the bend as follows: Total length of the complete curved portions of bend $= (6.2832\ R) + (0.0698\ R\beta)$. Therefore, total length of straight pipe (from face to face of the flanges) required for finished bend $= (6.2832\ R) + (0.0698\ R\beta) + 2B + F + G = (6.2832 \times 51) + (0.0698 \times 51 \times 30) + (2 \times 12) + 9 + 9 = 320.44 + 106.80 + 24 + 9 + 9 = 469.24$ inches or 39 feet 1¼ inch.

When laying out the piping system to scale on a drawing board, the designer should fix the general dimensions of the pipe bends and take care of all clearances; that is, he should fix the governing dimensions of the bends so that proper clearance will be allowed between other members of the piping system, machinery, building walls, columns, etc.

* * *

IMPORTANCE OF STRONG BENCH VISES

The importance of providing bench vises heavy enough for the work to be done, thereby obviating loss of effect because of work being inadequately supported was forcibly brought out by an incident occurring in a Western Pennsylvania shop recently. A great deal of casehardening of small parts is done in this shop. The inspector customarily tests the work on an old vise by holding one of the pieces of the lot in the vise and striking it with a hammer in order to observe the depth of case. He recently used a much larger and heavier vise when testing a lot of casehardened parts and did not immediately consider the effect of the larger and heavier vise. He noticed that the piece struck by the hammer snapped off very easily, and for the time being assumed that the pieces were casehardened to a depth that made them brittle, but as the depth of case appeared to be normal he tried another piece with the same result. Then the thought occurred to him to employ the same conditions as formerly, and taking one to the old vise he found that it broke with the customary number of blows.

This little incident indicates again the well-known truth that a given blow has the greatest effect on work that is massive or massively supported. This holds true no matter what the work is—chipping, filing, etc. Workmen too often are inclined to think that a vise is a vise, overlooking the fact that weight and rigidity of vises are an extremely important factor in efficient bench work. Of course the vise must not be too heavy and too cumbersome for light work, but in all cases it should be chosen with due regard to weight and strength as compared with the work to be done.

POWER PRESS GUARDS*

A VARIETY OF DEVICES FOR PROTECTING THE OPERATOR FROM BEING INJURED

BY MANCIUS S. HUTTON†

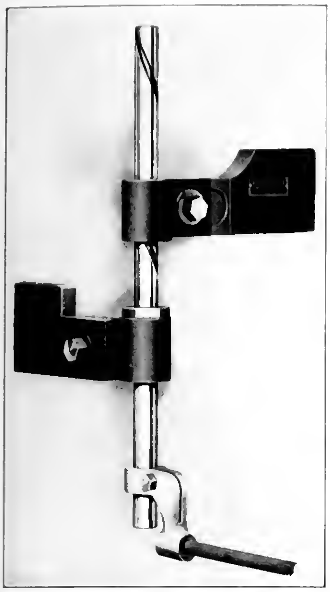


Fig. 1. Hemphill "Push Guard"

In discussing the subjects of safeguards for power presses all machines will be considered on which punching, embossing and stamping is done, both in the large and small sizes. There are two classes of power presses: first, those in which the piece is fed mechanically under the descending ram; and second, those which must have the metal placed in position by hand. Very few accidents happen to employes operating presses of the former class, but in the case of the latter, a large number of operators have their fingers crushed or sheared off by the descending ram. There are four types of mechanical feeds for primary operations and four for secondary operations, any of which is absolutely safe provided the press is stopped at the end of each stroke. A primary operation is one that is done by the machine upon merchant stock in the form of a sheet or bar, and which gives a shape or form to such stock. The secondary operations are done upon this shaped or formed blank.

There are two means of throwing the clutch into mesh to cause the ram to descend: first, by the operator pressing his foot on a treadle; second, by the operator moving a lever with one or both of his hands. To prevent power press accidents, the hands of the operator should be kept from under the ram when it descends by means of safeguards put on the machines for this purpose. There are four methods by which this can be done. First: by having a guard which pushes the hand away before the ram descends. Second: by having a device which prevents the clutch being thrown, locking the ram in its upper position while the operator's hands are under the ram but releasing it when the hands are removed. Third: by having a guard entirely surrounding the danger zone. Fourth: by requiring both hands to be used to operate the machine. The machines which are operated by the foot will require guards of the first, second or third classes, as the hands will be free to get in the way of the descending ram. A machine so designed as to require the use of both hands to operate it is a safety device in itself; but if only one hand is required, then it would be advisable to adopt one of the other three methods.

Foot Operated Machines

To prevent the occurrence of accidents, it is essential that the persons who operate power presses should not have their minds diverted from the work in hand. It is a fact that the continual working of the foot treadle by the operators, and the feeding of pieces with the hands soon becomes second nature. The result is that they acquire a certain automatic rhythmic movement which is likely to prove disastrous, should a mental disturbance of the rhythm be caused by a sudden noise or movement in the vicinity of the operators, or a desire on their part to look around at something happening near them. It might be safely said that practically all power press accidents occurring on this type of machines, in which the operator has one or more fingers crushed, are due to his mind being diverted for the instant, causing him to forget to take the fingers away from the point of danger before the treadle is depressed and the ram descends.

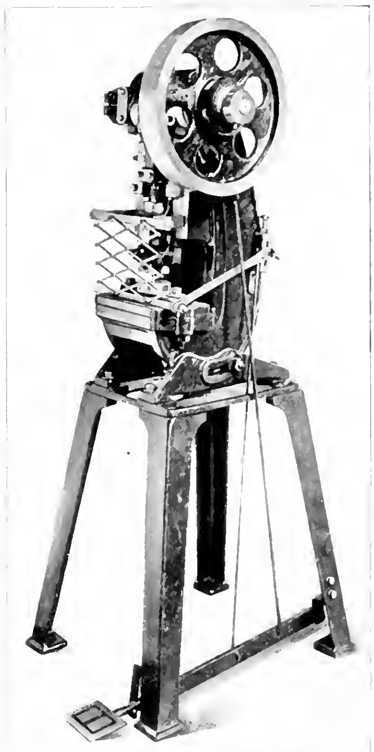


Fig. 3. Geuder, Paeschke & Frey "Lock" Type of Guard

In operating these machines, the ram should be allowed to come to a full stop in its upper position before the treadle is depressed again. In piece work it often happens that the operators do not take time to allow this to be done; and to remedy this condition, several of the press makers have a device by which the clutch lever detaches itself from the treadle action each time the latter is depressed, by means of a cam upon the main shaft which, itself, performs the stopping action of the clutch. Accidents are sometimes caused by the clutch getting out of order or by the flywheel seizing due to improper lubrication, thus causing the ram to descend when it is least expected. Where small objects are required to be formed or repunched, necessitating placing them between the dies, they should be inserted and removed with a stick of pine wood instead of the fingers.

Fig. 2. A Safeguard of the "Lock" Type

* For additional information on the safeguarding of power presses and allied subjects published in MACHINERY see also "Safeguards for Power Presses," by Edward K. Hammond, November, 1912; "A Mechanically and Electrically Operated Safety Device," by Benjamin C. Waite, July, 1912; "Prevention of Industrial Accidents," by F. R. Hutton, April, 1912; "Accidents in the Machine Shop," November, 1911; "Safety Device as Applied to Machine Tools," by Clarence Bolton, November, 1911; "The Prevention of Industrial Accidents," November, 1911; "The Mechanical Engineer and Prevention of Accidents," March, 1911; and "Practical Safeguards in the National Cash Register Co.'s Plant," by Ethan Viall, January, 1910.

† Address: 257 West 86th St., New York City.

It sometimes happens that an operator places a piece in the die in the wrong position, and then at the moment of depressing the treadle with the foot he discovers his mistake. An accident will occur if he attempts to remedy the mistake with his hands at the moment of discovery. This is not an unusual thing to occur in a machine shop. If the fingers are required to be under the ram while doing repair work or in changing the dies on the machine, a block of wood or metal should be placed in such a manner that the ram will be unable to descend if the treadle is depressed accidentally. The same thing should be done in case the clutch gets out of order or the flywheel seizes. The gears on the front of the presses should be enclosed with metal guards and the belting should also be covered. These guards are especially needed on machines which are operated by women, in which case there is a possibility of their hair being caught.

Push Guards

The guards in this class push the hand of the operator away from the danger zone before the clutch engages the flywheel and causes the ram to descend. One of the first of this type of guards to be put on the market is that shown in Fig. 1, which is made by A. J. Hemphill & Co., 11 Broadway, New York City. From the illustration it will be seen that the hands of the operator are forced away from the danger zone by a radial arm, which swings across the face of the lower die as the ram is descending. This arm is actuated by means of a nut which fits in a helical groove in the upright at the left-hand side of the machine. Another guard which belongs to this class but which works on a little different principle is that illustrated in Fig. 4. This guard is made by the H. & A. Lock Co., 156 Fifty-third St., Brooklyn, N. Y. It consists of a metal plate which lies flat on the bed plate of the press when the ram is in its upper position, but which swings outward and upward toward the operator by means of a bell-crank operated by the treadle, throwing his hand away from danger before the clutch becomes engaged.

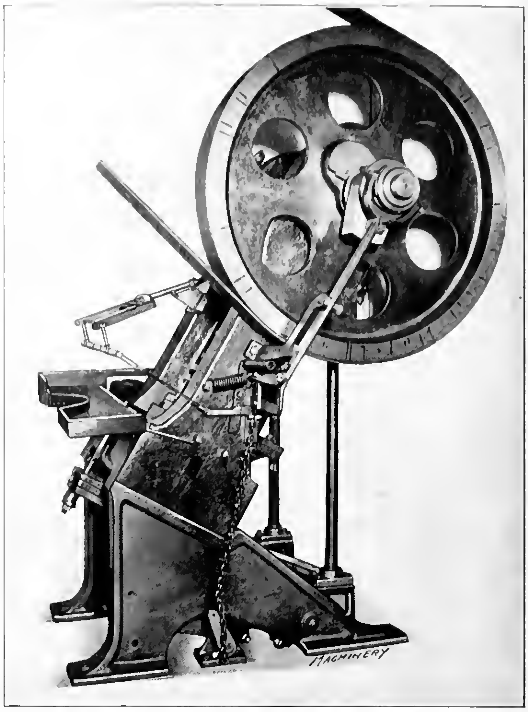


Fig. 5. Corbin "Lock" Type of Power-press Safeguard

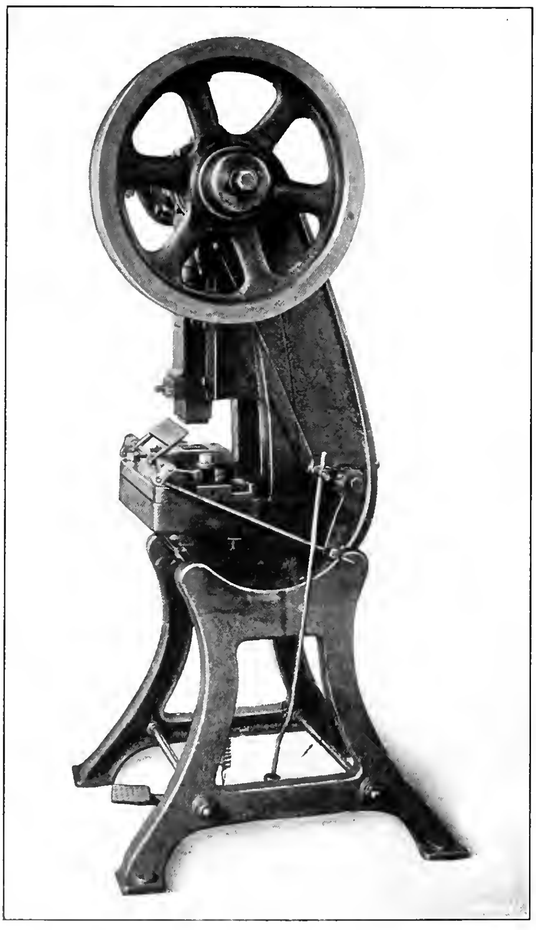


Fig. 4. H. & A. Lock "Push Guard"

Lock Guards

In this class belong those guards which so lock the clutch that the treadle will not operate the machine until the fingers are removed from the danger zone. In Fig. 2 there is illustrated a safeguard which is in use in a large number of factories in the United States. It is a product of the Lockhart Hodge Co., 12 Waverly St., Buffalo, N. Y. As the foot of the operator depresses the treadle of a machine equipped with this guard, a long lever swinging on a pivot is drawn down and carries with it the gate that descends in front of the dies. This gate drops almost to its lowest point before it reaches the bottom of the yoke, and it is only when the bottom of this yoke has been reached that a downward movement is communicated to the rod leading to the latch which sets the press in motion. From this it will be seen that the gate must be flush with the bed plate before the latch will operate to set the machine in motion. Therefore, should a person's fingers be under the gate at the time he depresses the treadle, the machine will not operate until such time as he withdraws them. Means are provided in connection with this guard to prevent the gate from rising until the press is again at rest.

Another make of guard working on somewhat the same principle as that just mentioned is shown in Fig. 3. It consists of a lever fulcrumed to one side of the press frame and attached at the end to a folding gate. A rod joins this lever to the rod leading to the clutch treadle and, depressing the treadle, causes the gate to unfold before the clutch engages. Should the operator place his fingers or anything else which is more than 1/8 inch in thickness in front of the descending gate, the clutch will not be tripped until he has removed it. This guard is made by Geuder, Paeschke & Frey Co., Milwaukee, Wis.

One of the simplest, and at the same time a very effective guard of the lock type is illustrated in Fig. 5. It consists of a free swinging rod of wood or other light material which is suspended across the front of the machine. In the operating position it hangs straight, but should the employe put his hand in the danger zone the rod will be swung forward by contact with his arms, causing a second rod attached to it to

lock the trip. The wood rod is attached to a bracket on the machine and can be removed or replaced at will. The Corbin Cabinet Lock Co., New Britain, Conn., is the manufacturer.

Fender Guards

In this class belongs those guards which completely surround the danger zone. There are very few guards of this kind, since they can, by the nature of their construction, be used in only a limited number of cases. In Fig. 6 is illustrated a safeguard of this type which is in use in Germany. The construction closely resembles that of a collapsible cup fitted to the under side of the ram, bottom side up; and the moving ram oscillates, as it were, within the cup. The cup is so adjusted for height that the fingers of the operator cannot pass between the edge of the cup and the bottom die. The sheet metal, however, can be fed through the space that is left. It will be plain, therefore, that the work can be fed to the danger zone but the fingers are not allowed to get through. As the ram descends upon the stock the cup collapses, as the rings of which the cup is formed slide within each other. On the up stroke the cup extends itself again, leaving room for the strip of stock to pass beneath its lower edge. If any variation in the thickness of the strip occurs,

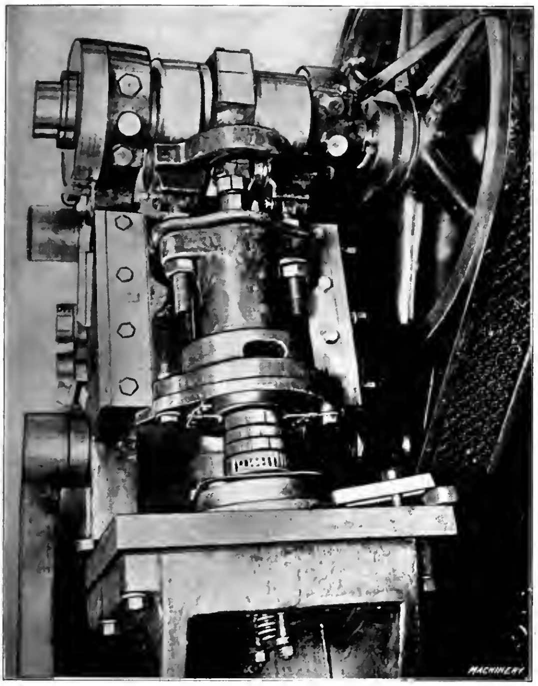


Fig. 6. Fender Type of Safeguard for Primary Operations

the cup collapses accordingly. This guard, which was developed by the Allgemeine Elektricitäts Gesellschaft, Berlin, Germany, can be used in most cases on the large machines, and is only effective for primary operations.

Hand Operated Machines

In the machines previously discussed, the clutch which actuates the ram is operated by the workman's depressing a treadle with his foot. He does not need his hands to operate the machine, only using them to place or feed the stock in the dies. In the class now to be considered, both the feeding—if there is no automatic feed—and the operating are done by either one or both hands. Nothing would be gained as regards safety by having only one hand do the engaging; therefore, practically no machines are in existence which depend on this operating method. Should a machine requiring a lever movement by both hands to make it operative be automatically fed, then the workman would not have to take his hands off the operating mechanism and he would be able to work faster, at the same time keeping his hands away from the danger zone. But should there be no automatic feed attached to the machine, the workman would not be able to work as fast as in the case of a machine having a treadle engagement and fitted with one of the guards previously mentioned. An advantage of this class is that there is no rhythmic movement which will be dangerous, and any noise or movement on the operator's part will not result in an accident. For this reason the two-handed engagement principle is by far the best safeguard.

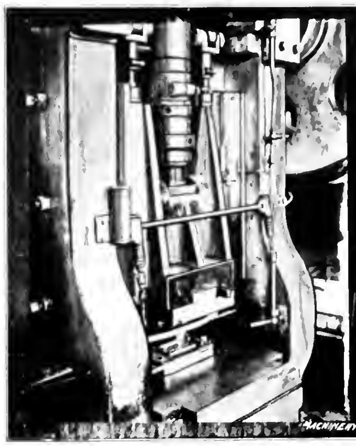


Fig. 7. Type of "Two-handed" Guard

Fig. 8 shows a machine equipped with a safeguard made by the Benjamin Electric Mfg. Co., Chicago, Ill. It has two levers placed one on each side of the machine, which are required to be pressed down by the hands of the operator before the clutch is engaged with the flywheel. The pressing of one lever will not start the machine. Another safeguard of this class is illustrated in Fig. 7 where the two handles in the illustration must be moved forward by the hands of the employe to operate the machine. This guard is used by the National Cash Register Co., Dayton, Ohio.

There are two kinds of guards which cannot be put in any class. The first is an amusing German suggestion to secure safety by placing a belt around the waist of the operator, and from a ring on this belt at each side having a short chain or strap passing around his elbows and then back to the ring. The length of the chain is so adjusted that the operator is able to place the pieces in the feeding mechanism in front of him but is not long enough to get his hands in the danger zone while sitting at his work. This safeguard can only be used where an automatic feed mechanism is attached to the machine, as it would not be a safety device without an automatic feed. This guard will probably never be used on this side of the water as no American workman would stand for having himself hampered in this manner.

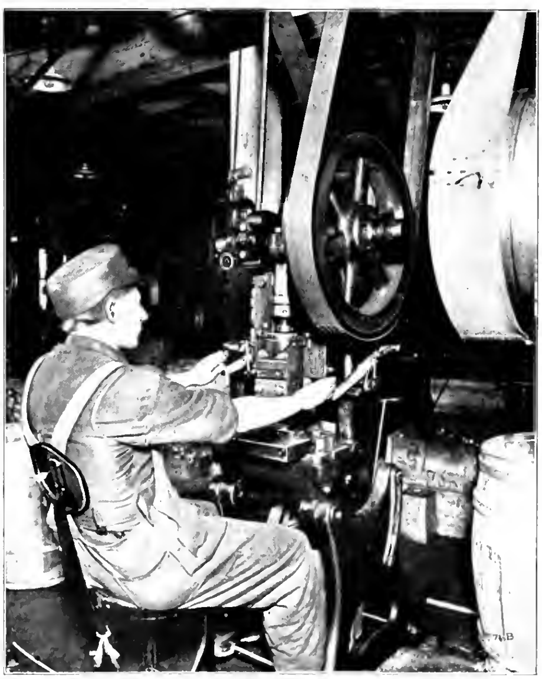


Fig. 8. Benjamin Guard that requires the Use of Both Hands to trip the Press

The second guard referred to, which is a more practical suggestion, is that the bed plate or die shall be in connection with an electric battery, with a condensing coil on the line. The plate shall be put in circuit by the motion which throws in the clutch, so that any fingers resting on this plate will receive a sharp shock and the muscles involuntarily contract, thus pulling the endangered fingers out of the path of the descending ram. This requires that the electrified plate shall be insulated from the metallic strip which the operator is feeding, and that the operator shall be grounded while at work, so that he may receive the shock when his fingers are in the danger zone. This idea is probably taken from central station practice, where the tools on a tool board are electrified to prevent unauthorized persons being tempted to take them. The shock they will receive as the tool is detached will usually cause it to fall from the hand which grasps it, and a considerable surprise and probable alarm is administered to the offender. To use this idea as a safeguard on a power press is both novel and interesting.

A guard should be made so that it will protect the worker against the possibility of his putting his hands in the danger zone from either side of the machine, as well as from in front, if it is to meet all the requirements of a guard. The guard shown in Fig. 6 meets this requirement while those illustrated in Figs. 1, 2, 3, 4 and 5 do not show that this condition has been met. A guard must not hamper the workman by preventing him from turning out the maximum number of pieces per day, and it should be so attached to the machine that it cannot readily be removed and not used. It should also consist of as few parts as possible. The guard shown in Fig. 2 is composed of a number of parts and is almost impossible for the operator to remove without spending considerable time; while Fig. 5 shows a guard which has very few parts and can easily be removed.

It cannot be said that any one of the preceding guards would meet all conditions under which a press may be used. It is a fact that with this class of machines very few of the guards are used continuously in the manufacture of one form or finished piece. It is more than likely that one machine will be used on different classes of work during a period of one year, and it has been found that each class of work would need its own special type of guard. On this account it is very hard for the employer to determine what make of guard he shall purchase.

* * *

The International Engineering Congress which meets in San Francisco, Cal., September 20-25, inclusive, will treat of engineering problems broadly. A symposium of subjects of great interest to all engineers is that on materials of engineering construction. The list of topics that will be treated in this section are as follows:

1. Timber.
2. Preservative Treatment of Timber.
3. Substitutes for Timber in Engineering Construction.
4. Brick in Engineering Structures.
5. Clay Products in Engineering Structures.
6. Probable and Presumptive Life of Concrete Structures made from Modern Cements.
7. Aggregates for Concrete.
8. Slag Cement.
9. Waterproof Concrete.
10. Cements containing Additions of Finely Ground Foreign Material.
11. Economics of the World's Supply of Iron.
12. The Life of Iron and Steel Structures.
13. The Employment of Special Steel in Engineering Construction.
14. The Place of Copper in the Present Engineering Field, and the Economics of the World's Supply Thereof.
15. Alloys and Their Use in Engineering Construction.
16. Aluminum in Engineering Construction.
17. The Influence of the Testing of Materials upon Advances in the Designing of Engineering Structures and Machines.
18. Cement Testing.
19. Testing of Metals.
20. Testing Full-sized Members.
21. Proof Testing of Structures.

Further information may be obtained from W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

METHOD OF CALIPERING A FIVE-FLUTED TAP

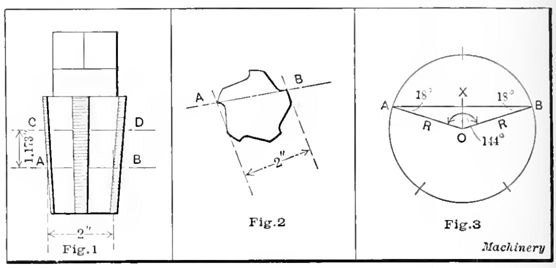
BY JOHN T. ENWRIGHT*

It is often necessary—especially in boiler work—to fit plugs by the size indicated by chalk on a five-fluted tap. For this purpose, the inside of the hole to be tapped is covered with chalk which marks the depth to which the tap has penetrated. When a tool with an even number of flutes is used, the required size for the plug can be taken directly from it. In the case of taps with an uneven number of flutes, however (generally five) a computation is required to secure the desired dimension. The method of making this computation is explained by the following.

The first step is to caliper the tap on the cutting edges at the point which marks the extent to which it has entered the hole. This would be at the line AB in Fig. 1. The dimension so obtained is multiplied by the constant 0.0489 and the product divided by the taper of the tap in inches per inch. The next step is to measure a distance AC parallel to the axis of the tap and then caliper the diameter at this point. The measurement of the tap on the line CD represents the size of the hole which is tapped out when the tool enters to the depth marked by the line AB. The distance AC measured parallel to the axis of the tap is determined by the following formula:

$$AC = \frac{\text{Diameter} \times 0.0489}{\text{Taper in inches per inch}}$$

To illustrate the method of using this formula, the following problem will be carried through. Consider a case in



Figs. 1, 2 and 3. Diagrams showing Method of deriving the Formula

which the dimension of the tap calipered on the line AB is 2 inches and the taper of the tap 1/12 inch per inch. The required distance AC at which the tap must be calipered to obtain the true size of the hole is then found to be

$$AC = \frac{2 \times 0.0489}{\frac{1}{12}} = 1.173 \text{ inch}$$

The method of deriving the formula for the distance AC is as follows: Referring to Fig. 3, AB corresponds to AB in Figs. 1 and 2. The triangle AOB is an isosceles triangle in which the angle $AOB = 2/5 \times 360 = 144$ degrees. The angle $OAB =$ angle $ABO = \frac{1}{2}\ (180 - 144) = 18$ degrees. $OA = OB = R =$ radius of the tap. The next step is to bisect the angle AOB so that $AX = BX$. By construction, the angle OXA is a right angle.

$$\frac{XA}{R} = \cos 18 \text{ degrees}$$

$$XA = R \times \cos 18 \text{ degrees} = R \times 0.9511$$

$$AB = 2\,R \times 0.9511 = D \times 0.9511$$

The difference between the true diameter of the five-fluted tap and the size calipered on the line AB is found to be:

$$2\,R - 2\,R \times 0.9511 = 2\,R \times 0.0489 = D \times 0.0489$$

The product of the diameter D by 0.0489 is divided by the taper of the tap in inches per inch, in order to obtain the distance AC which must be measured parallel to the axis in order to determine the location of the line CD on which to caliper the tap to determine the size of the hole that it will produce when it enters the work to the line AB.

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SAFETY AS APPLIED TO GRINDING WHEELS*†

CAUSES OF GRINDING WHEEL ACCIDENTS AND MEANS OF AVOIDING THEM

ALL rapidly moving machine members present possibilities for the occurrence of serious accidents, and in view of the fact that it is necessary to operate grinding wheels at such speeds that the cutting surface travels at about a mile a minute, more than usual precautions must be observed in their operation in order to provide for the safety of the operators. These precautions may be sub-divided under two headings; first, to eliminate as far as possible, all causes which are known to have been responsible for grinding wheel breakages; second, to provide adequate means of protection for men and property in event of a wheel breaking. Reputable manufacturers of grinding wheels test each wheel before it is shipped. This is done by rotating the wheel at a speed which subjects it to between three and four times the centrifugal force that would be exerted when operating under average conditions. The wheel is then marked by the inspector to show that he has found its condition satisfactory.

The design and condition of grinding machines as well as the foundations on which they rest, are very important factors in the prevention of accidents, as such accidents can often be traced to these causes. The modern grinding machine with its heavy spindle and massive base, and its long closely adjusted bearings, is responsible for the elimination of many accidents which would otherwise occur. Grinding machines should be kept in good condition and they should be mounted on a rigid foundation. Machines used for rough work, such as snagging castings, are frequently subjected to severe abuse and it is significant that statistics show that the majority of grinding accidents occur in foundries where such conditions exist.

A somewhat unusual cause of breakage of grinding wheels is that resulting from undue heating of the wheel. In such cases this is usually due to the wheel becoming glazed so that excessive pressure is necessary to maintain the desired rate of production. Where this condition exists, the wheel is unduly heated at its periphery and this leads to uneven expansion, resulting in rupture. This danger is eliminated by keeping the wheel properly dressed at all times. Another source of danger arises from the possibility of damaging wheels used in snagging castings. Where the casting is suspended by a chain hoist as shown in Fig. 1, the operator may allow the casting to strike the side of the wheel with sufficient force to either break it directly or weaken it so that it will break later on.

The relative merits of safety flanges and safety hoods were discussed in a previous paper (see MACHINERY, January, 1914). While one of these measures is very necessary for use on all grinding wheels, the observation of suitable precautions in mounting the wheels is a most important factor in preventing them from breaking. Fig. 2 illustrates an example of dangerous mounting. The outside flange was lost and the operator substituted a small washer in its place. This produces such a severe strain on the wheel that it either breaks immediately upon attaining the operating speed or soon after it is put to use. Fig. 3 shows how an accident was caused in a factory in the Middle West. The operator had a piece to grind that was of such a shape that the outside flange on the wheel interfered with the work. Without obtaining permission from anyone, he removed the nut and the outside flange, and then obtained a rough forged washer in which—for some unknown reason—he was very careful to hammer a lead bushing from an old grinding wheel. He then mounted the wheel as shown. The man lost his life from the breakage which resulted when he attempted to work with the wheel in this condition.

Causes of Grinding Wheel Accidents

1. *The wheel receives a blow from the side.*
2. *The work-rest is improperly adjusted.*
3. *The wheel is unduly heated by forcing the work excessively.*
4. *The operator is careless in handling heavy work, thus causing the wheel to be damaged.*
5. *The wheel is mounted between flanges of unequal size.*
6. *The flanges have an uneven bearing against the wheel.*
7. *The wheel is running out of truth.*
8. *The inside flange is loose on the spindle.*
9. *The spindle is too tight a fit in the hole in the wheel.*
10. *The flanges are not provided with the necessary relief to assure an even bearing.*
11. *The nut on the spindle is tightened excessively.*
12. *The washers are either too small or omitted.*
13. *The spindle and spindle bearings become overheated.*
14. *The wheel is run at too high a speed.*
15. *The wheel is mounted in such a way that the nut on the spindle works loose.*

Methods of Avoiding Grinding Wheel Accidents

1. *The use of protection hoods or safety flanges to provide for the safety of the operator in the event of the wheel breaking.*
2. *The use of wheels which have been subjected to a speed test by the grinding wheel manufacturer to discover any defects which may exist.*
3. *Testing each wheel before it is mounted on the grinding machine ready for use.*
4. *The use of machines of the necessary rigidity and the mounting of such machines on rigid foundations.*
5. *The exercise of the necessary supervision on the part of the superintendent or foreman to be sure that none but wheels of the proper size are used on each machine, and that these wheels are driven at suitable speeds.*
6. *The use of goggles and spark shields to protect the eyes of the operators from injury.*

In order to avoid accidents resulting from broken wheels, be sure that the flanges used are of equal size and that their diameter equals at least one-half of the diameter of the wheel. It is also highly important for the flanges to have an even bearing on the wheel. Where the bearing is uneven, it is usually caused by the flanges being damaged to such an extent that they lose their original shape. In rare instances, flanges have been used which were not machined, but were taken right from the casting in the sand. Such practice brings unequal stresses to bear on the wheel and a breakage is the logical result. The wheel must also run true, in order to avoid subjecting it to uneven strains. When it does not run true, it may be due to the hole in the wheel being much too large for the size of spindle, or to the fact that the flanges do not hold the wheel properly. This, in turn, may be caused by the nut becoming wedged on the spindle before it has been drawn up to the flanges, due either to dirt in the thread of the spindle or in the thread of the nut. The man mounting the wheel gets the impression that he has properly drawn up the flanges against the wheel, when such is not the case. Another cause for wheels running out of true is directly traceable to failure to give proper attention to the machine bearings. The bearings become highly heated, the bearing metal flows, a heavy brake action is produced on the spindle, and when the machine is stopped the momentum of the grinding wheel is sufficient to loosen the mounting. When the wheel is started again the nut will not automatically tighten and the wheel will be running under a dangerous condition.

Wheels should not be allowed to remain partly submerged in water, because they will be badly out of balance when started. Some people seem to believe that water has a detrimental effect on grinding wheels. This is not true of modern grinding wheels; even those bonded by means of silicate bonds are made waterproof. Another noteworthy precaution is to have the inside flange either keyed or pressed on the

* For other articles on the safeguarding of grinding machines published in MACHINERY, see also "Grinding Wheel Protection Devices," by R. G. Williams, January, 1914; "Guards for Polishing Wheels," November, 1913; "Prevention of Industrial Accidents," by F. R. Hutton, April, 1912; "The Bursting of Emery Wheels," July, 1903; and "Fastenings for Emery Wheels and Grindstones," December, 1902.

† Paper by R. G. Williams presented before the National Machine Tool Builders' Association convention, Worcester, Mass., April 24, 1914.

spindle. Accidents have been known to result from the work being rubbed against a loose inside flange, thus exerting a brake action on the flange, which in turn, caused the nut on the spindle to crawl. In this way, enough pressure was exerted on the wheel by the flanges to crush it.

An accident may result by having the wheel screwed on the spindle when the hole is too tight a fit. The illustration Fig. 4 shows the result when the hole is too small for the spindle. The lead bushing becomes deformed by the wheel being screwed on over the spindle, with the result that each flange only bears on the wheel for a small distance. The remedy for this is to make sure that the hole is of such size that the wheel will slide on the spindle easily. Fig. 5 shows a possible result from the use of unrelieved flanges. As an illustration, consider an instance where the operator exerts excessive pressure on the nut when mounting the wheel. This causes straight flanges to become slightly convex, as shown in the illustration, and concentrates the retaining pressure near the center of the wheel instead of distributing it uniformly throughout the area of the flanges. The remedy for such a situation is to have the flanges—either straight or beveled—relieved to such an extent that a bearing surface approximately 1/16 of the diameter of the flanges is left near the rim. By the excessive tightening of the nut, sufficient pressure can be set up between the wheel and the flanges to crush the structure of the wheel. It has been calculated that where the size of the spindle is 1½ inch in diameter, a man with a four-foot wrench can exert a pressure between the wheel and the flanges of over a ton and a half. The nut should not be tightened more than enough to hold the wheel firmly.

Washers of blotting paper or some other compressible material should be used between the wheel and the flanges. These tend to distribute the stresses set up when the flanges are tightened against the sides of the wheel. The washers should be somewhat larger than the flanges. It is possible for a small piece of metal to become caught in some way between the wheel and the flanges, which, if no compressible washer is used, will cause an excessive strain to be set up at this particular point when the flanges are tightened. The use of compressible washers in such an instance tends to distribute such unequal stresses. When the spindle becomes overheated, the heat is conducted to the lead bushing of the wheel, which may expand to a point where it causes the wheel to break. This danger can be readily overcome by proper attention to the bearings of the machine. Another possibility of accidents is due to the fact that a careless workman may so equip the machine that the revolutions per minute of the spindle is far too great for the particular size of wheel in use; or it may possibly be that through a foreman's desire to increase production, he speeds up the wheels so that they will cut faster. Again, where a machine is equipped with cone pulleys and the belt is loose, it is possible for the belt to automatically shift to a smaller step and thus greatly increase the speed of the grinding wheel. Sometimes ignorant workmen will mount large wheels on a machine which is equipped and intended for very much smaller ones, thus creating a dangerous condition.

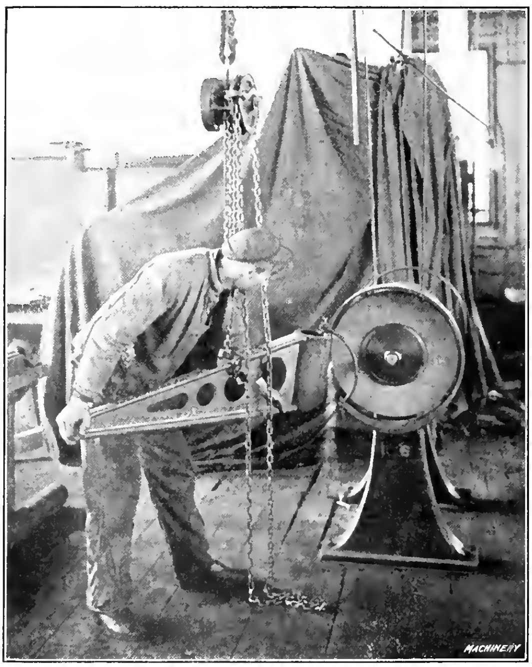


Fig. 1. Snagging a Heavy Casting supported by a Chain Hoist

TABLE OF SMALLEST SPINDLES FOR VARIOUS SIZES OF GRINDING WHEELS

Diameter of Wheel	Maximum Thickness of Grinding Wheels in Inches													
	1	1¼	1½	1¾	2	2¼	2½	3	3½	4	4½	5	5½	6
8	¾	¾	¾	¾	¾	¾	1	1	1	1	1¼	1¼	1¼	1¼
9	¾	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼
10	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1½	1½	1½
12	¾	1	1	1	1	1¼	1¼	1¼	1½	1½	1½	1½	1¾	1¾
14	1	1	1	1¼	1¼	1¼	1¼	1½	1½	1¾	1¾	1¾	1¾	1¾
16	1	1¼	1¼	1¼	1½	1½	1½	1¾	1¾	1¾	1¾	1¾	1¾	2
18	1¼	1¼	1¼	1½	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2
20	1¼	1¼	1½	1½	1¾	1¾	1¾	1¾	1¾	2	2	2	2	2¼
22	1¼	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼
24	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼	2½
26	..	1¾	1¾	1¾	1¾	2	2	2	2¼	2¼	2¼	2¼	2½	3
28	..	..	1¾	1¾	2	2	2	2	2¼	2¼	2¼	2½	3	3
30	..	..	1¾	2	2	2	2	2¼	2¼	2¼	2½	3	3	..
32	..	..	2	2	2	2	2¼	2¼	2½	2½	3	3	..	..
34	..	..	2	2	2	2¼	2¼	2½	2½	3	3	..	..	..
36	..	..	2	2	2¼	2¼	2¼	2½	3	3	..	..	..	..

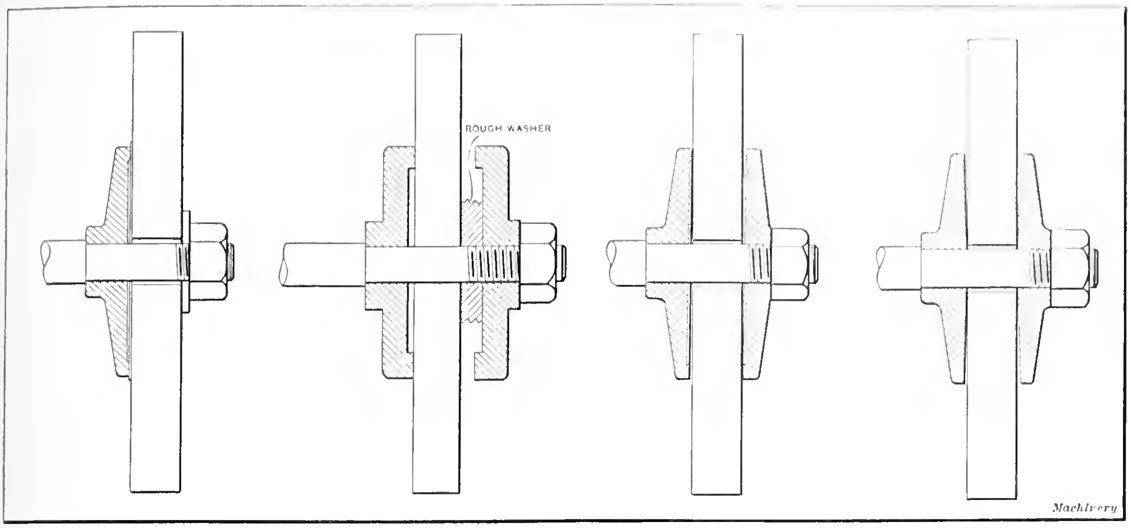
Machinery

Polishing stands are sometimes used for rough snagging work, with wheels which are much too heavy for this type of machine. Bench and floor types of grinding machines are usually designated by the size of the spindle on which the wheel is mounted. It is, therefore, a common practice to designate the maximum size wheel to be used on any machine by tabulating spindle sizes and wheel sizes, as presented in the above table. An accident may be caused by mounting a wheel so that the nut works loose, which will cause the wheel to run badly out of true. This can happen in three ways: 1. A machine is taken apart for repair and when set up the spindle is turned end for end from its original position. 2. The motor or shafting which drives the machine is changed so that it will revolve in the opposite direction from which it should. 3. When putting on a new belt, an unreliable workman may use a twisted instead of a straight belt. All of these conditions can be very easily remedied by a little care on the part of some responsible person. In addition, belt locking devices may be used, and so set in the base of the machine as to make it impossible to mount too large a wheel. To further guard against such mistakes it is good practice to have a special notice attached to each machine giving information as to the size of the wheel to be used, the number of revolutions per minute at which the wheel should be run and the class of work for which it should be used.

Exhaust Systems and the Use of Goggles

Laws in almost every country require the removal of dust from grinding. This necessitates the use of a hood, and if a hood must be used, it might just as well be strong enough to offer protection in case of the wheel breaking. A proper hood affords complete protection, which flanges cannot give; but in instances where a hood would interfere with the proper use of the wheel, flanges offer the next best method of protection. There are many satisfactory types of protection hoods on the market, the reason for more than one type being found in the variety of grinding operations.

There are several satisfactory designs of goggles for grinding, and every operator doing snagging work should be required to wear them. Since the particles cut off by grinding wheels are comparatively small, a heavy type of goggle is not necessary. Goggles should have side guards of wire or



Figs. 2 to 5. Examples of Defective Mountings that are likely to cause Accidents

leather, as particles coming from the side have been known to enter the eye. A glass spark shield which can be attached to the top of a protection hood is found very satisfactory where wheels are used intermittently, as in the case of a general purpose wheel in a machine shop. It is recommended that wire glass be used. Glass spark shields have not been found entirely satisfactory where wheels are used continuously, however, due to the fact that the glass soon becomes pitted from the heated chips of metal. Another form of protection from grinding wheel sparks is a device consisting of a piece of leather attached to the top end of a protection hood and extending down over the face of the wheel, a slot being cut in the leather of the approximate width of the grinding wheel.

Dressers

Grinding wheel dressers are sometimes the cause of accidents. If the work-rest is not properly adjusted there is a possibility of the dresser being caught between it and the wheel, and the revolving cutters sometimes break into pieces large enough to cause serious damage. A type of dresser is recommended which has a hood as an integral part of the handle, the hood serving to protect the user in case the cutters break. The ordinary type of dresser can be made more safe by attaching a thick guard of sheet iron over the cutters.

There is great need for the standardization of grinding wheel protection devices. This subject is to be taken up in the near future by the National Council for Industrial Safety and the National Machine Tool Builders' Association. These two organizations will consider all the important phases of this subject and endeavor to arrive at specifications which can be adopted as standard for protection devices used in connection with grinding wheels. In conclusion, it is gratifying to note that the efforts for safety as applied to grinding wheel operations are accomplishing results, in that the number of serious accidents is rapidly decreasing. We will always have a few unpreventable accidents, but until every preventable accident has become a thing of the past, we should strive for a better understanding and an improved use of the modern safety devices for grinding wheels.

* * *

PREVENTING MOISTURE FORMING ON WATCHMAKERS' EYE-GLASS

In certain branches of the machinist's trade, and especially in fine toolmaking, the use of a watchmaker's eye-glass is frequently required for long periods. It will be found that after the eye-glass has been in continuous use for a certain length of time—depending principally upon the temperature of the surrounding atmosphere—the lens becomes covered with mist on the side nearest the eye. This interferes with the use of the glass.

There are many good preparations on the market which can be rubbed on the lens to prevent this "fogging," but as they are more or less opaque, they are not to be recommended when accurate work is essential. A very simple and effective method which is found in use in some shops is to drill four equally spaced holes through the hard rubber shell about 1/8 inch back of the lens. A No. 54 drill is about right for this purpose. If this method is followed the eye-glass can be kept in the eye indefinitely without "fogging" the lens.

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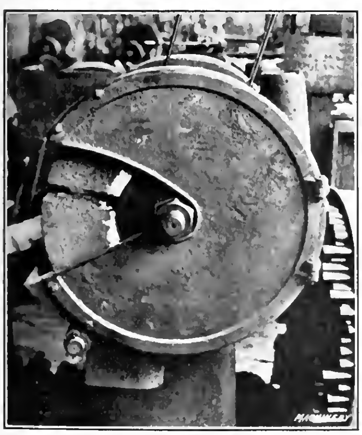

Fig. 6. An Efficient Type of Protection Hood used by the International Harvester Co.

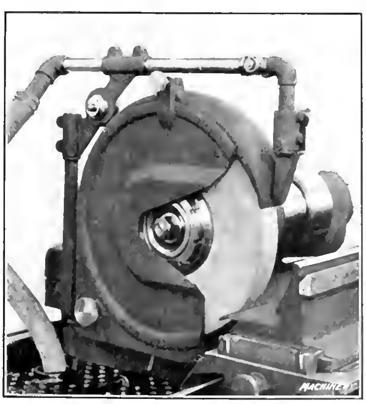

Fig. 7. Type of Protection Hood applied to Norton Grinding Machines with Satisfactory Results

Fig. 8. Same Type of Hood shown in Fig. 6, with End Cover swung back

THE VALUE OF A PATENT*

BY FORD W. HARRIS†

There are no questions in relation to patents more important than those which deal with their commercial value. Practically all patents are applied for with the idea of making profits, and the value of a patent is the one great question in which every inventor is interested. This article is intended to indicate how an approximate value of a patent may be arrived at. It may be said in the beginning that there is a popular misconception of the true meaning of the grant of letters patent. In the popular mind a patent is a licence for the inventor to build the thing disclosed in the drawing and the specification, and, further, a legal bar to prevent others from building, making or using that thing. These, to the popular mind, are the purposes of a patent—first, to allow the inventor to use, and second, to prevent everyone else from making or using the invention.

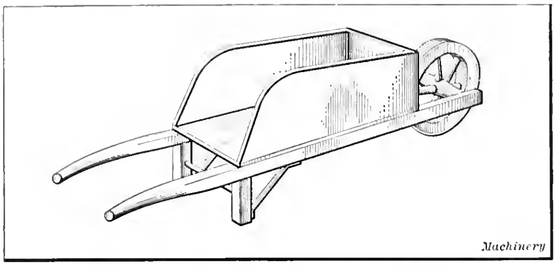

Fig. 1. Wheelbarrow as covered by Jones' Patent

The first of these, that is, the license purpose, is not the intention of the patent. The law does not contemplate licensing an inventor. It merely contemplates giving him a monopoly; that is, he can stop others from making, renting or using the invention claimed in his patent, but whether he can do so himself or not depends on several things. This and the points to follow can best be illustrated by specific cases. For example, let us assume that no one has ever invented a common wheelbarrow and that Jonas Jones has a patent on it, as illustrated by Fig. 1. Let us further suppose that he has claims as follows:

1. A barrow comprising a load-holding means, wheel means at the forward end thereof, and handle means at the rear end thereof.
2. A barrow comprising a load-holding body, a wheel supporting the forward end of said body, legs supporting the rear end of said body, and handles by which the rear end of said body may be raised.
3. A barrow comprising two handle members having handles formed on one end thereof, a wheel supported between the other ends of said handle members, a rectangular body supported on said handle members, and legs extending donwardly from the said handle members.

Let us further suppose that Jones was clearly entitled to these claims and that his invention is the very first that even remotely resembles a wheelbarrow. In this case the government has given him a broad patent and one that is difficult to avoid infringing. Claim (1) is very broad, covering as it does the combination of any sort of a load-holding means, any sort of wheel means at the forward end of the load-holding means, and handle means at the other end of the load-holding means. While it could be avoided by placing the wheel and the handles on the same end or by omitting one of the three elements named, it is evident that if this is done we will not have a wheelbarrow. It will be noted that this claim does not specify any legs. Nevertheless it cannot be avoided by adding legs. In other words, if the three elements specified in the claim are used for the same purpose and in the relation specified in the claim, the claim cannot be avoided by adding another element.

Let us now suppose that Bronson Brown invents the wheelbarrow shown in Fig. 2 after Jones has obtained his patent. The patent office would grant claims about as follows:

1A. A barrow comprising a saucer-shaped metal load-holding means, wheel means at the forward end thereof, and handle means at the rear end thereof.

2A. A barrow comprising a load-holding means, wheel means at the forward end thereof, hinged handles at the rear end thereof, and locking braces for said handles.

To the average person it would seem that Bronson, having a patent which describes and claims a certain type of wheelbarrow, should be entitled to make, use and sell that wheelbarrow. As a matter of fact the issue of the patent has not affected Bronson's rights to make, use and sell in the slightest degree. His invention contains all the elements of the first claim of Jones and clearly infringes it. In other words, he has absolutely no right to make it until the Jones patent runs out.

His patent simply grants him a right to prevent others from making the structure claimed. An examination of Claim (1A) discloses that it is like Claim (1) except that it specifies a "saucer-shaped metal load-holding means." The claim grants to Brown the sole right to use such a load-holding means. Now Jones can prevent Brown from making any kind of a wheelbarrow, but Brown can prevent Jones from using his peculiar type of load holder. The patent to Jones is broad or generic, while the patent to Brown is narrow or specific. If no patent had ever been granted to Jones and the wheelbarrow shown in Fig. 2 was the first of its class Claim (1) could have been granted thereon as well as upon the wheelbarrow shown in Fig. 1. If, however, Brown's attorney were incompetent, and asked only for Claims (1A) and (2A), these would be all the claims Brown would get. In this case any one could build the wheelbarrow shown in Fig. 1, as this neither has the "saucer-shaped load-holding means of Claim (1A), nor the "hinged handles" of Claim (2A). In this case Brown would have lost a valuable invention due to having a poor attorney.

In the same manner Claim (3) of Jones patent specifies "a rectangular body supported on said handle members." If Jones had no broader claim than this, he could not stop Brown from making a body not rectangular, nor could he stop any one from doing this or from making a body supported otherwise than on the handle members. In other words, if Jones had only Claim (3) he would have a narrow, specific patent in the place of a broad generic one.

A patent covers what it claims, not what it shows. Every claim is a patent in itself and may be sued on and adjudicated

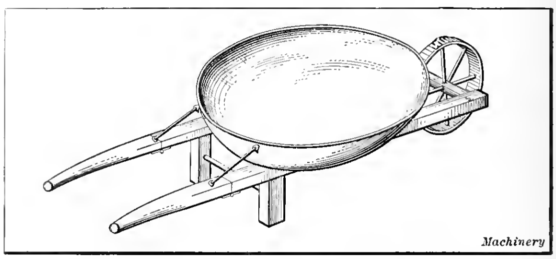

Fig. 2. Wheelbarrow covered by Brown's Subsequent Patent

quite apart from the remaining claims. Each claim consists of a combination of several elements modified by limiting clauses. Omitting one of the elements from a structure avoids that claim so long as an equivalent element is not added in its place. This is the general theory of claims.

Claims are, however, interpreted by the courts in the light of what has gone before. If, for example, Jones had antedated Brown by several years, and was clearly the first inventor of any sort of a wheelbarrow, the courts would not attach much importance to the "rectangular" in Claim (3). It might be argued that this distinction was immaterial and that the word had slipped in inadvertently. If, however, wheelbarrows like Fig. 2 were already known, it would be evident that Jones must limit himself to rectangular bodies to have a valid claim, and that the word "rectangular" would be essential and not inadvertent. The courts will also consider various collateral circumstances, such as the relation of Jones and Brown and the utility and value of the invention

* See MACHINERY, April, 1914, "Patents—Some Essential Facts for the Engineer," and other articles there referred to.
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at issue. For this reason the wording of claims is not always conclusive, but in general the rule is as stated.

Having now a certain patent, we wish to know its value. Let us suppose that Brown's patent is to be examined to determine its value, and let us further suppose that we know nothing of Jones' wheelbarrow. How shall we arrive at the value of the patent to Brown?

The first thing is to determine the prior state of the art at the time Brown applied for a patent. This can be done by having the patent office make a typewritten copy of the file-wrapper and contents, and send them to us with the references to prior patents found and cited by the examiner in the prosecution of the case. We can then carefully review the case, see what claims Brown made originally and what claims he had to cancel and abandon. We can see further just what the prior patents were with which he had trouble. If the case is very important we may send for file-wrappers and contents on some or all of these prior patents and study them. Further, we would go ourselves to the patent office and search the records for patents that the examiner did not regard as pertinent or overlooked in his search. This would all take time, but would result in a clear conception as to exactly what Brown was entitled to when he applied.

The claims in the Brown patent are then studied to see what the elements of the combination are, and to see if one or more cannot be omitted and yet have a commercial device. If one of these elements is not absolutely essential or if a limiting clause is present which may be omitted without hurting the article it is sought to manufacture, it may be at once said that the patent is of little or no value. Many patents are valueless on their face due to limiting clauses therein or to elements that are not essential. Many others are valueless because they are dominated by earlier and broader patents. The search in the patent office and the study of the data collected should disclose these broader patents if any exist. It may be said, however, that there is no sure way to find absolutely all the prior patents that may affect the right to manufacture an article. This is due partly to the fact that a claim for a collection of elements used, for example, in a wheelbarrow, may be found in a wagon, a railroad car or an aeroplane patent. You may be sure that you cannot manufacture an article due to a prior patent, but you can never be sure you are not infringing the rights of some one else.

Strictly speaking, the only way to determine a patent's value is to submit it to a lawsuit. After a patent has been passed upon by a Federal court and has stood the test of litigation its value may be said to be fixed. This is very expensive and slow, and no business man wants to wait for such action by the courts. There is no reason, however, why a competent patent lawyer cannot arrive very closely at a patent's value at a very moderate expense. Certainly, no one should pay for patent rights or embark in a business based wholly or in part on patent rights without first getting such an opinion.

* * *

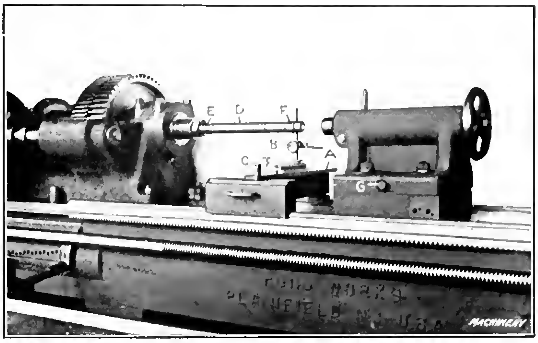
LINING UP ENGINE LATHE HEADSTOCKS AND TAILSTOCKS*

BY ALFRED SPANGENBERG†

The first requirement in aligning engine lathe headstocks and tailstocks on the beds is to determine the horizontal alignment, both as regards parallelism with the ways on the bed and relative height between the headstock and tailstock spindles. This is owing to the fact that if any errors are discovered which exceed the allowable limits of variation, the part at fault must be removed and either filed and scraped to bring it true, or machined if the circumstances warrant such a procedure. By the usual method of making this test, where the indicator is carried in a fixture fitting the bed vees or clamped in the regular carriage toolpost, it becomes necessary to first align the headstock and, tailstock spindles sideways; otherwise, the line of motion of the indicator point in traveling from one collar to the other on the test-bar would not be parallel with the axis of the test-bar and the readings would be false.

A fixture that permits the testing of horizontal alignments regardless of the errors sideways, thereby saving much time, is shown in the accompanying illustration, which also shows a headstock and tailstock in position on the lathe bed ready for the test. As will be seen, the fixture fits the V-tracks on the bed and is provided with a plane surface *A* which is scraped true to support the Brown and Sharpe indicator *B*. The idea is to pass the indicator point under the test-bar in a crosswise direction, the maximum reading indicating the true height. Clamp *C* is used to clamp the indicator on the fixture when testing alignments sideways.

The method of "lining up" is to place the test-bar *D* in the taper hole in the headstock spindle, and with the indicator set as shown, the spindle is revolved slowly by hand to test the concentricity of the taper hole. A chalk mark is then



Fixture for aligning the Headstock and Tailstock, which permits of making Height Tests regardless of Sidewise Alignment

made on the test-bar and a corresponding mark on the spindle nose to denote a point that is a mean between the "high" and "low" points on the bar. All subsequent readings of the test indicator are taken from this point. This test is obviously necessary, since the bar is particularly likely to run out at its free end due to a number of conflicting elements, the error in any one of which may be infinitesimal. The fixture is now moved along to collar *E*. The indicator is passed under the bar in a crosswise direction and the indicator dial is set to zero at the highest reading. A similar reading is taken at collar *F* which shows the error as regards parallelism with the vees of the bed. The bar is then moved over into the tailstock spindle hole and readings are taken on both collars in order to test its parallelism and the relative height of both spindles. Each reading is properly noted on a suitable form, and if the errors are within the permissible limits of variation, the headstock is set parallel with the vees sideways and the dowel pin holes are reamed.

The setting of the headstock sideways is accomplished by again placing the test-bar in the head spindle and indicating on the side of the bar, the clamp *C* being utilized to hold the indicator rigidly. As was previously explained, the spindle was moved a quarter turn before this test so as to indicate on the same point on the bar. The indicator point is, of course, set at a height the same as that of the spindle axis, as nearly as the eye can judge, and at the same time the dial is set to read zero. After the head is set parallel and pinned, the test-bar is moved over into the tailstock spindle hole, and having adjusted the set-over screw *G* to bring this spindle in line with that in the headstock (the reading being zero, the same as before) the tailstock spindle is tested for alignment sideways.

In setting the indicator at the starting point, care should be taken to make the maximum movement of the indicator needle not exceed 0.005 inch above its normal position, as otherwise the spring of the dial supporting arms is likely to cause false readings, especially if there is considerable variation in the different readings.

* * *

The city of Sheffield, England, has 400 concerns engaged in the manufacture of steel.

* For additional information on this subject, see also "Assembling a 24-inch Engine Lathe," published in MACHINERY for November, 1909; and "Repairing Lathes and Milling Machines," published in July, 1911.

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DYNAMICS OF GAS ENGINE CAMS*

A CONSIDERATION OF THE MUSHROOM TYPE OF VALVE LIFTER

BY M. TERRY†

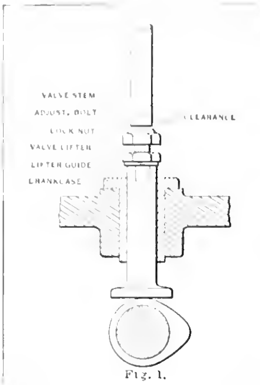

Fig. 1. Valve Gear with Mushroom Type of Lifter

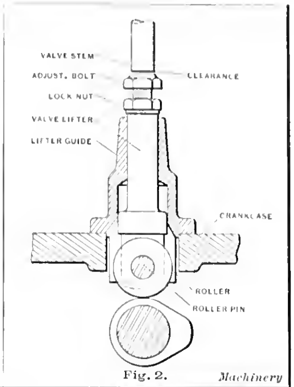

Fig. 2. Valve Gear with Roller Type of Lifter

WHILE this article bears the same general title as those that appeared in MACHINERY for November and December, 1912, it is entirely independent of them, as it deals with a different type of cam. For the benefit of the readers who have missed the former series, the article here presented will be made as clear as possible without going into minute details and repeating what has already been published.

What is generally known as the mushroom type of valve lifter, used for actuating the valves of a gasoline engine, is shown in Fig. 1; and the more popular form of lifter—known as the roller type—is shown in Fig. 2. The main difference between the two types lies in the fact that the valve gear equipped with the mushroom lifter possesses fewer parts and requires less machining, piece for piece, than does a similar valve gear equipped with the roller type of lifter; in short, the former is cheaper to build. Its chief disadvantage lies in its noisy operation, and this characteristic—said to be inherent—has prevented its general introduction on pleasure cars, particularly those of the type that make their appeal to the buying public through their mechanical perfection rather than their low selling price. This statement is not made with the object of condemning the mushroom type of lifter; on the contrary, when we become acquainted with some of its peculiarities, a proper place will be found for it, where from a mechanical point of view it will be on a par with the roller type, and considered from a commercial standpoint will even be in the lead.

We shall now proceed to design a cam-shaft to meet the following requirements: Base circle of cam, 1.000 inch in diameter; cam lift, $3/16 = 0.1875$ inch; clearance between valve and valve lifter, 0.006 inch; timing, as per diagram shown in Fig. 3. All these conditions govern the shape of the two cams, and we shall presently commence with the inlet cam. Referring to the timing diagram, Fig. 3, we observe that the inlet valve is open for 200 degrees of the crankshaft circle. Since the inlet cam which directly actuates this valve is mounted on the half-time shaft, its active angle is 100 degrees. To this we must add twice the clearance angle to compensate for lost motion (due to clearance between the valve stem and the valve lifter) on the up and down strokes. In the mushroom type of valve gear, the clearance angle is determined entirely by the base circle of the cam and the radius of the arc AB, as shown in Fig. 4. The latter, in its turn, is governed by the lift of the cam, its active angle and also by its clearance angle. The relation being mutual and rather complicated, the writer has developed a very simple cut-and-try method which need never involve more than one trial.

In Fig. 4, the cam and its lifter are shown in a position where the latter is ready to rise. When in this position, the arc AB is tangent to the line MN and also to the base circle of the cam at the point A. The center from which the arc AB can be struck to satisfy these conditions must obviously lie on the vertical line AH. The active angle of the cam being 100 degrees, its center line cannot be less than 50 degrees from the line OA; as a matter of fact, the true angle made by the center line of the cam with this line OA is 50 degrees plus the clearance angle. Assuming that the clearance angle is 2 degrees, we draw our preliminary center line OF 52 degrees from OA. Next strike the arc CD with a radius of 0.6875 inch $(0.500 + 0.1875)$ which limits the lift of the cam; arc CD intersects OF at E. Now the arc AB should intersect our assumed center line OF at a point F such that OF is greater than OE. The reason for this is that if OF were less than OE, we would fail to obtain the required lift; and if OF were equal to OE, we would succeed in maintaining the required lift but the cam would terminate in a sharp ridge, which would be a poor design. Also, for the sake of quiet action (as will be proved later on) the radius of the arc AB must be as small as possible. Limited by these two conditions, there is left only a very small range through which the value of this radius can vary, and we select the nearest even dimension, namely 2½ inches.

As the cam revolves in a counterclockwise direction, the lifter rises and the point of contact between MN and AB moves to the right of A; at the same time, the center H of the arc AB describes an arc HH_1, with O as its center. But as long as MN remains tangent to AB, the distance between MN and H remains constant, namely 2½ inches, and hence the rise of the valve lifter at any instant must be equal to the rise of H above the horizontal line HI. If the lifter rises the distance MM_1, or 0.006 inch (clearance), H moves to a new position H_1, such that GH equals 0.006 inch; and the cam,

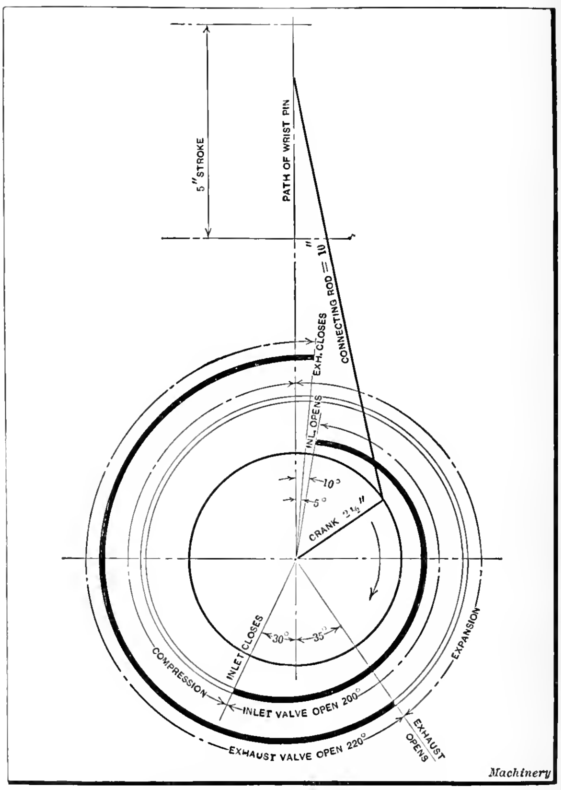

Fig. 3. Timing Diagram for the Cams

* For additional information on this subject see "The Valve Problem on Gasoline Engines," published in the March, 1914, number of MACHINERY, and other articles there referred to.

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in the meanwhile, has turned through an angle α, which obviously is our clearance angle.

$$\cos \alpha = \frac{1.994}{2.000} = 0.997.$$

$$\alpha = 4 \text{ degrees } 30 \text{ minutes}.$$

The real center line of the ram is OE_1, which makes an angle of 54 degrees 30 minutes with OA and the total included angle of the inlet cam is 109 degrees as shown in Fig. 6. The common practice in regard to the fillet is to place its center on the center line of the cam, and our next problem consists in accurately determining the radius of the fillet which will be tangent to both AB and CD and whose center lies on OE_1. From Fig. 5 we find:

$OH = 2.000$ inches $= X$.

$OO_1 = 0.6875 - S$ inch $= Y$.

$O_1H = 2.500 - S$ inch $= Z$.

angle $HOO_1 = 125$ degrees 30 minutes $= \theta$.

$$\cos \theta = \frac{X^2 + Y^2 - Z^2}{2XY}.$$

cos 125 degrees 30 minutes = cos $(90° + 35° \; 30') = -\sin 35$ degrees 30 minutes $= -0.5807$.

$$\text{Hence } \frac{Z^2 - X^2 - Y^2}{2XY} = 0.5807.$$

Substituting actual values for X, Y and Z, we obtain

$$(2.500 - S)^2 - (0.6875 - S)^2 - 4 = 0.5807 \times 2 \times 2(0.6875 - S)$$

$$6.25 - 5S + S^2 - (0.4726 - 1.375S + S^2) - 4 = 1.5968 - 2.3228S.$$

By adding, subtracting and transposing we get:

$$1.3022S = 0.1806.$$

$$S = \frac{0.1806}{1.3022} = 0.139 \text{ inch}.$$

The object of determining the radius of the fillet in thousandths of an inch is to enable the toolmaker to form an accurate templet with the help of which he shapes the first master cam. The templet is shown in Fig. 8; in laying this out, the distance OO_1 must be given in thousandths of an inch, and this, of course, is impossible unless the radius of the fillet is accurately determined. The fillet hole is drilled first—in this case—with an under sized 9/32-inch drill; next, the base circle hole is drilled, and finally the remaining metal is removed by filing.

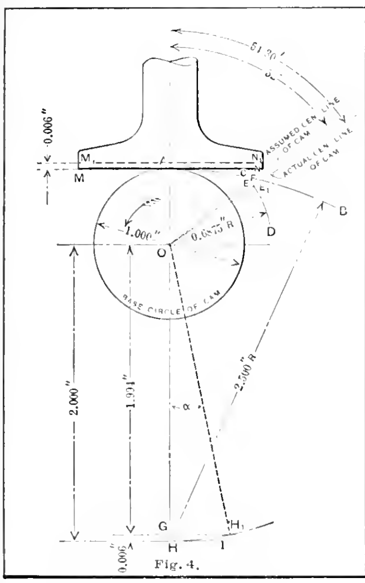


Fig. 4. Method of determining the Clearance Angle

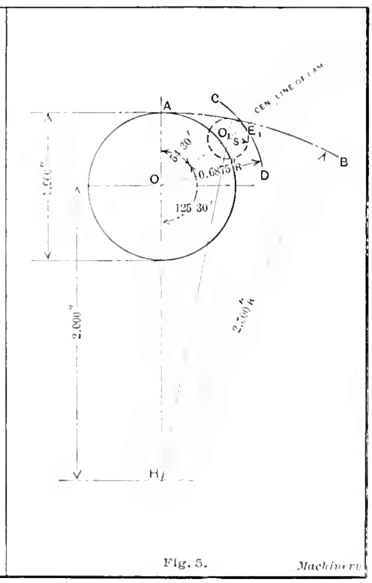


Fig. 5. Method of determining the Radius of the Fillet

The exhaust cam is generally made up of the same arcs as the inlet cam, except that, being wider, it possesses a dwell—amounting in this case to 10 degrees—as shown in Fig. 7. Considerable gain, so far as quietness of operation is concerned, may be secured by taking advantage of the wider angle of the exhaust cam for the purpose of shortening the radius of the arc that controls the clearance angle. It is evident from Fig. 4 that the shorter the radius of the arc AB, the greater is the clearance angle α for a given amount of backlash between the valve stem and the valve lifter; and it will be proved later on that, other things being equal, the greater the clearance angle for a given amount of backlash,

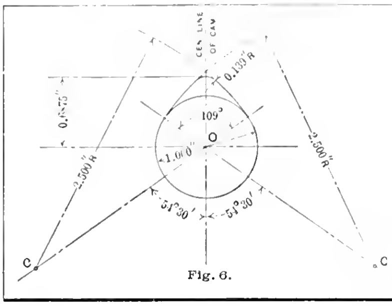


Fig. 6. Method of laying out the Inlet Cam

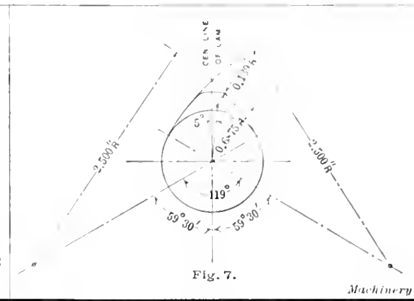


Fig. 7. Method of laying out the Exhaust Cam

the quieter is the valve gear. This principle has been pointed out in the analysis of the roller type of valve gear ("Dynamics of Gas Engine Cams," engineering edition of MACHINERY, November and December, 1912) and it applies equally well to the mushroom type.

Spacing of Cams

Our next problem is to space the inlet and exhaust cams that operate the same cylinder so as to secure the succession of events prescribed by the timing diagram shown in Fig. 3. The Otto cycle consists of four strokes of the engine, generally considered as taking place in the following order: First, suction or inlet stroke; second, compression stroke; third, expansion stroke; and fourth, exhaust stroke. Any suction stroke follows immediately after the exhaust stroke of the preceding cycle; or, to put it in other words, the action of the exhaust cam immediately precedes that of the inlet cam, which is also evident from Fig. 3. A simple graphical method for spacing the exhaust and inlet cams is shown in Fig. 9. With the cam-shaft revolving counterclockwise, we select the horizontal line OA for the center line of our exhaust cam. Fig. 3 calls for 220 degrees of exhaust valve opening; the active angle of the exhaust cam mounted on the half-time shaft will be 110 degrees, and, hence, the "exhaust opens" line OB lies 55 degrees ahead of OA. Again, according to Fig. 3, the "inlet opens" and "exhaust opens" lines are 225 degrees apart; hence, in Fig. 9, OB is 112 degrees 30 minutes ahead of OC. The active angle of the inlet cam being 100 degrees, its center line OD is 50 degrees behind OC. This gives us 107 degrees 30 minutes for the angle between the center lines of the inlet and exhaust cams operating the same cylinder. Fig. 10 is a diagrammatic end view of the cam-shaft designed for a four-cylinder engine; it shows the proper arrangement of the four sets of cams that would enable the engine to fire as indicated, *viz.*, cylinders 1, 3, 4 and 2.

Fig. 11 is what may be properly termed the "broadside" view of the cam-shaft. It shows the usual arrangement of cams along the shaft and the supporting bearings. The size of the center journal might be a source of wonder to the uninitiated; the reason for this lies in the fact that when assembling the cam-shaft in the motor, four of the eight cams must pass through the center bearing—hence, the size of the

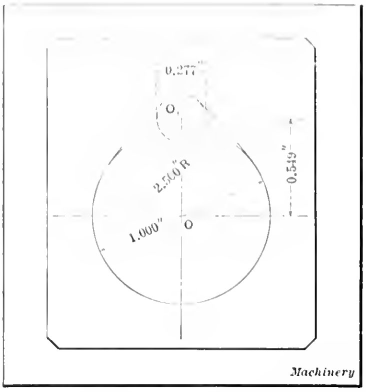


Fig. 8. Templet for the Inlet Master Cam

latter. The cam-shaft shown in Fig. 11 is a one-piece forging, with the cams forged integral with the shaft, which is almost the universal practice today.

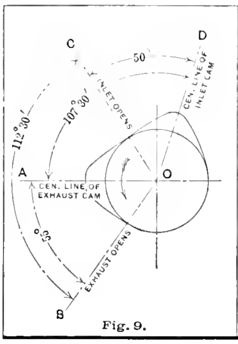
Clearance Angle on the Roller Type of Valve Gear

Fig. 12 is a diagram used for determining the clearance angle on the roller type of valve gear. The proportions are those commonly used, namely, 1 inch diameter for the roller and 1 inch for the base circle of the cam. The cam and its roller are shown in a position where the latter is just on the point of rising, and $OC = 1.000$ inch. When the backlash is closed, the distance between the cam and roller centers is 1.006 inch. The cam, in the meantime, has turned through the angle COC_1 which is our clearance angle a.

$$\cos COC_1 = \frac{OC}{OC_1} = \frac{1.000}{1.006} = 0.994.$$

$$a = 6 \text{ degrees } 15 \text{ minutes}.$$

We shall use this particular valve gear later on for the purpose of comparing it with the mushroom type. Unfortunately, such a comparison cannot be fair to either valve gear.



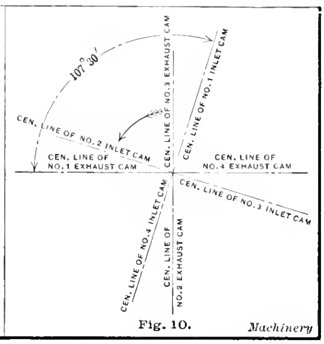


Fig. 9. Method of spacing Inlet and Exhaust Cams

Fig. 10. Diagrammatical End View of a Four-cylinder Engine Cam-shaft

There are so many points of difference between the two types that it is impossible to bring them, figuratively speaking, to the same denominator, as we have done in the preceding series when comparing a tangential and a uniformly accelerated and retarded motion cam operating absolutely the same type of valve gear. Nevertheless, such a comparison will help us to realize what we can expect from either type when built along conventional lines and operating under similar conditions.

Origin of Noises

It has been conclusively proved in the former series that the noise produced by the valve gear is wholly due to the clearance between the valve stem and the valve lifter. The instant this backlash is closed, the valve stem is at rest, while the valve lifter possesses a definite velocity. This state of things results in an impact which is repeated on the down stroke when the velocity of the valve is suddenly checked by the valve seat. Simple observation tends to show that noise increases very rapidly with the speed of the engine, and, hence, with the impact of the various parts of the valve gear. Impact may be defined as the instantaneous transferring of energy from one body to another; the greater the energy stored in the moving parts, the greater the impact, and hence noise, that is produced. From the foregoing it seems reasonable to assume that the noise varies in a direct ratio to the mass of striking parts of the gear and to the square of their velocity.

Mushroom vs. Roller Type

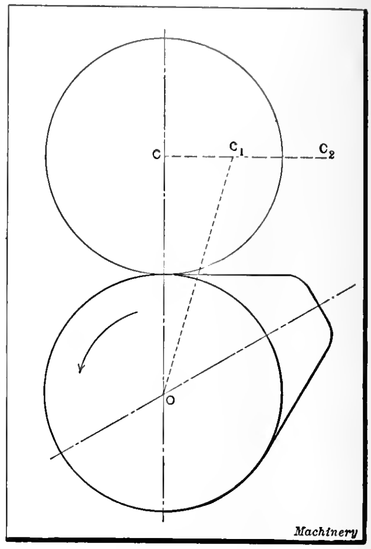


Fig. 12. Relation between the Clearance and the Clearance Angle

Let us assume two similar engines running at the same speed; one equipped with the roller type of valve gear and the other with the mushroom type, but both gears being identical as to their weight, clearance, etc. It is obvious that the quieter of the two engines will be the one whose valve lifters possess the least velocity at the instant the clearance is closed. We need not go into a minute study of the motion of the lifters, as the following simple consideration will help us to decide which of the two types is the noisier, and to what extent. Both lifters start with zero velocity and both rise 0.006 inch before the clearance is closed; but the roller lifter covers this distance in 6 degrees 15 minutes of the cam-shaft angle, whereas the mushroom lifter accomplishes the same result in 4 degrees 30 minutes. With both cam-shafts revolving at the same speed, the mushroom lifter must have greater average velocity in order to cover the same distance as the roller lifter in less time. The average velocity in both cases equals one-half the final velocity, *i. e.*, one-half the velocity at the instant that the impact takes place. While this statement is not strictly true, it is accurate enough for our purposes. Let

S = clearance in inches;

V_1 = final velocity of roller lifter in inches per second;

V_2 = final velocity of mushroom lifter in inches per second;

T_1 = time in seconds corresponding to an angular movement of 6 degrees, 15 minutes of the cam-shaft at any R. P. M. of the engine;

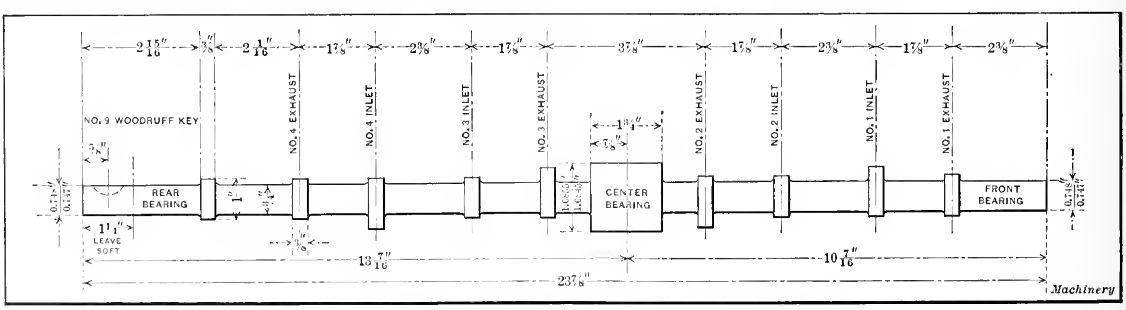


Fig. 11. "Broadside View" of the Cam-shaft of a Four-cylinder Engine

T_2 = time in seconds corresponding to an angular movement of 4 degrees 30 minutes of the cam-shaft angle at the same R. P. M. of the engine.

We then have:

$$S = \tfrac{1}{2} V_1 T_1. \qquad (1)$$

$$S = \tfrac{1}{2} V_2 T_2. \qquad (2)$$

From (1) and (2)

$$V_1 T_1 = V_2 T_2. \qquad (3)$$

$$\frac{V_2}{V_1} = \frac{T_1}{T_2} = \frac{6^\circ\ 15'}{4^\circ\ 30'}. \qquad (4)$$

The noise caused by the two lifters is proportional to the squares of their respective velocities. Hence we may write:

$$\frac{\text{Noise of mushroom lifter}}{\text{Noise of roller lifter}} = \frac{V_2^2}{V_1^2} = \left(\frac{6.25}{4.5}\right)^2 = \left(\frac{25}{18}\right)^2 = \frac{625}{324} = 1.93.$$

In other words, the mushroom lifter is almost twice as noisy as its rival. It is obvious that the only way to diminish this noise is to increase the clearance angle, *i. e.*, to shorten the radius of the arc AB, Fig. 4. Our conclusions in regard to the relative amount of noise hold good for the downward stroke of the valve, since the weight of the latter remains unchanged whichever type of lifter is employed; on the upstroke, however, the ratio of noises is considerably lower, owing to the fact that the mushroom lifter usually weighs from 30 to 40 per cent less than the roller type. About two years ago when designing a new engine, the writer discovered for himself the principles underlying quiet operation of valve gears. While recognizing the advantage of the roller type accruing from its lower speed of impact, he selected the mushroom type and by properly proportioning the cam of the latter, obtained some very gratifying results. This engine is known to have run at over 1800 revolutions per minute and its quietness of action was a matter of comment.

About a year ago the writer chanced to see an engine designed to run at not over 1200 revolutions per minute, the speed being controlled by the governor. The mushroom type of valve gear was used first, but the cam was so poorly designed, the clearance angle amounting to only 2 degrees 30 minutes, that the noise was very pronounced and the roller type of gear was eventually substituted in its place. As compared with the first engine, the impact at the same engine speed was in the ratio of:

$$\frac{4.5^2}{2.5^2} = \left(\frac{9}{5}\right)^2 = \frac{81}{25} = \frac{3.24}{1}.$$

The failure on the part of the designers to recognize the principles governing quiet operation of valves is no doubt responsible for the widespread opinion, often voiced by the technical press, that the mushroom type of gear is a noisy one, and that, as such, is unsuitable for rapidly revolving engines. The writer not only takes exception to this statement, but he contends that the mushroom cam and lifter can be designed to work at their best only on high-speed engines. The latter require early opening of the exhaust valves and late closing of the inlet valves, in accordance with principles explained in an article entitled "Timing an Offset Automobile Engine" published in the engineering edition of MACHINERY for February, 1911. In other words, the angle of the valve opening, and, hence, the active angle of the cam, is greater. Now if we turn to Fig. 4, it will be seen that if the active angle of the cam were increased, *i. e.*, if the center line were brought closer to the horizontal line, it would be possible to describe the arc AB with a shorter radius and thereby increase the clearance angle α. A further slight advantage could be secured by decreasing the lift of the cam. Now, short valve lifts coupled with the use of large valves is a condition which becomes more and more desirable as the speed of the engine increases. The slow speed engines, on the other hand, should have shorter valve openings, and, hence, smaller active cam angles—a condition decidedly unfavorable to a large clearance angle, and in such a case either quietness of action or proper timing must be sacrificed. This is the explanation of the apparent paradox that the noisy mushroom type of valve gear can be used to better advantage on high-speed than on comparatively slow engines.

DON'TS FOR BALL BEARING USERS*

BY ARTHUR V. FARR†

Lubrication and Care

Don't run ball bearings without plenty of lubricant. The highly polished surface of the balls and races suffers if run without lubrication.

Don't use any lubricant that is not chemically neutral, *i. e.*, without acid or alkali. For high-speed machinery, use a light machine oil and for heavy loads use a heavy mineral vaseline.

Don't fail to inspect and clean the bearings at regular intervals, flushing out the bearings with a clean supply of gasoline or kerosene whenever lubricant is charged into the bearings. Remember that dust and dirt may have entered the housing and it should be removed to avoid damage to the bearing.

Don't forget to keep the lubricating and drain holes of the housing closed to prevent the leakage of the lubricant or the entrance of dirt.

Don't tamper with the bearings or their housings unless you are compelled to do so for some good reason.

Shipping and Packing

Don't unpack the bearings from the box until you are ready to install them on a machine.

Don't put bearings on the bench or on the floor until you have provided a thoroughly clean surface for them.

Don't ship machines containing ball bearings unless you are certain that no dirt, grit or water can get into the ball bearing housings during the crating or while in transit.

Don't let ball bearings or machines with ball bearings leave the shop without being certain that the bearings and housings are scrupulously clean and filled with lubricant.

Mounting

Don't mount a ball bearing unless the shaft and housings are turned perfectly true, carefully finished and tool marks removed to insure the proper seating of the races. In case split housings are found desirable, great care should be taken to see that the housing sections do not squeeze the bearing.

Don't forget to clean the housing thoroughly with kerosene oil before mounting the bearing.

Don't use a steel hammer directly on the inner race when driving it into position. Light blows struck with a soft metal hammer or wooden mallet are sufficient.

Don't drive the outer race into the housing. This should have a sucking fit and should go into position without force.

Don't forget to provide for shaft deflection unless the bearing itself provides for it, to allow for inaccuracies of mounting and housing.

* * *

DRILLING HOLES IN GLASS

The following is a satisfactory method of drilling holes in glass. Take a piece of straight copper tubing, the outside diameter of which is the size of the hole that it is required to drill. The tubing should have a wall 1/32 inch or more in thickness, depending upon the diameter. The tube is set up in a drill chuck and driven at a speed corresponding to that of a twist drill of the same size. The tube is fed down onto the glass with an intermittent movement, and a mixture of emery and oil is dropped onto the glass at the point where the hole is to be drilled. After a ring has been cut in the glass on one side, the work is turned over and the drilling operation completed from the opposite side. This will prevent chipping the glass when the drill goes through. The copper tubing is soft so that it holds the emery, and as copper is an excellent conductor of heat, it draws the heat away from the glass, preventing it from being cracked. An idea of the rapidity with which holes can be drilled in this way may be gathered from the fact that a 5/16-inch hole can be drilled through an ordinary sheet of window glass in about seven minutes. The title of the article is somewhat misleading because this is really a grinding rather than a drilling operation.

V. P. C.

* For "Don'ts" previously published in MACHINERY, see "Don'ts for Drilling Machine Operators," in the January, 1914, number of MACHINERY and "Don'ts" there referred to.

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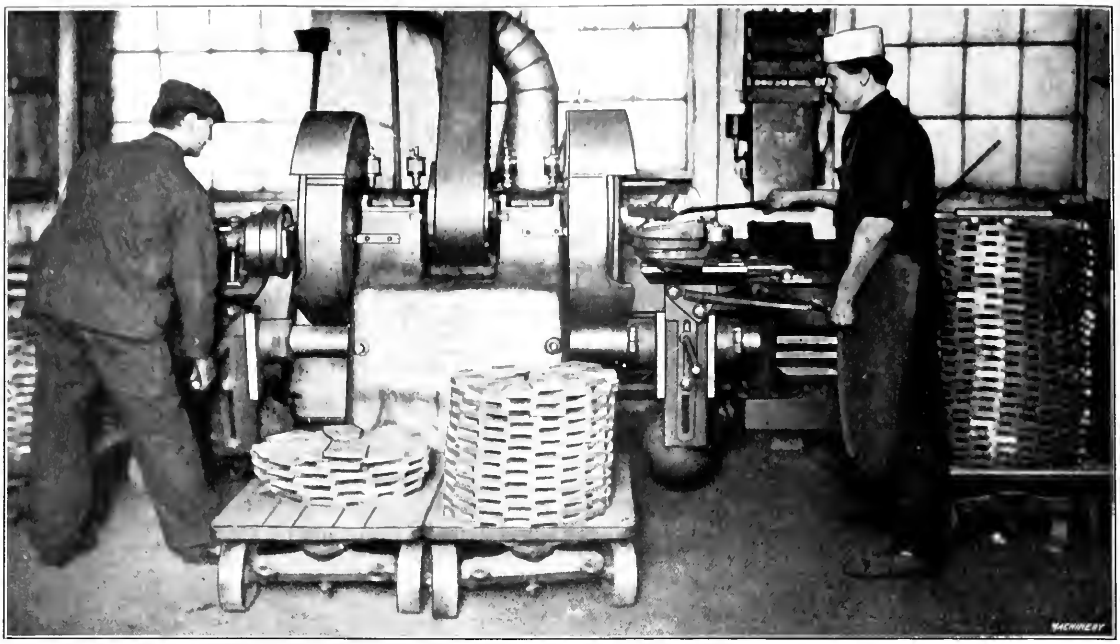

Fig. 1. Finishing Sad Irons on a Ring-wheel Grinder

FINISHING SAD IRONS ON A RING-WHEEL GRINDER

BY CHESTER L. LUCAS*

The machining of castings for sad irons presents difficulties that at first thought are not apparent. There are two general methods of doing this work—milling and grinding. The milling of the faces of flat irons was described in an article in the November, 1912, number of MACHINERY. Through the courtesy of the Simplex Electric Heating Co. of Cambridge, Mass., we are able to describe its method of finishing sad irons by grinding.

The machine on which the grinding is done is a No. 16-24 Besly ring-wheel grinder, shown in Fig. 1. Two men operate the machine, the one at the left working on faces, while the one at the right does the edge grinding. The grinding operation consists of the finishing off of the top face, the lower face, the straight back or heel, as it is called, and the edges.

The operations of grinding the upper and lower faces of the sad iron castings are performed at the left-hand side of the machine. For this purpose, the castings are held on a magnetic chuck shown in Fig. 2. In this illustration the casting is shown in the chuck ready for the finishing of the lower face. The upper face is similar, except that there is only a narrow edge to be cleaned off. The operator stands, as may be seen in this illustration and in Fig. 1, and with the casting rotating with the magnetic chuck, feeds the carriage, chuck and work to the wheel with his left hand, while with the right hand the grinding carriage is swung on its horizontal axis across the face of the ring grinding wheel. This combined rotary and lateral movement rapidly faces off the casting. An idea of the speed with which the face grinding is done may be obtained when it is stated that the upper face is ground at the rate of one hundred and twenty castings per hour and the lower face at the rate of seventy per hour. The next operation consists of grinding the heel or back of the iron. This is a simple grinding operation and is performed on two castings at a time. The heels of one hundred and twenty sad iron castings are ground per hour.

We now come to the most interesting part of this grinding operation—that of finishing the edge. By referring to Fig. 3, it will be seen that the edge of the sad iron combines a straight section near the heel, a long radius section immediately following, and at the point a section that conforms to a much shorter radius. The opposite side of the iron is, of course, the reverse of this. This operation is shown being performed on the right-hand side of the machine illustrated in Fig. 1. The special fixture is mounted on a table of the ring-wheel grinder after the manner shown in Fig. 3. It is held on the grinding machine table and the table swings on the horizontal axis as shown. At the front is a handle to facilitate swinging the fixture and at the rear is a weight to counterbalance it. The grinding of the edge consists of finishing the straight section near the heel, then grinding the long radius section adjacent and finishing up with the short radius

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Fig. 2. Rotary Magnetic Chuck for Face Grinding Use

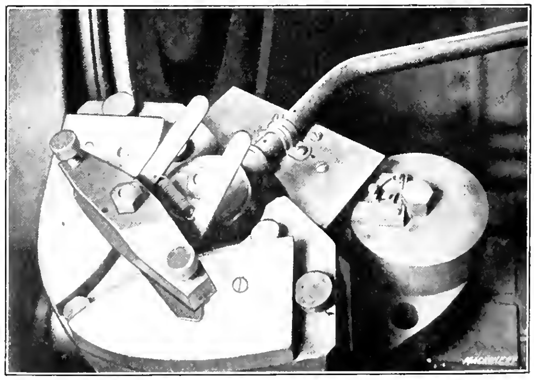

Fig. 3. Edge Grinding Fixture

near the point. By swiveling the fixture with the operating handle, the different sections of the edges are successively ground.

Some conception of the rapidity with which this grinding is done may be obtained from the production figures: Heel grinding, 120 castings per hour; top face grinding, 120 castings per hour; bottom face grinding, 70 castings per hour; edge grinding, 70 castings per hour.

* * *

COMPENSATING FOR ANGULARITY IN FITTING TAPER GIBS AND SLIDES

BY HAROLD F. PENNEY*

Everyone who has undertaken to fit taper gibs to their slides knows that whenever the slide is angular or dovetailed the taper on the slide is not the same as that to which the gib was originally planed. Possibly each mechanic has his own method for compensating for the angularity. The writer, with no claim of originality, has worked out a table to be used in connection with a common method that has been found to give satisfactory results and believes that this may be of interest and value to others. While the table covers the general range of practice, its derivation is also included to accommodate any special work.

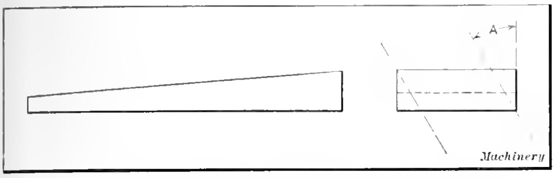

Fig. 1. Gib with Taper planed but with Angles Square

In following this method the gib is first planed to the proper dimensions including the taper, but with the angles square, as shown in full lines in Fig. 1. The corners are then planed off to give the desired angle A as shown by the dash lines. The slide is next planed, one side being kept straight or parallel and the other tapered to agree with the gib. The amount of taper is found from the table by following across under the heading "Original Taper of Gib," through the column headed "Angle of Slide," to the column headed "Taper of Slide." For example, if we were cutting a 40-degree dovetail slide having a gib tapered 1/8 inch per foot, we should find the taper of the slide to be 0.163 inch per foot. The table also gives the angle corresponding to the taper in inches per foot at which the slide should be set.

This method provides a constant means of checking the setting, for as soon as the roughing cut has been taken on the slide the gib can be tried in place. If the setting is correct the dimensions M and N, Fig. 2, which shows the gib in place, will be equal. If they are not equal, adjustment can be made and the cut continued until the readings agree and are of the desired value.

The values for the table were found as follows: Referring to Fig. 3, O represents the original taper at which the gib was cut; and F is the effective taper at which the gib acts, due to the angle A of the slide. From the relation of the parts of right angle triangles:

$$F = \sec A \times O.$$

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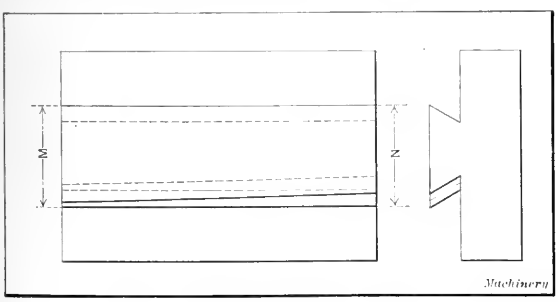

Fig. 2. Dovetailed Slide with Gib in Place

Substituting in the case already used as an example:

$$F = \sec 40 \text{ degrees} \times 0.125 = 1.3054 \times 0.125 = 0.163.$$

The angle corresponding to the taper is found from the following simple equation:

Tangent of taper angle = inches of taper per foot ÷ 12.

Continuing with the same example:

$\tan A = 0.163 \div 12 = 0.01360.$

Looking up this value in a table of functions we find:

$A = 47$ minutes.

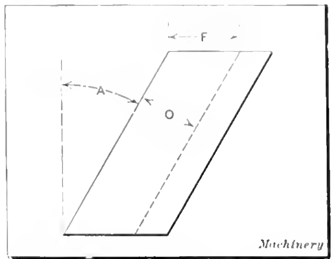

Fig. 3. Diagram showing Method of deriving Required Taper for the Slide

While no reference has been made to a machine other than a planer, it is apparent that the method and tables are just as applicable to the milling machine, or to any other machine which could be used for this type of work.

* * *

Several of the largest representative American manufacturing plants in full operation are to be taken to South America by means of the "movies" in order that the merchants there may see the advanced method of making American goods. By this method the makers of road-building machines, conveyors, laundry supplies, and other large machines will show their wares in full operation without the necessity of carrying the actual machinery. Accompanying the expedition will be a party of some thirty American salesmen who will represent the exhibition from sixty manufacturers. The *Kroonland*, upon which the exhibit is to be carried, will visit about twenty of the leading South American cities. This will be the first time that a foreign trade display has been made in this way.—*Moving Picture World.*

TAPERS FOR DOVETAILED SLIDES CORRESPONDING TO VARIOUS GIB TAPERS

Original Taper of Gib, Inches per Foot	Angle of Slide, Degrees	Taper of Slide, Inches per Foot	Corresponding Angle, Degrees	Corresponding Angle, Minutes
1/8	15	0.129		37
	30	0.144		41
	40	0.163		47
	45	0.177		51
3/16	15	0.194		56
	30	0.217	1	2
	40	0.245	1	10
	45	0.265	1	16
1/4	15	0.259	1	14
	30	0.289	1	23
	40	0.326	1	34
	45	0.354	1	41
5/16	15	0.324	1	33
	30	0.361	1	44
	40	0.408	1	57
	45	0.442	2	6
3/8	15	0.388	1	51
	30	0.433	2	4
	40	0.490	2	20
	45	0.530	2	32
1/2	15	0.518	2	28
	30	0.577	2	45
	40	0.653	3	7
	45	0.706	3	22

Machinery

* * *

The value of the imports of machinery into Norway, in 1913, amounted to nearly \$7,500,000, showing a very rapid increase during the last few years. Seven years ago, the imports amounted to only \$3,500,000 a year. The total value of machinery and tools imported into Norway during the last six years amounts to about \$40,000,000. The Scandinavian countries have undergone a great industrial development during the past ten years.

THE TRUING DIAMOND

BY DAVID D. MACLAUGHLIN*

Much has been written of late regarding truing diamonds for dressing grinding wheels, their selection and the excessive cost of upkeep, etc. While the quality of the stones used for this purpose varies, it will generally be found that with proper handling the length of service which a truing diamond will give is in proportion to the price paid, as most companies handling these stones grade them according to weight, shape and quality. A stone costing $25 ought to show less fracture than one costing say $10. The high priced stone should have a smooth unbroken surface, and be of such proportions that it will withstand shock without breaking. The cheaper stones are usually flat or elongated and show considerable fracture to the naked eye. They should be used only on light work, and will last longer for hand-truing than when fixed on a toolpost or slide-rest fixture. That there are causes, other than poor quality stones, which contribute to make this part of the grinding business troublesome and expensive, I shall try to show. While the quality of the diamond plays a very important part, the poorest stone may be used in such a way that it will give longer service than a good quality of stone improperly handled.

Setting the Diamond

It is necessary, of course, that the truing diamond be set in a suitable holder, and on this operation of setting depends, to a great extent, the length of service which the diamond will give. The usual method is as follows: A hole a little larger than the diamond is drilled in a piece of soft steel or copper of suitable shape to fit the holder supplied with the machine. The stone is then placed in the hole thus provided and held in place by peening the metal close around it; in some cases the piece of metal used is heated to a red heat so that it may be more easily closed around the diamond. That a diamond set in this way may survive the ordeal, goes without question; but unless the greatest care is used in the operation, the stone is only worth so much salvage in the form of diamond dust. Unfortunately, the damage done very often goes unnoticed until the truing diamond reaches the grinding machine operator, who proceeds to true up his wheel. Sooner or later he finds that the diamond is fractured but, fearing that he may have forced it in the operation of truing, keeps on using the stone in the hope that it will hang together. The result is inevitable, however—piece after piece crumbles away until what remains looks like so much granulated sugar. The operator then goes to the head of his department with a long face and a report that the diamond was "soft," "seemed to crumble away," etc., etc. While a perfectly good diamond may easily be ruined in use, the damage, in nine cases out of ten, is caused by improper setting.

One of the points which is often overlooked in setting a diamond by the above method is the manner in which the stone is actually held in its setting. Consider that the truing-diamond is a rough shaped, natural stone with corners or projections, and with flat and concave or convex portions on its surface. Then think of what is likely to happen when this stone is placed in a round hole, bored so that the stone is a loose fit in some kind of metal holder, and the metal closed round the stone haphazard, leaving one corner projecting. On account of the uneven or eccentric periphery of the wheel being trued, the diamond is subjected to a series of knocks in rapid succession, which tend to cause it to revolve or turn in its setting. It is prevented from turning by the projections holding onto the metal in which it is encased. The projecting points, therefore, act like so many levers tending to pry the stone apart. The life of the stone—usually very short in a setting of this kind—will depend greatly on the lay of the grain in relation to these corners.

To avoid the risk of breakage, it is essential that the truing diamond be set in such a manner that the *whole surface of the stone*, except the point exposed, *is in contact with the metal in which it is embedded*. This may be accomplished in several ways as follows: (1.) Drill a hole in a piece of copper bar to a sufficient depth to leave the diamond just exposed, using a drill a little smaller than the diamond; and then with the aid of a small set of chisels comprising a 1/4-inch diamond point chisel, a 1/4-inch cross-cut chisel, and a 1/4-inch round nose chisel, proceed to shape the hole to conform to the shape of the diamond set in position to obtain the best cutting point. Tap the stone very gently in place, using a small block of wood and hammer, and complete the operation by tamping the copper close around the exposed point with a hammer and center punch or nail-set. The greatest care should be used so that the diamond is not subjected to shock, either from the tools coming in contact with it or the copper being tamped against it with undue pressure. (2.) Another method of setting, which has many advantages without the risks attached to the method just described, has been practised with success and is carried out as follows. Drill a hole in a soft steel holder about 1/8 inch larger in diameter than the diamond, and to a sufficient depth so that the cutting point will just show. Undercut the hole so that the setting will dovetail into the holder and complete the operation by melting around the stone in place enough granulated brazing spelter to run flush with the cutting point. For this part of the setting, a blow-pipe is required which will produce a flame capable of melting the spelter. This method has the advantage that the diamond may easily be taken out by melting the setting, when it is desired to reset the stone to obtain a new cutting point, which is a very important advantage, as the stone will last much longer if reset when it is found that the tool is working unsatisfactorily. Also, a diamond set in this way, with its whole surface in contact with the material in which it is embedded, will better withstand the strain to which it is subjected than if set by any other method.

Of the several clamp holders which are sometimes recommended, whereby a diamond is held in a miniature vise, I have nothing to say in this article except that I leave them to the readers' judgment in the light of the preceding suggestions. As in setting the diamond, so in using it, the greatest care should be exercised so that the stone is not abused; the operator should see that the diamond is passed across the work so that it will cut without excessive pressure, and when possible, a great saving may be effected by using a Huntingdon dresser to roughly true the grinding wheel, only using the diamond for a finishing cut. For this purpose, a special detachable rest would be necessary in a great many cases, but the saving would make it worth while. When truing wheels made by the "elastic" process, use a diamond only. A suggestion was made by the writer of a recent article on this subject, that in the near future an artificial stone may be produced as good as the diamond or nearly so, and much cheaper. I might point out that as soon as something of this kind is discovered, the grinding wheel manufacturer who is ever ready to improve his product will pounce on the new abrasive and proceed to make it up into grinding wheels, so that the last state of the grinding man is worse than the first. It may be a long time before anything is found to equal the diamond for truing the grinding wheel. In the meantime give the diamond a square deal.

* Address: American Emery Wheel Works, Providence, R. I.

* * *

The foreman of a repair shop tells the following story in a contemporary: "The other day a man called and wanted a job, saying that he was quite experienced on repair work and had worked in many small repair shops. I put him to work chipping the flanges of a steam chest. He started out fine, but at four o'clock I found him sitting on a bench by the side of his job comfortably smoking. I asked why he was doing this, as smoking was not allowed in the shop. He replied: 'I've always been in the habit of having a smoke at four o'clock in the afternoon, and if so be that you don't like it, you can pay me off.' I did as he requested, but after he had gone, on looking up his job I found that he had knocked a corner of the flange off from one hole to the next, necessitating the replacement of the entire steam chest." This method of getting laid off and drawing the pay before the damage is detected seems more ingenious than honest.

BAD EFFECTS OF SHAFT STRAIGHTENING

BY L. LANGHAAR*

It is frequently necessary in building machinery to straighten shafts which have sprung during the process of manufacture. The company with which the writer is associated is engaged in building a multiple spindle turret machine in which great accuracy and durability are essential. The spindles in these machines are made with standard taper holes, and each spindle slides in its bearings, as well as rotating in them. The taper hole must be exactly central and in accurate alignment. In making these spindles it was decided not to resort to the use of a straightening press, but to machine them to remove any inaccuracy produced in hardening. Needless to say, this makes a considerable increase in the cost of production, as compared with the use of the time-honored straightening press, as it involves several different turning operations before grinding. It is felt, however, that a number of important improvements are obtained.

The chemist and the metallurgist have shown that steel consists of iron and iron compounds, each minute particle of which is held to neighboring particles by a force known as "cohesion." Like every elastic material, a bar of steel exhibits certain well-defined properties when loaded. Up to a certain limit the bar will return to its original form when the load is removed, this statement being based on the assumption that a load—however small—will cause a certain deflection of the bar. This is a proved fact. The limit of loading beyond which the bar fails to return to its original position is generally known as the "elastic limit," but our German friends very appropriately call it the "proportional limit." The reason for this name is that up to the proportional limit the deflection and the load are proportional to each other. Beyond the elastic limit the load and the deflection are no longer proportional, and the deflection becomes permanent, a "permanent set" having been produced in the bar. The strength of the steel is also found to be permanently reduced after it has been loaded beyond the elastic limit. The straightening press would be useless unless it strained a shaft beyond the elastic limit, and, therefore, it is reasonable to assume that the strength of a shaft which has been straightened cold in a press has been reduced.

To further explain this point it may be stated that the elastic limit is the point at which cohesion between the iron particles begins to give way, and this weakening of the cohesive force cannot be overcome by subsequent heat-treatment. It makes no difference whether the straightening is done before or after the heat-treatment to which the shaft is subjected; the steel is permanently weakened in either case. Heat-treatment generally has the effect of springing a shaft, but if this deformation is to be removed without a reduction of strength, the use of a straightening press should never be resorted to. The deformation should be overcome by grinding the shaft. A rule-of-thumb mechanic was recently heard boasting how he had repaired an automobile. The axle shaft, which was made of really high-grade chrome-nickel steel, had broken, and this man felt that particular credit was due him because he had replaced it with a shaft made of cold-rolled steel, which had already been in service longer than the original shaft. From this experience he inferred that what he styled "new fangled" ideas were no good.

The writer happens to have accurate personal knowledge of the construction of the automobile in question. The best materials and the highest grade of workmanship are used. The greatest care is taken in all machining operations, and heat-treatment is conducted along the most approved lines. However, the use of a straightening press is resorted to after the axle shafts are heat-treated. Those that do not show visible cracks after straightening are passed by the inspection department, when, as a matter of fact, many of them are in a state of incipient rupture. There is not one scientifically educated man holding a responsible position in this particular automobile factory, and it is perhaps worthy of mention that the company is now in its second receivership. There are doubtless a number of contributory causes for this state of affairs, but the little trick of straightening shafts in a press may be one of them. The car manufactured by this company is noted for its excessive weight, and it has apparently been found necessary to use a heavier construction than that employed in many other cars of the same power in order to obtain the required strength.

In the case of machine tools, a much heavier construction is necessary than that required in automobiles. Machine tools demand exceptional rigidity in order to turn out a product which is sufficiently accurate to meet modern requirements, and this means that the parts must be of ample strength. The following argument may be advanced against what has been said in regard to the straightening of spindles with taper holes: If the spindles are straightened by grinding, the taper hole will still point in the direction in which it was sprung, and, as a consequence, the hole will be out of alignment with the outside of the spindle that was finished by grinding. To avoid this difficulty, we use an alloy steel which has been previously heat-treated so that it is as tough as it is possible for it to be and still enable the machining operations to be performed by high-speed steel tools. Several adjustments and turning operations in the lathe make the taper hole perfectly true with the turned and splined spindle, and no subsequent heat-treatment is resorted to which will affect the accuracy of the spindle. The final grinding is merely for the purpose of finishing the spindle to the exact size.

To obtain the best results from heavy-duty machinery, the writer believes that the straightening press should be used very cautiously and only on the advice of a competent engineer, who will not be likely to recommend it for parts that are subjected to severe stresses. It appears likely that many so-called mysterious cases of the failure of shafts may be traced to this cause. At all events, it is certain that, other things being equal, shafts which have been straightened under a press cannot equal in strength and driving power those which have been straightened by some more suitable method.

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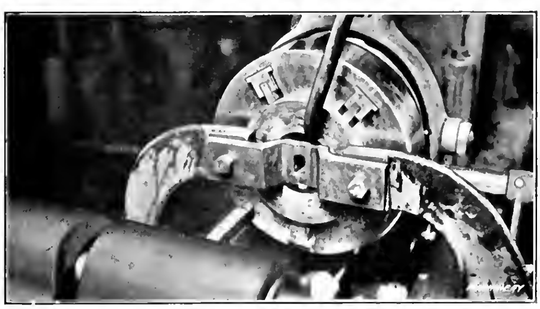
CUTTING PIPE WRENCH THREADS ON BOLT CUTTER

The Acme Machinery Co., Cleveland, Ohio, is using a five-chaser die-head with a special guide for cutting threads on pipe wrench movable jaws of the Stillson type. The accompanying illustration shows the die-head, the guide for the wrench jaw and the wrench jaw gripped in the vise. With five chasers and the guide which holds the part to be threaded closely, it has been found possible to cut very smooth and accurate threads even though the part is of approximately rectangular cross-section.



Five-chaser Die-head and Guide used for cutting Threads on Pipe Wrench Jaws

The company is cutting all sizes of jaws from 3/8 inch to 2 inches on an Acme No. 2 machine. Each size requires a different chuck for holding the jaw and a different guide. The object of the guide is to hold the shank rigidly while it is being threaded, and five jaws are used instead of four in order that one die may always be working. This overcomes any chance of twisting the shank while threading. About five wrenches per minute may be threaded with this rig.

F. L. H.

* * *

Don't forget that if a sleeve collet slips around in the spindle or a drill slips around in the sleeve collet, the surface of the tapers have become nicked and need smoothing off.

FORMING TOOLS FOR GEAR CUTTERS*

A SIMPLE METHOD OF MAKING A FORMING TOOL ON THE UNIVERSAL MILLING ATTACHMENT

BY JOHN EDGAR†

THE making of a forming tool for forming gear cutters is a job that a great number of shop men would, no doubt, like to tackle; but they would not know just how to go about it if the problem was put up to them. Making forming tools for this purpose is not work that is frequently given to the toolmaker, but there are some instances when a special gear cutter is wanted and lack of time prevents having it made by the cutter manufacturer, who is not always very prompt in filling such orders. The ordinary practice is to lay out the tooth curve full size or several times enlarged, and then make master tools to this drawing, by which the formed tool is planed. Following this method, it is necessary to make a special master planing tool for each side of the tooth and planing tools for the curves at the bottom; and this coupled with the method of using the tools and making the necessary corrections for the distortion due to the angle

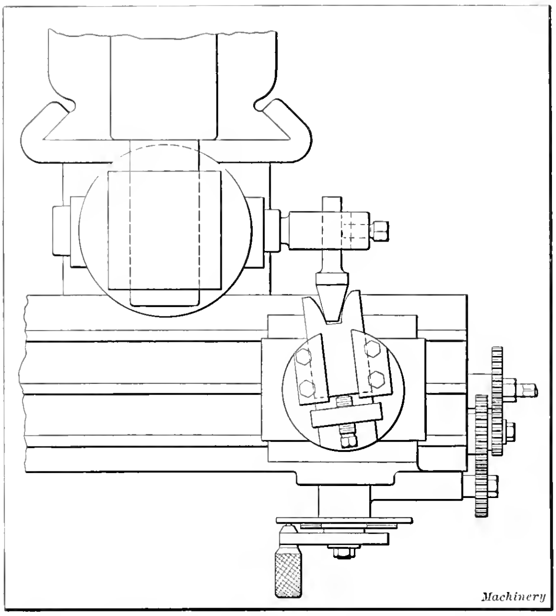


Fig. 1. Milling Machine set up to generate Forming Tool for Gear Cutters with a Rack-shaped Tool

in which each tool is set in planing, are all likely to lead to inaccuracies in the tooth curve, making the results anything but satisfactory. It is the intention to show in this article that all these master tools and complicated settings, and the "mysterious nothings" that hang around the job and make it appear out of the ordinary are unnecessary to the successful production of a forming tool. By the method to be described all the multiplied inaccuracies incident to copying from this original draft are omitted. This method consists of generating the forming tool direct without any intermediate steps, and by mechanical means that alone determine the shape of the tooth curve, so that a correct involute curve is obtained without any approximations whatever.

Probably the greatest drawback to the first method of procedure referred to is the necessity of making the original drawing of the tooth curve, there being so many methods in use that are mere approximations. Such methods are all well enough for the purpose of representing gear teeth on a drawing, but if it is attempted to make the teeth themselves to these layouts, trouble is more than likely to put in an appearance with a loud protest. Almost any toolmaker worthy of the name can produce a tool very close to the original

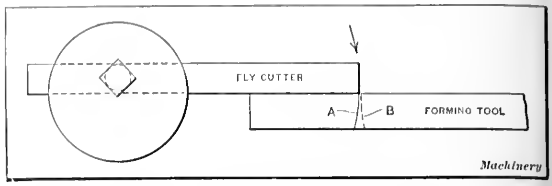


Fig. 2. Shape of Tool produced by Fly Cutter and Shape required for Clearance

curve; but the proposition of getting exactly the original curve is a job that must be left to some mechanical means if we are to get the closest possible degree of accuracy. This means is now to be found in the toolroom of any pretentions, and is the trusty universal milling machine. For the operation of generating the tool, a universal milling attachment is required, which may make the use of the method impossible in some cases; but these attachments are now commonly found in the toolroom in connection with the milling machine. There are two methods by which the tool may be made, that are to be described in the following. (1) By using a rack tooth shaped fly tool or cutter. (2) By using a straight faced tool or plain side mill of narrow face, and setting the axis of the cutter spindle and the ways of the table at the angle of the pressure line.

Fig. 1 shows the set-up of the machine for using the rack-shaped fly cutter. Here we have the forming tool clamped in the special chuck held in the spindle of the dividing head, which is set in the vertical position. The head is shown set up with the change gears as in spiral cutting, the pitch for which the gears are chosen being equal to the circumference of the pitch circle. The universal spindle of the attachment is set at right angles to the axis of the main spindle and parallel to the direction in which the table travels. Set up in this manner, the machine is ready to generate the involute sides of the forming tool, when the fly cutter is shaped like the tooth of a rack of the same pitch. The process is similar to that used in some way in all generating machines. By setting the top of the forming tool blank at the height of the axis of the cutter spindle, and the fly cutter so that the cutting plane passes through the center of the cutter spindle, next adjusting the fly cutter to produce a gash of the proper depth, and then starting the machine and throwing in the feed to the table, we can generate the tooth space shown. This space is of the correct shape at the top of the tool only, as the angle of the fly cutter with the top of the forming tool affects the shape at all other positions deeper in the tool. This is obviously the reverse of the generating method described in my article in the May number of MACHINERY, in relation to the generating of hob tooth shapes. A tool made

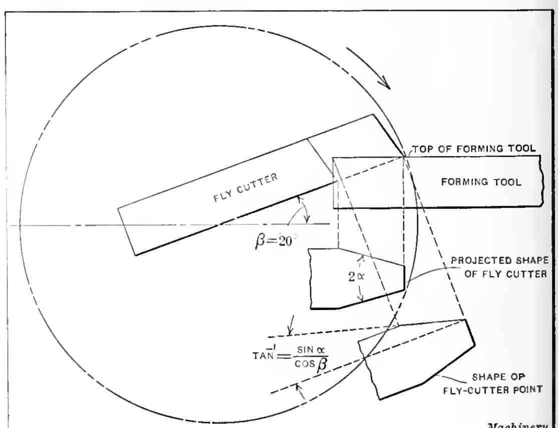


Fig. 3. Method of setting Fly Cutter to obtain the Required Clearance on the Forming Tool

* For additional information on forming cutters and allied subjects published in MACHINERY, see also "Making a Forming Tool for a Gear Cutter," by Earle Buckingham, May, 1914; "Making Formed Cutters," by F. B. Jacobs, April, 1914, and other articles there referred to.

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in this manner would appear as shown at *A* in Fig. 2, and to make it of use as a forming tool it must be relieved up to the top for clearance. This can be done by filing or other means, so that the finished tool would have the 20-degree clearance shown dotted at *B*, extending all around the form. With the fly cutter made to close dimensions, the space generated will be of the correct width at the pitch line and to depth; and a forming tool made with it would likewise be of the correct size in relation to thickness and depth.

The necessity for relieving the tool after generating may be eliminated by setting the fly tool as shown in Fig. 3, 20 degrees being chosen as giving plenty of clearance for the tool in the forming and backing off of the cutter. If the cutter teeth are to be given more than the ordinary amount of relief, the angle should be increased. With the use of the fly cutter in this position, a correction will have to be made to counteract the angle at which it is set. This is done by making the angle of the fly cutter such that the angle on a line parallel with the top of the forming tool will be twice the pressure angle. The corrected angle of the side of the fly cutter may be found by the formula:

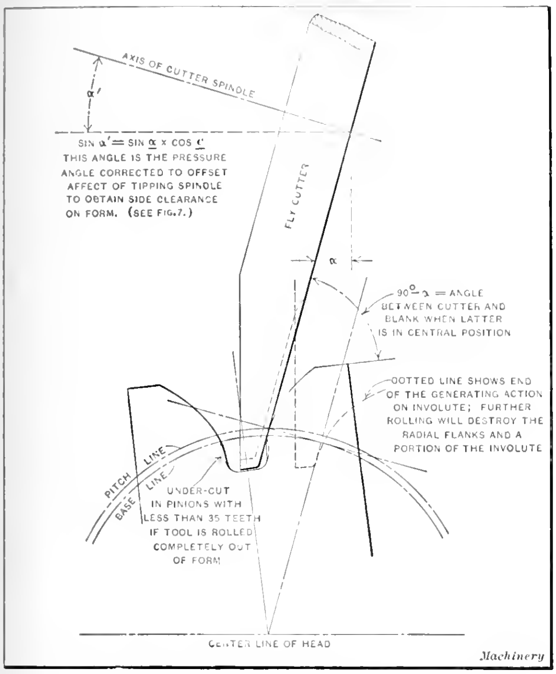


Fig. 4. Second Method of setting Milling Machine to generate Forming Tool for Gear Cutters with a Straight Fly Cutter

$$\text{Tangent of angle of side of fly cutter} = \frac{\sin \alpha}{\cos \beta}$$

where α = pressure angle and β = clearance angle.

The included angle of the tool is twice the angle of the side, and the height at which the forming tool is set above the center of the cutter spindle is found by trial, by setting the fly cutter as shown in Fig. 3 and bringing the forming tool to the height of the tip of the fly cutter. This height is, of course, dependent on the radius of the circle swept out by the fly cutter. The fly cutter should be set to sweep out as large a circle as possible, to give the least possible amount of concavity to the forming tool. The shape generated by the fly cutter is nearly correct throughout the thickness of the forming tool when the latter is thin as compared to the sweep of the fly cutter; and the forming tool can be sharpened by grinding across the top face without greatly changing its form. The clearance of the forming tool decreases as it is worn by sharpening; but the amount of use to which an emergency tool is put will not usually call for much grinding. The clearance, as produced in the case of the fly cutter set according to the preceding instructions, is not adapted to work that requires side relief, as in the case of small numbers of teeth nor for bevel gear cutters.

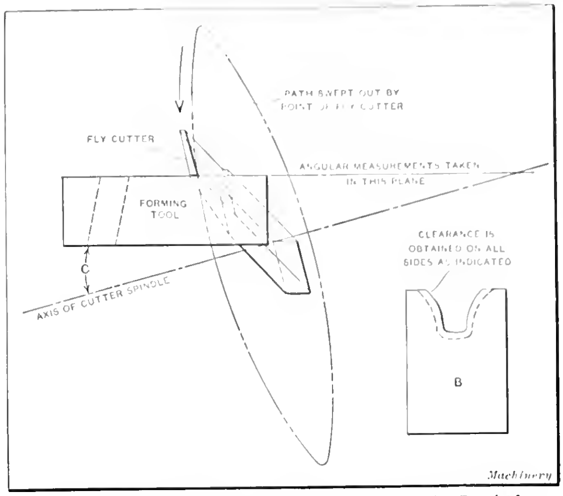


Fig. 5. Method of setting the Fly Cutter to give the Required Side Clearance to the Forming Cutter

The second method of generating the forming tool is shown in Fig. 4. The machine is set in the same manner as in the case shown in Fig. 1, with the exception of the angle between the cutter spindle and the table. This can be obtained by either setting the cutter spindle to the angle of the pressure line, after making a correction to counteract for the effect of the clearance angle, or by swinging the table to that angle—whichever is the most convenient. The cutting edge of the tool is at right angles to the axis of the cutter spindle, which makes it necessary to make a separate setting for each side of the form—setting a tool of the other hand to the opposite angle. The clearance in this case is obtained by setting the fly cutter as in Fig. 3, and giving the cutter spindle an upward tilt—shown by the angle *C* in Fig. 5—that is desired for side clearance. This may be the same as the radial relief or it may be less, a 10-degree angle being plenty for most cases. This sidewise setting is shown in Fig. 5; and the effect of the setting on the clearance is shown at *B*, in the same illustration. In generating with the fly cutter to sweep out the forming tool at this compound angle, the side of the forming tool is not straight as might be surmised, but is warped as in the case of spiral gears. This does not affect the shape of the tool materially, but it increases the clearance angle as the tool is worn down. There is no need of any other correction being made in this case, as the tool sweeps out a plane in which the side of a rack tooth would lie.

The amount of roll to give the forming tool is an important point in the case of pinions with less than 30 or 35 teeth, as it is in these smaller numbers that the teeth of the generated gear are undercut and it is obvious that a milling cutter will not mill undercut teeth. These pinions are made with radial flanked teeth, having that portion of each tooth that is below the base line radial. A full generated forming tool for the

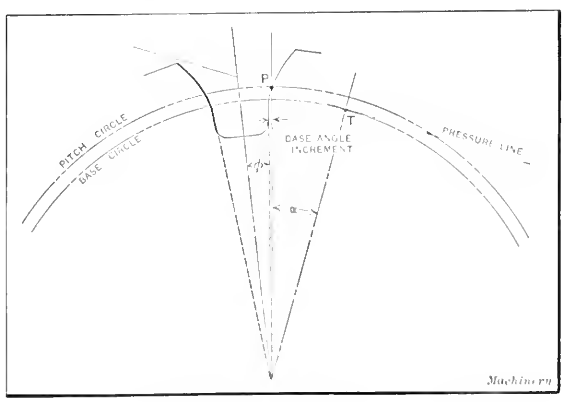


Fig. 6. Diagram illustrating Derivation of Formula for the Value of the Angle φ

cutter for a twelve tooth pinion would be undercut in the manner shown in Fig. 4 by the dotted lines, while the full lines show the proper radial flanked form. This radial flank is obtained by stopping the roll at the point where the fly cutter becomes normal or at right angles to the base line in the dotted position. A convenient way in which this may be done is to find the angle of the radial tooth space, which can be done as follows: In Fig. 6 we first draw the pitch circle and then the pressure line intersecting it at P; and tangent to this pressure line draw the base circle, the point of tangency being T. Next draw the lines intersecting the point of tangency and the point P, and passing through the center of the pitch circle. The length of the pressure line between the points P and T is given by the formula:

$$\text{Length} = \tfrac{1}{2} \sin \alpha \times \text{pitch diameter}.$$

This length projected on the base circle locates the end of the involute curve at the base circle and its distance from the point T. The angle embraced between these two points is given by the following formula:

$$\text{Included angle} = \frac{360 \times \sin \alpha \times \text{pitch diameter}}{2 \times \text{circumference of base circle}} = \frac{360 \sin \alpha}{6.2832 \cos \alpha}.$$

The angle included between the points P and T is the pressure angle α, which subtracted from the preceding result, gives what we will term the "base angle increment." The angle included between the pitch points of the teeth on the opposite sides of the space is $360 \div 2N$, and the base angle increment subtracted from one-half of this gives the angle ϕ which the radial flank makes with the center line of the space. Expressed as a formula this is:

$$\phi = \frac{360}{4N} - \left(\frac{360 \sin \alpha}{6.2832 \cos \alpha} - \alpha\right) \text{ degrees}$$

where N is number of teeth in gear.

Having found the angle of the flank with the center of the tooth space, the rolling of the forming tool is stopped when the angle between the side of the tool blank and the fly cutter becomes equal to the difference between the pressure angle α and the center angle ϕ of the radial space, as shown in Fig. 7. This may be done by stopping the feed when the head has traveled toward the fly cutter an amount equal to

$$\frac{\left[\left(\dfrac{360}{4N} + \alpha\right) - \phi\right]}{360} \times \text{pitch circumference}$$

from the central position in Fig. 4.

In making the forming tool blank, care should be taken to have the end planed square with the sides and the chuck should also be true. The space should be roughed out to depth, leaving sufficient stock for forming; and when the fly cutter is sunk to depth for the generating operation, the side of the blank should be at right angles with the line of travel of the table. It should also be at an angle with the cutting plane of the fly cutter, measured parallel with the top of the forming tool, equal to the complement of the pressure angle or of $90 - \alpha$, which in the case of the $14\tfrac{1}{2}$-degree tooth is $75\tfrac{1}{2}$ degrees. After the fly cutter has been sunk to depth, the tool should be cleared of the gash and the table moved with the gears in mesh so as to bring the fly cutter to the extreme left of the central position in Fig. 4, before the generating is commenced, so as to form the involute curve at the extreme point of the tool. When the gears to mesh are extremes as regards the number of teeth, the points of the teeth of the larger gear will have to be slightly relieved to avoid interference, as shown dotted in Fig. 8, the amount of the relief being a matter on which it is difficult to give a simple rule. The most certain and practical method is to generate templets while the machine is set up in each case, which can be rolled together and the teeth of the larger relieved as much as necessary to make the action smooth. Then the points of both the gears should be further relieved to ease the approach of the teeth so that the bearing of the teeth will not be so hard at the points as near the pitch line. The amount taken off the templets can then be measured in some convenient way and the forming tools relieved a like amount.

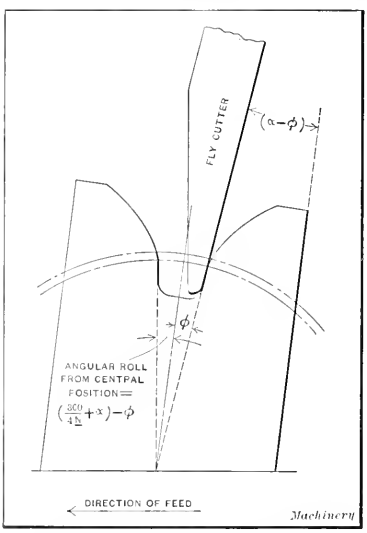


Fig. 7. Diagram showing Angular Relation between Fly Cutter and Forming Tool at Conclusion of Roll to give the Proper Radial Flank

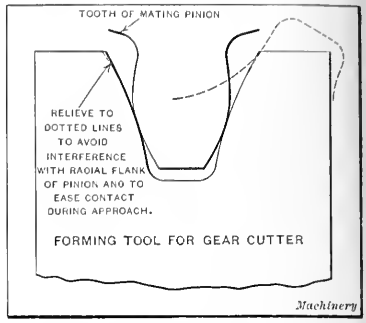


Fig. 8. Correction of Tool Setting to avoid Interference with Radial Flank of Pinions

There are, of course, limits to the application of the preceding methods, but they are capable of use in the majority of cases when the gears to be made are of reasonably moderate size in relation to the size of the miller that is available. The width of the space in the forming tool made by the second method is not made equal to the thickness of the tooth, but may be considerably wider and the cutter tooth formed one side at a time. This is necessary in the cases where a side relief is given.

These methods are especially valuable in those cases where it is desired to make cutters for any special number of teeth where the standard cutter is not satisfactory, as the methods in the hands of particular men are capable of producing a very high grade of forming tool and the second method is capable of extension so that when the fly cutter is replaced with a grinding wheel, the form of the tool can be ground after hardening to produce a tool free from the distortion due to hardening. This grinding also gives the tool a much keener cutting edge, resulting in a better job of forming in the cutter and a better finish on the gears.

* * *

Under the law governing the use of trademarks in Argentina, any person may register a trademark if such mark has not been previously registered in the country. This provision has permitted many unscrupulous persons to abuse the privilege by anticipating the advent into this market of a foreign trader or manufacturer. His trademark has been registered and he is then compelled to pay an exorbitant sum for the use of his own trademark. A provision has now gone into effect that a person who has registered a trademark cannot institute criminal proceedings for infringement, unless he himself manufactures or deals in the goods distinguished by the trademark in dispute. This has to some extent improved the conditions.

* * *

The permanent international committee for international aeronautics, 19 rue Blanche, Paris, has offered two prizes for competitions relating to aeronautic achievements. One of the competitions deals with the attaining of the greatest difference in speeds with the same aeroplane and the other with means for rising vertically, or nearly so, from a given point into the air, and for descending vertically. Further particulars may be obtained from the Commission Permanente Internationale d'Aéronautique, at the above address.

SCREW MACHINE TOOL EQUIPMENT*—1

STANDARD TYPE OF TOOLS USED ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

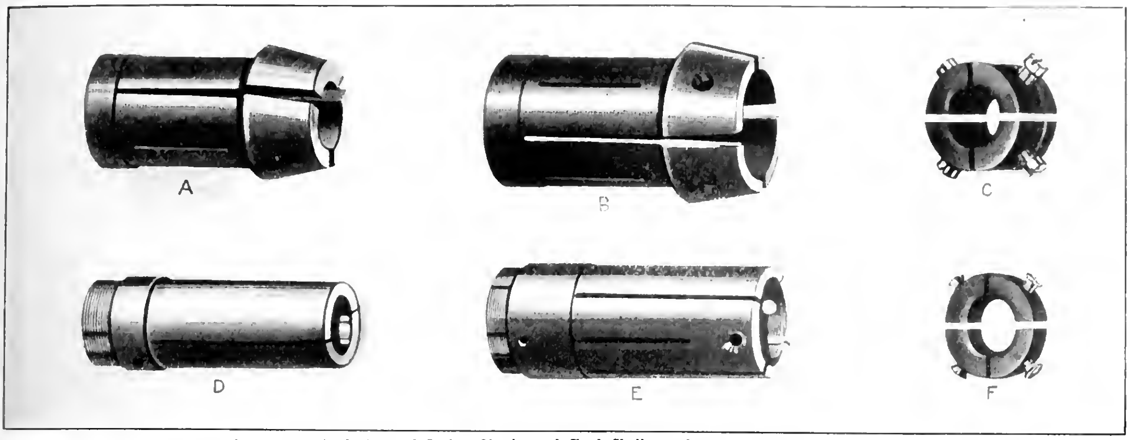
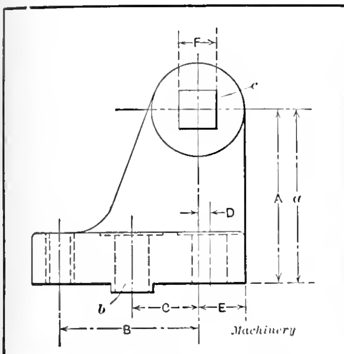


Fig. 1. Standard Type of Spring Chucks and Feed Shells used in the Cleveland Automatic

THE turret and cross-slide tools used on the Cleveland automatic screw machine differ only to a slight extent from those used on other screw machines, but of course there are a few tools particularly adapted to this type of automatic. As a general rule, forming tools of the flat type are are easily sharpened when dull, but the clearance on the sides, especially when diameters differing greatly in size are to be formed, is not nearly as good as on the flat type. Consequently this type of tool is used almost exclusively on Cleveland automatics.

PRINCIPAL DIMENSIONS OF SINGLE AND DOUBLE CROSS-SLIDES



Size of Machine	Model "A" Machine							Model "B" Machine						Model "C" Machine					
	A	a	B	C	D	E	F	A	a	B	C	E	F	A	a	B	C	E	F
Double Slides on Model "A" for these Sizes take the same Tool-posts as Models "B" and "C"																			
3/8	1 3/8	1 1/4	1 5/8	1/2	.....	7/16	3/8	1 3/8	1 1/4	1 5/8	1/2	7/16	3/8	.....	.....	.....	.....	.....	.....
5/8	2 5/16	2 3/16	1 1/4	*	.....	5/8	1/2	2 5/16	2 3/16	1 3/4	1	5/8	1/2	.....	.....	.....	.....	.....	.....
7/8	2 7/16	2 5/16	2 1/16	1	.....	11/16	9/16	.....	.....	.....	.....	.....	.....	2 7/16	2 5/16	2 1/16	1	11/16	9/16
1 1/4	2 11/16	2 9/16	2 1/16	*	5/16	1 17/32	9/16	2 11/16	2 9/16	2 1/16	1	11/16	9/16	2 11/16	2 9/16	2 1/16	1	11/16	9/16
2	2 11/16	2 9/16	2 1/16	*	5/16	1 17/32	9/16	2 11/16	2 9/16	2 1/16	1	11/16	9/16	2 11/16	2 9/16	2 1/16	1	11/16	9/16
For Single or Double Cross-slides. (All Dimensions in Inches)																			
2 1/4	2 7/8	2 5/8	2 1/16	11/16	.....	3/4	5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2 1/4	2 29/32	2 19/32	2 1/2	1 11/16	.....	1	5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3 1/4	2 29/32	2 19/32	2 1/2	1 11/16	.....	1	5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

used on the Cleveland automatic screw machine, because of the better side clearances obtainable. Circular forming tools

Spring Chucks and Feed Shells

The spring chucks used in the Cleveland automatics are of the push type as shown in Fig. 1; those up to 1 3/4 inch capacity are of the solid type as shown at *A*, and those larger

* For additional information on screw machine practice see "The Cleveland Automatic Screw Machine," in the April and May, 1914, numbers.
† Associate Editor of MACHINERY.

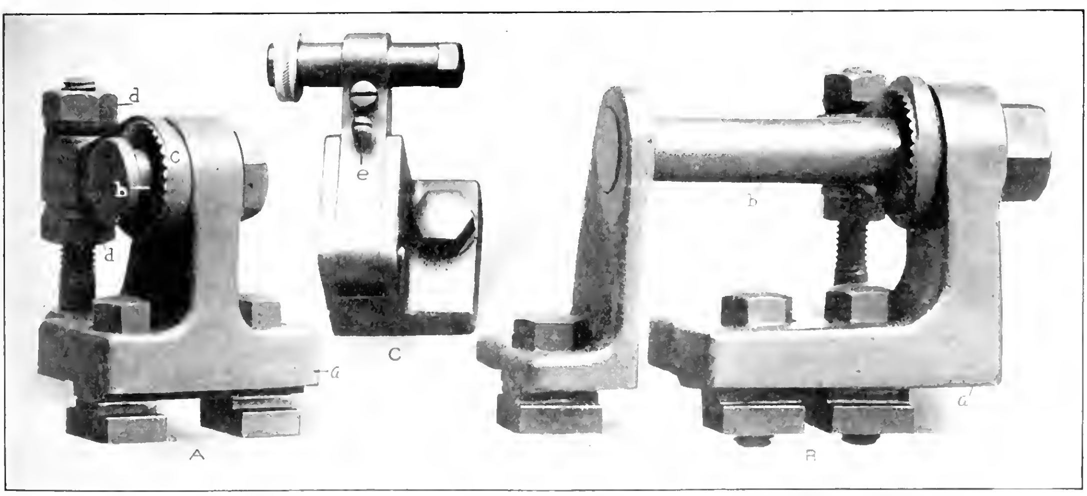


Fig. 2. Tool-holders for carrying Circular Forming and Cutting-off Tools and a Cross-slide Knurling Tool-holder

than this are of the type shown at *B*. The chuck at *B* carries pads which are held in the nose by screws, as shown, a pair of pads being illustrated at *C*. The feed shell used for pushing the stock through the chuck is of the spring type, as shown at *D* and *E* in Fig. 1, and on sizes up to 1 3/8 inch capacity the solid type of feed shell as shown at *D* is used.

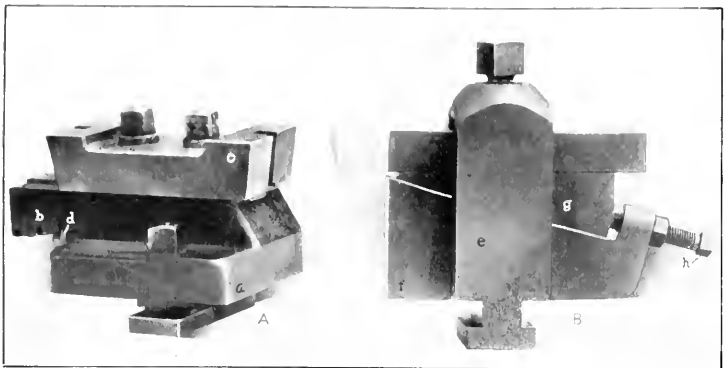


Fig. 3. Two Types of Flat Forming Tool-holders

For stock of larger diameter, the feed shell at *E* is used; this is provided with the pads shown at *F*, which are held by screws as illustrated. Both the spring chucks and feed shells, of course, are made to handle various shapes of stock; the chucks are ground 0.005 inch larger than the bar stock, and the feed shells are reamed 0.010 larger than the bar. This permits the chuck to get a better grip on the stock and hold it more securely while it is being operated upon. The hole in the chuck, of course, is made the same shape as the stock that it is intended to handle.

Toolpost for Circular Forming and Cut-off Tools

Two types of toolposts for holding circular forming and cut-off tools are illustrated in Fig. 2. *A* shows a toolpost known as the single type, which can be used for narrow forming tools or cut-off tools, whereas tool *B* is used principally for extra wide forming tools and is known as the double type. These toolposts are used either on the rear or front of the cross-slide, and they comprise a forging *a* which acts as a bracket for carrying the stud *b*. This stud fits in the hole in the tool and, as shown at *A*, is provided with a head which holds the tool up against the adjusting ratchet *c*. The outer face of this ratchet is provided with teeth which fit correspondingly shaped teeth in the inner face of the circular tool, holding the tool rigidly and at the same time making adjustment possible. This is secured by means of the adjusting nuts *d* which bear on cup-shaped washers fitting in similarly shaped holes in the extended arm of this adjusting member. Adjustment of the cutting edge of the tool is secured by moving these nuts up or down, as requirements demand. The forming toolpost shown at *B* is provided with an outer bracket which supports the extended bolt. This tool has three clamping bolts for securing it to the cross-slide of the machine. Adjustment for the circular tool is obtained in the same manner as for the type shown at *A*.

The accompanying table gives the dimensions for the circular forming type of toolposts for machines having capacities from 3/4 inch up to and including 3 1/4 inches. The 3 1/4-inch machine is about the largest size of Cleveland automatic on which the circular type of tool-holder is used. On sizes larger than this the flat type, which will be described later, is used almost exclusively. The upper portion of the table gives dimensions for toolposts which can be used on all three models A, B and C, having either single or double cross-slides; whereas the lower portion of the table gives toolpost dimensions applicable only to the model A machine. The spaces occupied by an asterisk indicate that the center of the tongue *b* is on the center line of the hole *c*. Hence, of course, dimension *C* is omitted.

Toolposts for Flat Forming Tools and Blade Cut-off Tools

The toolpost shown at *A* in Fig. 3 is the standard type of flat forming tool-holder that is used principally on machines having a capacity from 7/8 to 7 3/4 inches. This toolpost consists of a base *a*, the top face of which is beveled to an angle of about 15 degrees, which fits a beveled wedge *b*. The wedge *b* is provided with a tongue which fits into a corresponding groove in the top face of base *a*, and the top face of the wedge is provided with a groove that fits into a corresponding groove in the base of the flat forming tool *c*. Adjustment for height of the cutting edge of the forming tool is secured by means of a collar head screw *d*, which fits into a series of slots, depending on the height required, cut in the base of the wedge, and is screwed into the base *a*. The forming tool is held on the top face of the wedge by two clamping bolts as illustrated, and the entire toolpost is fastened to the cross-slide of the machine by bolts as shown.

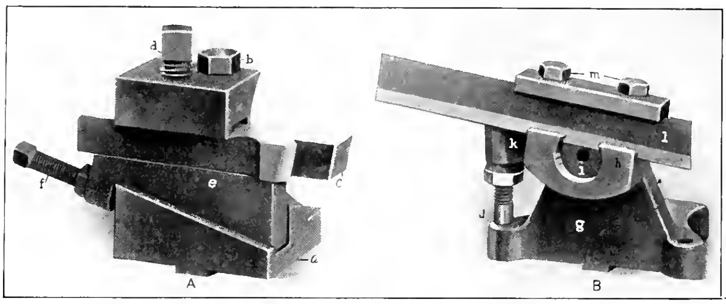


Fig. 4. Open-side Forming Tool-holder and Standard Universal Cut-off Tool-holder for Cut-off Tools of the Blade Type

B in Fig. 3 shows another type of toolpost used for light forming tools or for cut-off tools that are not of the blade type. This tool-holder is of simple construction as the illustration shows, and consists chiefly of three members, a clamping strap *e*, a base *f* and a tapered wedge *g*, the latter being adjustable to the desired height by a screw *h*. This holder, like those shown in Fig. 2, can be used on either the front or rear part of the cross-slide.

The tool-holder shown at *A* in Fig. 4 is known as an open-side forming toolpost for holding forming tools with square shanks. This toolpost comprises a block *a* which is fastened to the cross-slide by means of the bolt *b*, the lower end of which is screwed into a T-block. An additional clamping bolt in the base, not shown, is also used for clamping this

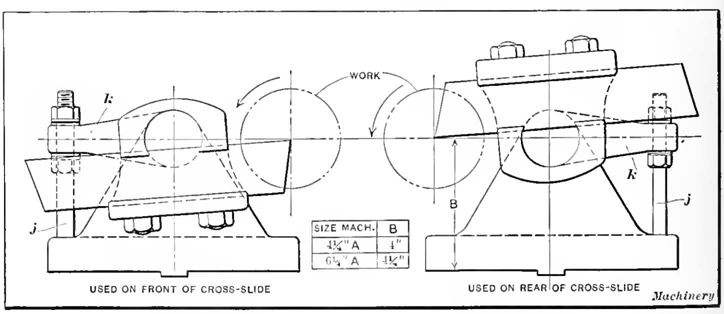


Fig. 5. Two Possible Combinations of the Universal Cut-off Tool-holder shown in Fig. 4

toolpost to the cross-slide. The forming tool c is held in the base by the set-screw d and is adjusted to the proper height from the cross-slide by the wedge e, the adjustment being secured by the screw f. The chief advantage of this type of toolpost is that a tool to be used in it can be made up very quickly and cheaply.

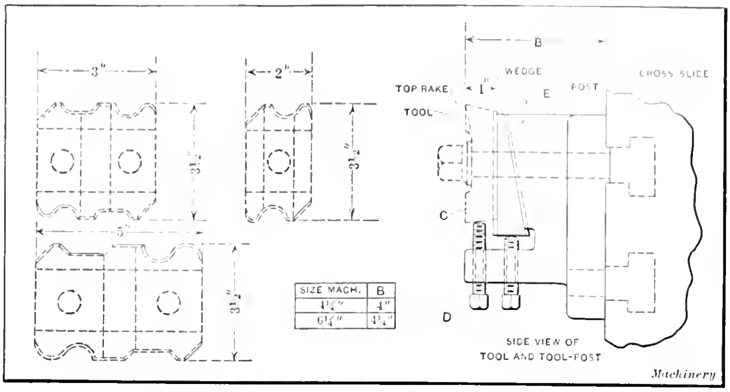


Fig. 6. Diagram illustrating Tool-holders for holding Large Flat Forming Tools and Proportions of Large Flat Forming Tools

The toolpost shown at B in Fig. 4 is known as a universal cut-off toolholder, and is adaptable for use on either the front or rear of the cross-slide, as clearly shown in Fig. 5. Referring to Fig. 4, the post g is so arranged that it may be clamped to either the front or rear of the cross-slide. The swinging tool-holder h is pivoted on the bolt i which also clamps the holder, ratchet and post together. A threaded stud j supports the ratchet k and this ratchet gives the adjustment to the tool-holder h. The blade type of cut-off tool l is clamped in place by two bolts m.

This toolpost can be used in various combinations, two of which are shown in Fig. 5. As shown to the left of this illustration, the cut-off tool blade is reversed with the cutting edge up, and in this position can be used on the front part of the cross-slide with the stock rotating in the direction indicated. It can be used on the rear of the cross-slide, as shown to the right of the illustration, with the cutting edge down and the spindle running forward as indicated by the arrow. It can be used on the rear of the cross-slide by reversing the blade and holder, cutting edge up, with the spindle running backward. Again, it can be used on the front of the cross-slide by reversing the position of ratchet k and threaded stud j, leaving tool-holder h in the same position that it formerly had, with the cutting edge up for the spindle running forward. It can also be used on the front of the cross-slide by reversing the tool-holder and blade, cutting edge down, and spindle rotating backward. Fig. 5 also includes a table giving the distance from the base to the center of the spindle on the 4¼- and 6¼-inch machines.

Fig. 6 shows the type of flat forming toolpost used on the larger sizes of machines from 4¼ inches up. The flat forming tool C is backed up by a set-screw D. This screw is not used for adjusting purposes, but simply to prevent any backward thrust of the cutter owing to a slight difference in the size of the hole and the diameter of the clamping stud. It also increases the rigidity of the tool.

The same illustration gives diagrams of the different sizes and proportions in which flat forming tools are made. The width in all cases is the same, but the length varies, depending on the work on which the tool is to be used. The angle E on the flat forming tool varies from 5 to 15 degrees, depending upon the material it is intended to cut. The top face of the tool is left flat as a rule, but on cutting cold-rolled steel and soft iron it has been found advisable in some cases to cut out the top; this is indicated by the dotted line in the end view, as top rake. Care must be exercised in doing this when the tool contour is of irregular shape. The peripheral speeds recommended for forming and cutting off various materials with cutting tools made from high-speed steel are as follows:

Material	Surface Speed in Feet per Minute
Brass	180–220
Cold-rolled steel	70–125
Tool steel	40–50

Drill, Reamer and Centering Tool Holders

Four different types of drill-holders are shown in Fig. 7. Type A is an ordinary drill-holder and is of simple construction, comprising a shank, the front end of which is drilled out to suit the tool, which is clamped by a set-screw located in a ring as shown. This holder will only retain drills of the size that it has been made for. B is a floating reamer holder. The holder shown at C is somewhat similar to that at A, but in this case the centering drill is held in position directly by the set-screw instead of depending on the spring of the metal. The holder at D is of the chuck type. The nose is bored taper, and a cone-shaped collet fits in it, which, when drawn back by the nut, holds the drill in position. A combination drill and chamfering tool-holder is shown at E in Fig. 7. This tool-holder, as the illustration shows, comprises a shank a, split on the front end and carrying the drill. Surrounding the front end of the shank is a holder b in which a chamfering tool c is held by a set-screw as shown. Holder b is clamped to the shank of the tool by a set-screw which, in addition to retaining the holder b in position, also clamps the drill.

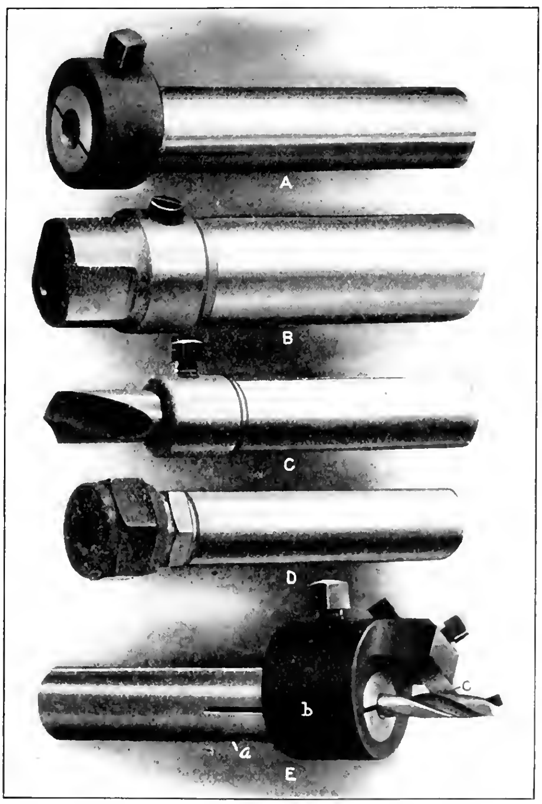


Fig. 7. Standard Drill, Reamer and Centering Tool-holders

The following gives the peripheral speeds recommended for drilling and counterboring operations when using tools made from high-speed steel:

DRILLING

Material	Surface Speed in Feet per Minute
Brass	180–250
Cold-rolled steel	90–100
Tool steel	40–50

COUNTERBORING

Material	Surface Speed in Feet per Minute
Brass	180–220
Cold-rolled steel	70–100
Tool steel	40–50

TUMBLER GEAR DESIGN*

BY S. C. B.

The accompanying illustrations will prove useful in calling attention to a number of points that are sometimes overlooked in tumbler gear design. In all the illustrations, the driving and driven gears are shown of the same diameter, and the force diagrams are drawn to the same scale. The force diagrams apply to involute teeth having a pressure angle of 20 degrees. The frictional losses in the bearings and between the teeth of the gears have been disregarded. In order to make the illustrations clear, only the pitch lines and base circles have been drawn. The outside circumferences of the gears have been omitted.

In Fig. 1, line *DE* represents to a given scale the force acting tangent to the pitch line of the driver, and *FE* is the resultant pressure normal to the tooth curve, and also the pressure on the bearings, *DF* being the component force acting to push the gears apart. The angle α is equal to 90 degrees minus the pressure angle of the gear teeth. Line *FE*, normal to the tooth curve, is tangent to the base circle and intersects the pitch lines on the line of centers.

Figs. 2 and 3 show the effect of changing the position of the tumbler gear with relation to the driving gear and also the effect of changing the direction of rotation of the driving gear with relation to the tumbler. Forces *EF* and reactions *GF* are determined as in Fig. 1. Completing the parallelogram of forces, we find *DF* to be the resultant force tending to move the tumbler gear. It should be noted that in each case *DF* passes through the center of the tumbler gear. The force *DF* multiplied by the perpendicular distance from *DF* (or *DF* extended) to the center *O* of the driving gear gives the turning moment acting on the tumbler arm *OH*. The great difference in the values of forces *DF* in Figs. 2 and 3 should be noted.

Fig. 4 shows a graphical method for obtaining the size and center of a tumbler gear in which there is no resultant force, due to the tooth pressure tending to rotate the tumbler arm *OH*. This diagram will also prove useful in designing idler gears carried on overhung studs, as it shows the theoretical size of an idler gear which would cause the resultant forces on the idler stud, due to the tooth pressures, to be reduced to a minimum. The center *H* is found at the intersection of the extensions of lines *KN* and *OR* which are drawn through the intersections of a common tangent to the base circles of the driving and driven gears with the pitch circles of the same gears. By construction, angle α equals 90 degrees minus the pressure angle, and the normal forces *FE* and *FG* oppose each other and have no resultant acting on the center *H* of the tumbler gear. There is, therefore, no tendency to rotate the tumbler arm *OH*.

It will generally be found that the theoretical tumbler gear thus determined will be too large, but the knowledge gained by an analysis of this kind will be a great help in arriving at a correct design. This article has been written with the hope of provoking further discussion upon this very interesting subject.

* For articles on tumbler gear design, previously published, see MACHINERY, December, 1907, "Tumbler Gear Design," and December, 1899, "Tumbler Gearing." See also MACHINERY'S Reference Book No. 14, "Details of Machine Tool Design," Chapter IV.

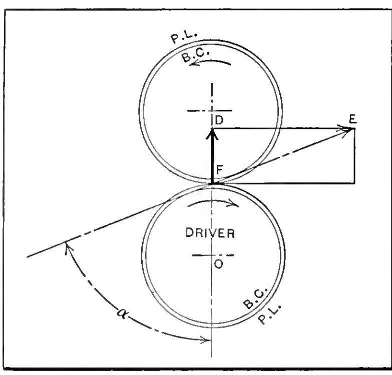
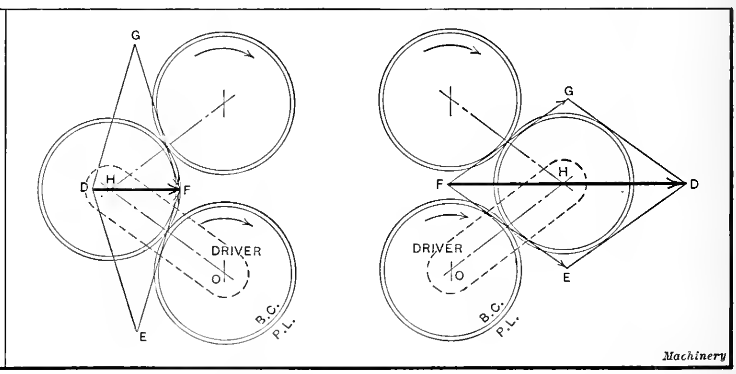


Fig. 1. Forces due to Tooth Pressure in Gearing



Figs. 2 and 3. Diagrams showing Effect of changing Position of Tumbler relative to Driving Gear

* * *

REMOVING PAINT AND ENAMEL FROM TIN

BY G. G.

It is sometimes required to remove paint or enamel from tin, iron or other metal surfaces. Under ordinary circumstances, this is a long and tedious job, especially if the surface under the enamel or paint is required to be left clean and bright. A method which I have used successfully to overcome this difficulty is described in the following. This consists of treating the surface from which the paint or enamel is to be removed with either metallic mercury or bi-chloride of mercury. If the pieces to be cleaned are small

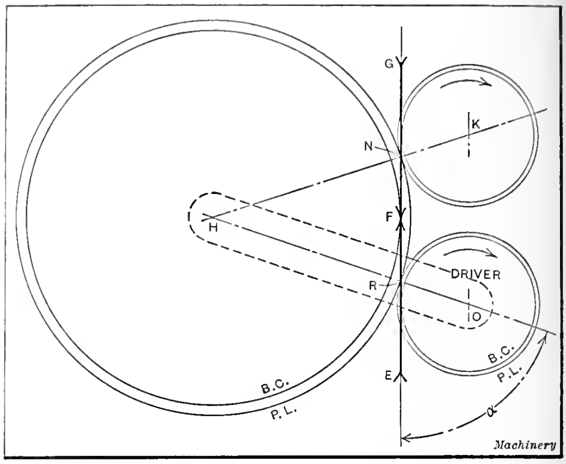


Fig. 4. Graphical Method of Tumbler Gear Design

enough in size, they may be placed in a receptacle containing a sufficient amount of mercury (quick silver) and held under the surface for about fifteen minutes. It will then be found that the paint or enamel may be easily rubbed off with the finger or a rag. If the pieces are too large to be treated in this way, lay them down so that the surface to be cleaned is horizontal, with the enameled or painted side up. Then cover these surfaces with metallic mercury and leave them for about fifteen minutes. The paint or enamel can then be rubbed off as previously described, leaving a clean surface. A typical application of this method is in the case of tobacco boxes, from which the enamel can be readily removed. When treated in this way, such boxes make attractive holders for small drills, reamers and other tools. If metallic mercury is not obtainable, bi-chloride of mercury will be found to answer the purpose nearly as well. A solution of this chemical is made by dissolving as much of it as possible in water. If this alternative method is used, great care must be exercised as bi-chloride of mercury is a deadly poison.

FILING YOUR OWN PATENT

BY BELL CRANK

In the February number of MACHINERY an article of this title was presented by Mr. Ford W. Harris, that should be particularly interesting to men who are developing ideas which they intend to patent. I have secured patents on several of my inventions and this experience has convinced me that it would be a distinct advantage for an inventor to make application for a patent without the aid of an attorney. In two cases I had my attorney make searches to see whether my inventions had been anticipated by others. He was an experienced and reliable man who was well-known to me, and he reported that there appeared to be no other patents that would prevent mine being granted. Yet when the patent office reported on them, they had found patents which so limited my claims that both patents were of but little more value than the expense to which I was put in securing them.

In another case I was so confident of the novelty of my device that, although I remembered the failure of his previous search, I instructed this attorney to go ahead. Again he reported favorably, but it was found by the patent office that my invention had been anticipated and so I lost the $15 fee charged by the government in addition to a $35 attorney's fee. In two other instances I secured patents without having a previous search made. This experience was the means of teaching me quite a little about the method of procedure in securing patents, and has given me a high regard for the thoroughness of the searches conducted by the patent office. As a result, I would not spend money to have a search conducted by an attorney because no attorney has facilities for making a search equal to that of the patent office. Even if he had such facilities and made a thorough search, he would charge so much for doing it that his fee would probably be more than the cost of an application for a patent.

There are a lot of "no patent no fee" attorneys who profess to make a free search to determine the patentability of an invention. It is extremely doubtful, however, if any of them do so; and if they report an invention non-patentable, which they very seldom do, it is not the result of a search but because they happened to know that the invention has been anticipated. When in doubt, they take chances and depend upon their skill and experience to "wriggle" through some sort of a patent, whether it is of any value or not, and thus obtain a fee. It is practically certain that if all patent attorneys prosecuted only such inventions as they honestly believed to be of any real value, about one-half of those now engaged in the profession would have to go out of business. It must not be forgotten that the usual attorney's search—for which the customary fee is $5—covers only United States patents. But there may be, and often are foreign inventions which interfere with the granting of a patent in this country. In the case of one of my own inventions, there were two foreign patents which prevented my obtaining two of the most important claims.

I feel sure that it is well worth while for an inventor of limited means to take the time and trouble to learn how to make application for a patent without employing an attorney. For the first fee of $15, the patent office makes an examination of the patentability of an invention that is far more thorough than any independent practitioner could conduct for such a fee. Unless an invention is entirely new, there are sure to be several previous patents cited by the patent office, which must be carefully considered in reference to the claims that are made. If the inventor believes that he has a very valuable device and the other patents do not seem to interfere materially with his claims, I would advise him to employ a reliable patent attorney to complete the prosecution of the patent. If, on the other hand, the invention is one of minor value and he feels sure that he is competent to carry the prosecution of the patent through to a satisfactory conclusion, the attempt may be made. Then, if the inventor finds it too difficult to go on with, he may still employ an attorney to complete the work. The inventor will find this very interesting work, and work which will increase his knowledge of the procedure of the patent office.

It is a common thing to hear people criticize the work of the United States patent office, but after an inventor has seen the facility with which the employes of this office find patents that interfere with the granting of his own, he is sure to have greater respect for their work. Even if he finds that his application cannot be granted because of previous patents, the knowledge which he has gained of the developments which have been made along the line of his own invention is usually worth all or more than the $15 fee which he has paid.

I believe that Mr. Harris' advice in regard to how an applicant for a patent should draw up his claims is about as clear as it could be made for the benefit of the novice. In this connection, I should like to earnestly advise those who have anything to do with applying for a patent to treat the examiners who have charge of their cases with the utmost courtesy, and to endeavor to make friends of them. The rules of the patent office are strict in regard to this matter and even a registered attorney may be disbarred for misconduct in prosecuting applications. You may think that the examiner is very strict in regard to a technical matter which appears of minor importance to you; but it pays to concede to his wishes in such things, for he is certain to know more about it than you do. The essential elements of the claims may easily be retained and still allow you to make the changes which the examiner suggests, as there is always more than one way of saying the same thing. The salaries paid the examiners are not as high as those paid to men of equal ability who are employed outside the government service. Those who continue in the patent office do so because of their interest in the work, for which they certainly deserve due respect.

In regard to the sort of attorney to employ, a contributor in the April number of MACHINERY—himself a patent attorney—lays great stress on the need of employing a practitioner, even though he is incompetent. In this contribution, the statement is made that the office registration of patent attorneys is a very strict matter and that the requirements are severely enforced. This may be so, but no satisfactory proof was offered to substantiate it. The rules of the office, as published, state that any citizen of the United States who is not an attorney may be registered, if he can satisfy the commissioner that he is of good moral character and possesses legal and technical qualifications to make him competent to render valuable services to applicants for patents, and to assist them in making their applications. It is well known that there are a large number of patent attorneys who were examiners in the patent office, and never studied any law except that which was incident to their work as examiners. There is also very little doubt that any inventor who has successfully prosecuted a few of his own applications would have little difficulty in getting registered as an attorney.

In regard to what the contributor in the April number of MACHINERY says about the value of patents, *i. e.*, that someone can usually be found who is willing to pay the attorney's fee for an interest in the patent, it may be observed that although many attorneys advertise their willingness to secure a patent or waive their fee if they fail, and offer numerous inducements in order to secure clients, you never hear of any of them advertising that they will assume all expenses of securing a patent for a part interest in it. This is a startling evidence of how lightly they value the patents which they prosecute for their clients. I once heard an eminent inventor say that he would not give $5 each for all the patents that are issued, if he had to take all of them. This is equivalent to saying that not one patent in each hundred is worth $500. There is little doubt that every patent attorney of any considerable experience knows that the majority of patents issued never bring as much to the inventor as they cost him.

* * *

At the present time there is one motor vehicle to every fifty-five inhabitants in the New England states. During the past year, the number of vehicles registered in these states increased by nearly 25 per cent. About one-tenth of the total number of automobiles in the United States is registered in New England, while the population in these states is only about one-sixteenth that of the whole country.

SPECIAL BORING MACHINE USED ON WILLIAMSBURG BRIDGE

MACHINE THAT ENLARGED PIN-HOLES FROM TEN TO THIRTEEN INCHES IN ONE PASSAGE OF THE CUTTER-HEAD

In the article on "Replacing Pins in the Williamsburg Bridge," in the June number of Machinery, mention was made of some of the problems connected with the strengthening of this bridge. As will be recalled by those who read this article, the work of reconstruction involved the replacement of the four hinge pins which connect the approach span trusses with those of the main span at points near the towers. The original pins were ten inches in diameter and it was necessary to rebore the holes to a diameter of thirteen inches for the new pins. In connection with this work a special boring machine had to be constructed, because of the unusual conditions which existed. A description of this machine and some interesting facts connected with its use are given in the following.

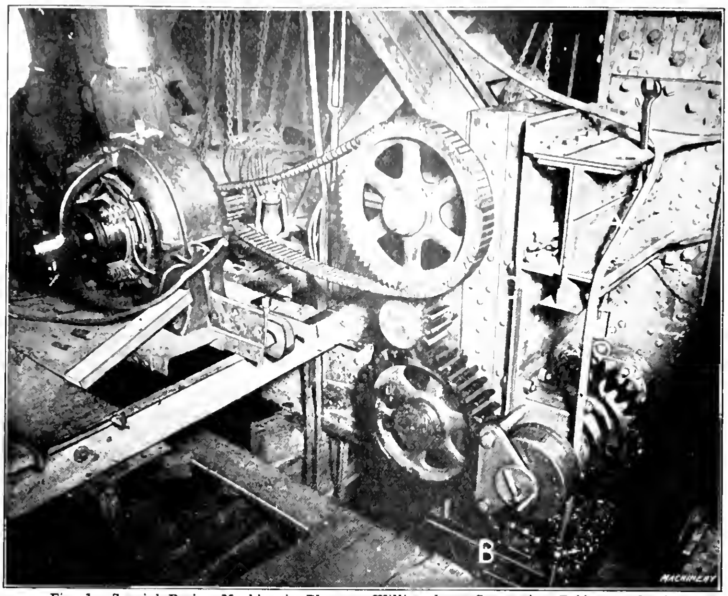


Fig. 1. Special Boring Machine in Place on Williamsburg Suspension Bridge ready for reboring Pin Hole from 10 to 13 Inches Diameter in One Passage of Cutter-head

As mentioned in the preceding article, the load carried by the old pins had to be transferred to a new girder erected transversely above the ends of the main span trusses close to the tower. In this way the pins were relieved of the dead load stresses, but part of the live and all of the "wind" loads were still transferred through these joints. Owing to this condition, it was impossible to rebore the holes while the railway and vehicular traffic continued across the bridge. As an interruption of this traffic during the day would cause great inconvenience, it was decided to do the boring at night, and nights of an even temperature and low wind were desirable, because, even under favorable conditions, it was considered hazardous to have a pin removed for more than two or three hours. Therefore, the time for the boring operation was limited, and even during this short time, the members held together by the pin were likely to move slightly and interfere seriously with the boring operation. Because of these conditions, it was apparent from the beginning that no ordinary boring-bar could be used, and it was decided to build a special boring machine; moreover, to prevent any relative movement of the members while boring, it was necessary to have them rigidly tied together. This was effected by an elaborate system of auxiliary members placed around the pin-hole. These were arranged so that they could be rigidly connected by bolts just before starting the boring operation, and be released as soon as the new pin was in place. The actual boring time was limited to a maximum of two hours, and a machine had to be designed to enlarge a hole thirteen inches for a distance of twenty-eight inches, in one passage of the cutter-head, and finish the hole to the required diameter within a limit of 1/64 inch.

In order to determine if a satisfactory hole could be obtained with roughing and finishing cutters working together, and to obtain the most efficient rate of feed, shape of tool, etc., a series of experiments were conducted in the shops of the Department of Bridges, and the data obtained were used in designing the machine. These preliminary tests showed that one of the most important points in the design was that of securing a rigid support, in order to avoid chattering. Among the special conditions that had to be considered were the ease of adjustment for centering the boring-bar as quickly as possible, the insertion and removal of the bar to permit placing the new pin in position, and the extremely limited space of only twenty inches between the center of the pin-hole and the side of the main tower. Furthermore, the machine had to be designed so that it

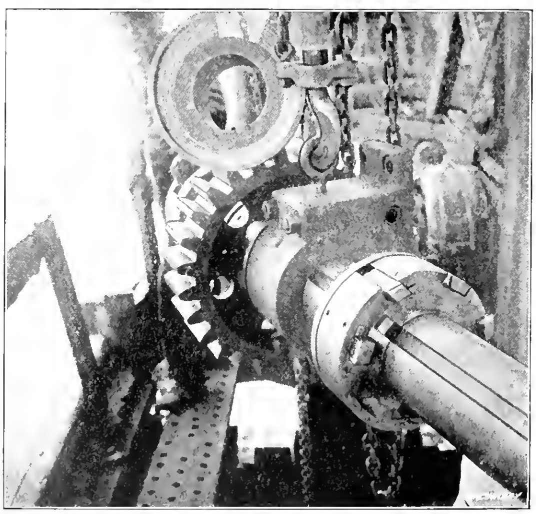


Fig. 2. Boring-bar and Cutter-head equipped with Seven Tools

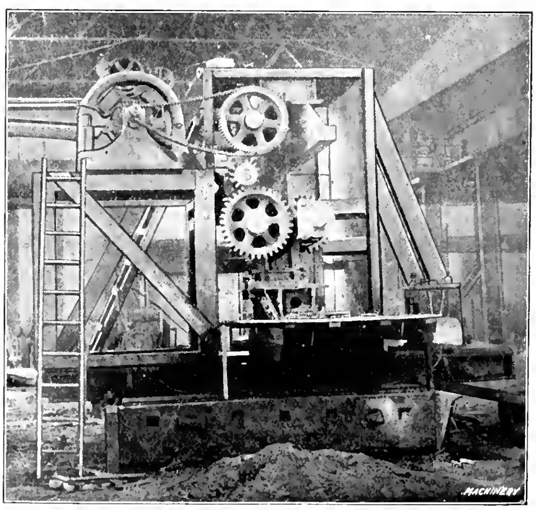


Fig. 3. Preliminary Test of Boring Machine

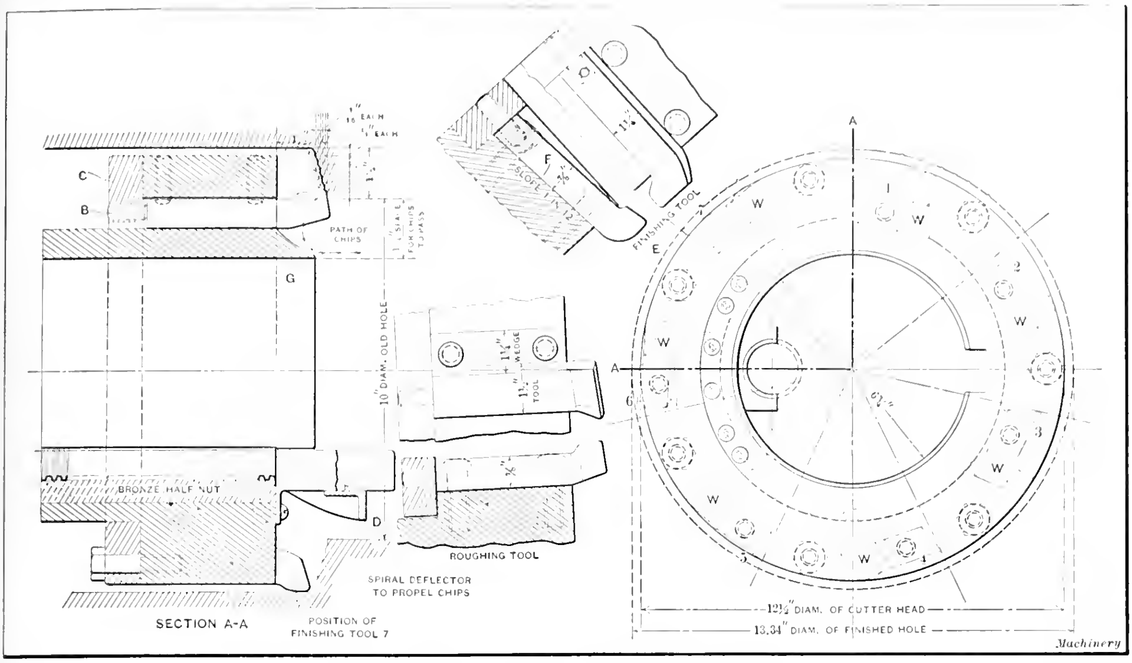


Fig. 4. Seven-tool Cutter-head used on Boring Machine

could be changed from right-hand to left-hand for boring the pin-holes on opposite sides of the tower. The most serious difficulty of all, however, proved to be the removal of the large quantity of chips without interference with the cutting tools, because in order to secure the necessary rigidity, the boring-bar was made 6¾ inches in diameter so that there was not much room between the bar and the ten-inch hole.

Owing to the importance and dangerous nature of this work, it would have been unwise to take any chances regarding the successful operation of the machine, and it was also imperative to know definitely the time required for the boring operation. To ascertain beforehand exactly what the machine would do a trial hole was bored, the conditions existing on the bridge being reproduced as nearly as possible. This preliminary test was made in the presence of representatives of the Department of Bridges at the shops of the Fawcus Machine Co. at Ford City, Pa., where the machine was built. Fig. 3 shows the machine assembled for testing. The post for this test was practically the same as the one on the bridge, and it was provided with members in the center arranged in the same slanting position that they occupied on the bridge members, so that the tools would work under corresponding conditions in each case. This test proved that the machine was entirely successful. The hole was enlarged from ten to thirteen inches in diameter in one hour four minutes, and a smooth surface obtained.

It was necessary to move the boring machine successively to four places on the bridge, but as the bridge construction in each place was similar, it was possible to utilize the framework of the bridge as a support for the machine. The connections of the roadway floor beams (the latter being detached to make room for the boring machine) were utilized for attaching the horizontal brackets *A* and *B* (Fig. 1). Bracket *A* held the upper end of the main post *C* of the machine, whereas bracket *B* supported the lower end. The open rivet holes of these connections located the supporting brackets in almost exactly the same position at all four points where the boring had to be done. The main post *C* rested on two taper adjusting blocks, which, in turn, were held by bracket *B*. These blocks gave both vertical and horizontal adjustment for post *C* and provision was also

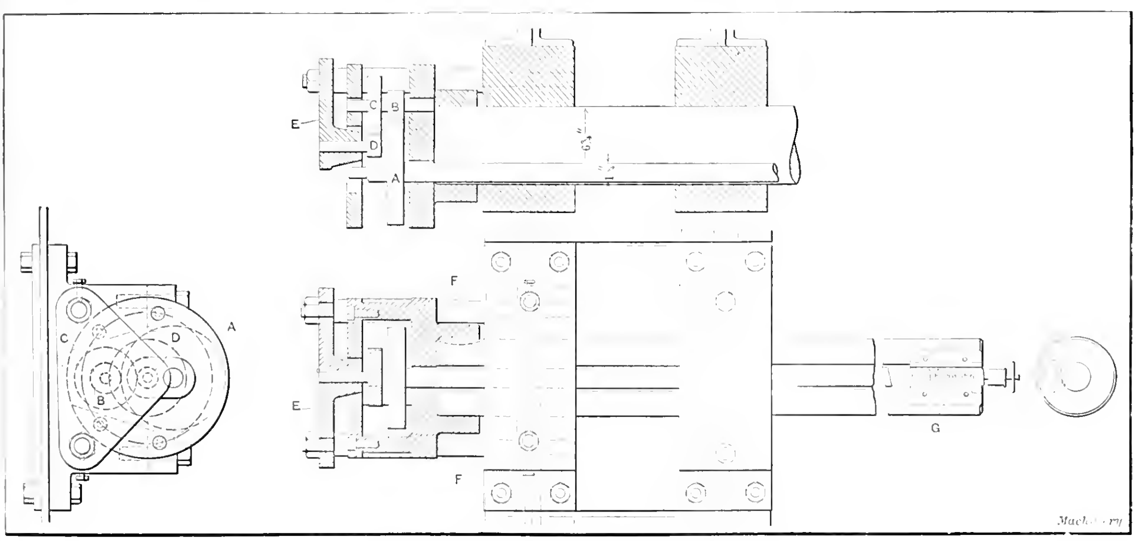


Fig. 5. Geared Feed Mechanism for Cutter-head

made for tilting this post transversely with relation to the bridge. The angle-plates connecting the post to bracket *A* were provided with slotted holes to permit of these adjustments. The post *C* consists of two built-up I-sections rigidly joined by plates. The driving gear on the bar (see Fig. 1) and its meshing gear enter between the two webs of this post. The power is transmitted from a 35-horsepower motor by a silent chain, and then through a train of gears giving a reduction of 49 to 1 from the motor to the bar. The journals for the gear shafts are attached to post *C*, which also carries the outer bearings of the bar. These outer bearings are bolted to finished surfaces on post *C*, so that the bar could readily be placed in position after the post was properly set. The rear end of the bar was supported by a journal clamped to the angles of the trolley track floor beams. This rear journal was so designed that it could be adjusted in all directions.

In order to center the journals of the bar, a piano wire was stretched through the small center hole of the old pin. The bearings for the bar, while attached to the main post

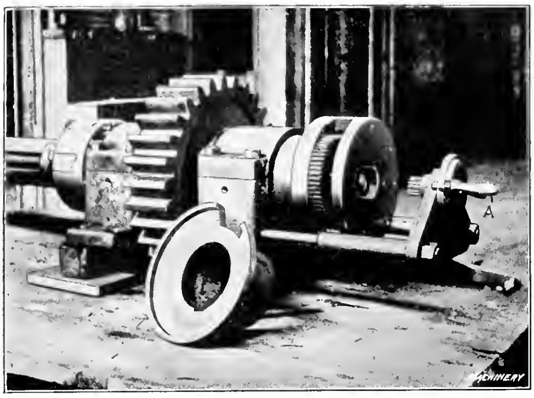


Fig. 6. Detail View of Feed Mechanism

of the machine, were then set central with this wire by adjusting the post, as required. The position of the bearings was checked by a gage consisting of a 1 7/16 inch bar which fitted the central hole of the old pin and carried three 6¾-inch removable collars which fitted the journals.

The cutter-head was fed along the bar by a feed-screw contained in a groove extending along one side of the bar. This feed-screw was operated by an epicyclic train of four gears, *A*, *B*, *C*, *D* (Fig. 5), located at the front end of the bar. These gears provided a reduction of 10 to 1, giving the cutter-head a feeding movement of 1/32 inch per revolution of the bar. The shaft of the central pinion *D* is journaled in the triangular plate *E* which is held by two studs *F* to the journal of the bar. To obtain an automatic feed, the pinion *D* was held stationary by the engagement of a pin in the handle shown at the right in Fig. 6, which engaged the plate shown. By withdrawing this pin, a hand feed of any desired rate could be obtained by turning the gear *D* in one direction or the other. For a quick return of the cutter-head, plate *E* was detached; then the feed-screw could be turned directly by a crank. The feed-screw was designed to be in tension during the boring operation, the axial thrust being taken by a stepped or collar bearing *G* (Fig. 5).

The forged steel cutter-head shown in Figs. 2 and 4 is 12½ inches outside diameter and six inches long. This cutter-head has seven cutters or tools, six being for roughing and one for finishing. Each of the roughing tools took a cut having a radial width of ¼ inch, the feed being 1/32 inch per revolution, as previously stated. The front edge of the inner cutter protrudes 1½ inch from the cutter-head, and the other tools are arranged in steps varying by 1/16 inch increments, toward the cutter-head, as shown in Fig. 4. The cuts were distributed between the different tools so that if one should break the following cutter could do the work of two tools. When boring one of the holes a tool did break, but this was not detected until the hole was successfully finished. The cutting speed for roughing was 45 feet per minute, and the speed for finishing was 51 feet per minute.

The four outer cutters are held in rectangular grooves cut across the edge of the cutter-head, whereas the three inner cutters are inserted into slots cut through the head. The roughing cutters are ⅞ by 1½ inch and are made of "Ultra Capital" high-speed steel. The rear edges of the tools are beveled and they are held by wedges *W*, which are forced downward by screws as shown. This method of holding the tools proved very effective. The position of all the tools can be adjusted longitudinally by means of set-screws *B* located in the back plate *C*. The finishing tool *E* rests in a seat *F* beveled axially so that the tool is not only adjustable in a longitudinal direction, but outward or radially to a limited extent. In this way, it was possible to regulate the diameter of the hole with considerable accuracy. The circular gage for setting the tools may be seen in the upper part of Fig. 2. It has a series of annular steps which represent the respective diameters to which the cutters must be set. The gage is partly cut away on one side and when it is placed on the bar, the steps or edges formed by this opening provide a simple but accurate means of setting the tools.

The removal of the chips presented a rather serious problem, as they had to pass forward through the long opening between the 6¾-inch bar and the wall of the ten-inch pin-hole. No chips could pass between the cutter-head and the thirteen-inch hole owing to the lack of room. This problem was solved by grinding the tools so as to produce chips in long curls not over 1½ inch in diameter, so that they could readily pass through the opening. As will be seen by referring to Fig. 4, the cutting edges incline backward in such a way as to curl the chips downward and cause them to follow the path indicated by the arrows. As the chips left the tool they were turned toward the front by the large fillet-like projection *G* on the cutter-head. To protect the feed-screw from the chips, a cover plate six inches long is attached to the front face of the cutter-head. On the face of this plate there is a spiral deflector *D* forming an angle of 45 degrees with the bar for propelling the chips forward. While boring the hole, the tools were cooled by a liberal supply of soap- and soda-water solution. Four barrels of this solution were placed on the top chord of the truss forty feet above the pin-hole, and the lubricant was directed onto the tools by the hose shown in Fig. 1.

All four of the pin-holes were bored without the slightest mishap. When boring the last hole, the old pin was removed at 10:30 P. M. and before midnight the boring-bar was ready for use. The traffic on the bridge was stopped at 12:15 A. M. Tying the members to be bored rigidly together, required fifteen minutes and the boring operation began at 12:30 A. M. The hole was enlarged to 13 inches by 1:30 A. M. While the machine was capable of finishing the hole in one cut, as originally planned, it was decided to take a 1/64-inch finishing cut in all cases, as there was time for a second cut. The latter required only forty-five minutes, as the motor ran faster under the light load. The new pin was in the hole and two new wind-chord members placed on it at 3:30 A. M. when the bridge was again ready for traffic after an interruption of only three hours fifteen minutes. That this work was done without a hitch was due to the careful planning of the Department of Bridges (F. J. H. Kracke, commissioner) and to the efficient design of the boring machine.

The power required to drive the boring-bar was calculated from the rules given by Taylor and Nicholson. The rule given by the former to allow as much power for feeding the tools forward as for turning the bar was adhered to. The ammeter and voltmeter readings taken at one minute intervals during the boring operation showed that nearly five horsepower was required for driving the machine when running without load, whereas the maximum power while boring was twenty-six horsepower. The calculated power was eighteen horsepower, but in this calculation no allowance was made for the friction caused by the chips in the hole, which proved to be quite high, as one horsepower less was required while boring the rear part of the hole from which the removal of chips could be assisted by hand. The weight of the boring machine frame is about two tons and that of the boring-bar, with the two main bearings attached, about 1400 pounds.

LETTERS ON PRACTICAL SUBJECTS

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DRAWING A CIRCULAR BRASS CUP

The following outlines the experience which the writer had in drawing a brass cup made from stock 1/16 inch in thickness. The first operation was performed in a combination blanking and drawing die of the usual type, and resulted in the production of a cup of the form shown by dotted lines *A* in Fig. 1. With the work carried to this point, it was desired to complete the cup in two operations, and the first attempt in this direction was made with the punches and die shown in Fig. 1. These tools were used in the following manner: A blank was placed in the die and the punch for the second operation was intended to force it down into the die, turning up the flange about point *E* and bringing the cup to the form shown in cross-section in Fig. 1. The punch for performing the third operation was similar to that used for the second operation, with the exception that the working rim was 1/16 inch longer. The purpose of this punch was to upset the lower edge of the rim. The trouble with this process occurred in the second operation. After the flange of the cup had been turned up about half way, the work offered so much resistance to being compressed that the metal began to turn up from the body of the cup at the point *D*, and this made it impossible to force the stock down into the die.

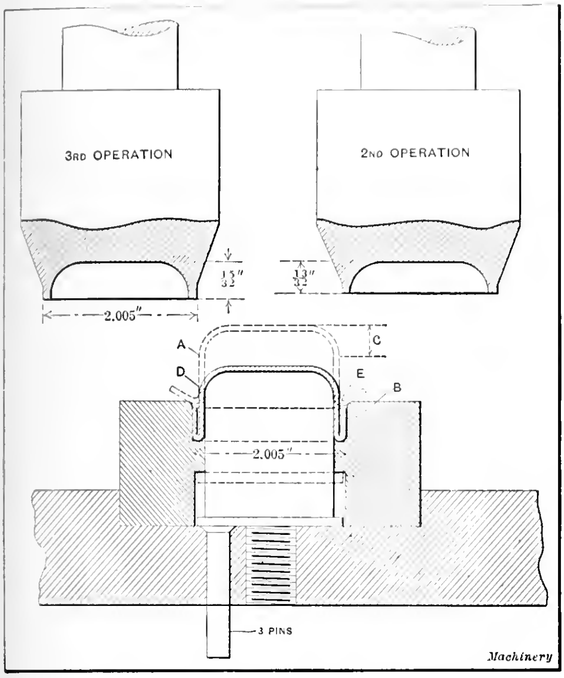


Fig. 1. Punches and Die that proved Unsuccessful for the Drawing Operation

To overcome this difficulty, the dies shown in Figs. 2 and 3 were designed. Fig. 2 shows the punch and die for performing the second operation, where it will be seen that the rim of the punch is extended in order to support the body of the cup at all points. The work is also supported from the inside by the spring plunger. When drawing the cup in this punch and die, deformation of the work is practically impossible. The design of the die provides for stripping the finished cup and also allows a free movement of the plunger, which is required to rise considerably above the die to facilitate locating the blank. The third operation is performed by the punch and die shown in Fig. 3, and the method of using these tools will be self-evident to any mechanic without a lengthy description. A blank upon which the second operation has been performed is inverted and forced down into the die. Great pressure is required to be exerted on the metal at *H* in order to upset it properly and produce a smooth surface. It was found necessary to taper the punch about 0.010 inch along the straight portion *J* in order to make it fairly easy to strip the cup from the die.

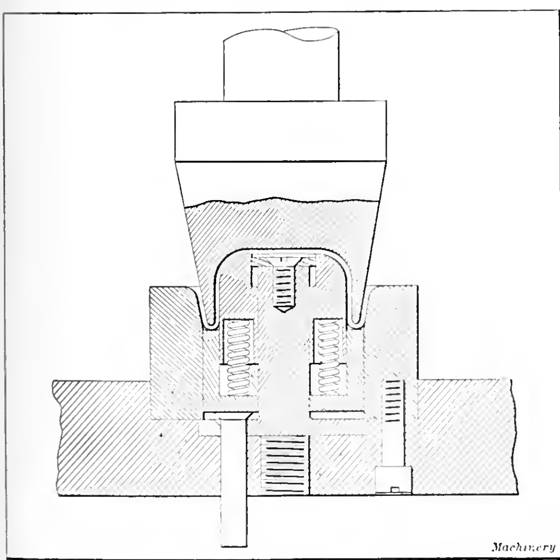


Fig. 2. Punch for Drawing Operation that gave Good Results

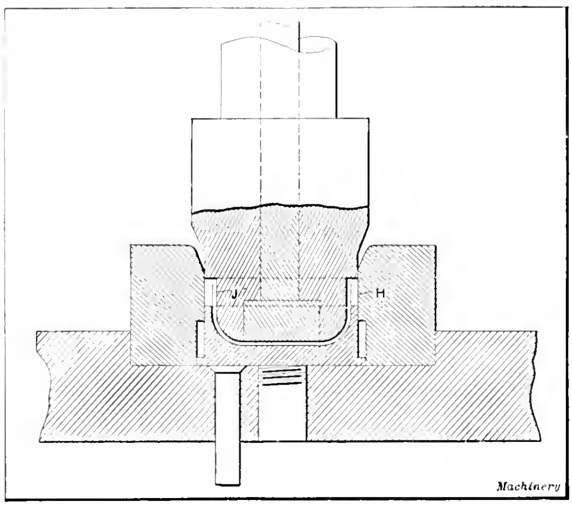


Fig. 3. Punch for upsetting the Edge of the Rim

Columbus, Ohio. OTTO R. WINTER

SETTING THE MILLING MACHINE TABLE AND KNEE

The method I am about to describe provides for locating a milling machine table and measuring the distance from the table to the center of the spindle, when it is desired to locate the table at a specified distance below the spindle. This method is rapid and accurate, and should be appreciated by milling machine operators who do a variety of work and are often required to bore or drill a hole at a certain distance from a finished face on the work, as in the case of a bearing bracket. The method of locating the table in a certain longitudinal position is also explained, this method being useful in cases where it is desired to locate the dividing head crosswise on the table and have it exactly opposite the spindle.

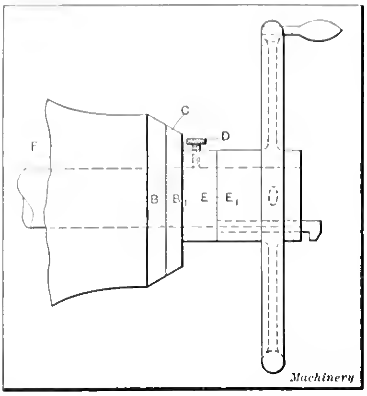


Fig. 1. Locating Height of Milling Machine Knee

Fig. 1 shows the knee handwheel, and a pair of angle plates for making the preliminary setting of the table relative to the spindle as shown in Fig. 2. The distance A is made any convenient length, and by the use of an indicator held in the spindle chuck the knee may be adjusted vertically until the spindle is centered on A. With this setting the table will be $\frac{A}{2}$ below the center of the spindle. Having proceeded thus far, a line is scribed on the column slide and knee, which serves as an approximate location. The zero line B_1 of the graduated dial C is next brought into coincidence with the zero line B on the boss of the knee, after which the dial C is locked to the feed-screw by means of the binding screw D. On the hub of the dial and the hub of the handwheel scribe zero lines E and E_1.

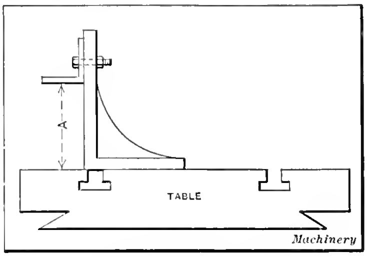


Fig. 2. Angle Plates for making Preliminary Setting

After the setting has been made in this way, the table may be returned to the starting point by first locking the dial C to the feed-screw F with the index lines E and E_1 in coincidence; then raise or lower the knee until the lines on the column slide and knee, and the index lines B and B_1 are both in coincidence. This shows that the table has been returned to the required point and the accuracy of the setting may be depended upon. Care should be taken that the tension of the screw is upward and that all of the table and knee locking screws are tight before the lines are scribed and the final adjustment is made. By locating the dial C with the index lines E and E_1 in coincidence, any location may be obtained by measuring with a scale from the line on the column slide and having the index lines B and B_1 correspond with the scale measurement.

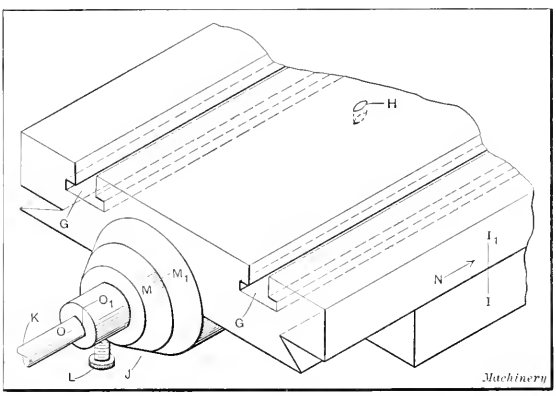


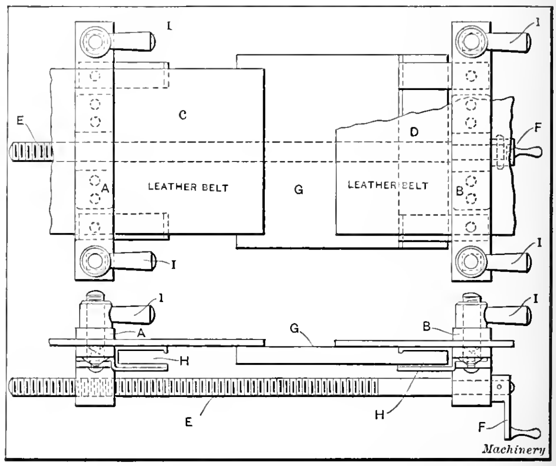
Fig. 3. Locating Longitudinal Position of the Milling Machine Table

Most of the milling machines used in jobbing shops are provided with an auxiliary baseplate or jig for use in setting the dividing head crosswise on the table, so that it is in line with the spindle. The method of making this setting is illustrated in Fig. 3. The jig is first located on the table by tongues which fit in the slots G and a dowel-pin H. With the dividing head in place on the jig, use an indicator in the chuck of the machine spindle to set the dividing head spindle in line with the machine spindle. When this setting has been made, scribe the index lines I and I_1 on the slide and table. Next lock the graduated dial J to the table feed-screw K by means of the binding screw L, having the zero lines M and M_1 in coincidence. Care should be observed to have the tension of the table feed-screw in the direction indicated by the arrow N when the lines are scribed and the final adjustment is made, and the same precaution should be observed in resetting. The reading of the handwheel and the distance of the table below center should also be observed and a memorandum of these readings should be preserved. To relocate the table in this position, the first step is to lock the graduated dial J to the table feed-screw K, having the index lines O and O_1 in coincidence. Then feed the table in the direction of the arrow N until the index lines I and I_1, and also the lines M and M_1 correspond. Using this method and having the jig located by the dowel-pin H, an accurate setting is assured.

Denver, Col. STANLEY EDWARDS

DEVICE FOR ADJUSTING DRIVING BELTS

The accompanying illustration shows a very simple and convenient device for stretching belting preparatory to cutting and lacing. It is similar in design to the various devices of its kind on the market today, but is particularly easy to manipulate. In the past I have been using the Gardner & Miller patent belt clamp, which is operated by two feed-screws with turnbuckles. This necessitates the use of both hands in tightening. It is also minus the cutting-board arrangement, which has to be supported by hand while cutting; I therefore "hit upon" the accompanying design.



Device for adjusting Driving Belts, equipped with a Cutting Board

The clamps A and B are operated by handle-nuts I, which work up and down on bolts with square shoulders, thus fastening the ends of belts C and D. The belts are then ready to stretch by means of the screw E which has a crank F on its squared end. The crank F is replaced by a wheel with a corrugated rim, which is used in preference to the regular crank when adjusting small belts, as it does not get too much tension on the belts and leaves them in condition for a future adjustment. The cutting-board G is then inserted in compartment H, leaving the belt ready for cutting and lacing.

Bronx, N. Y. ERNEST SCHWARTZ

A USEFUL T-SQUARE

While visiting a drafting-room recently my attention was attracted by a T-square that was being used by one of the draftsmen. From various catalogues, etc., in which the desired data could be found there had been clipped tables of decimal equivalents, bolt-head and nut sizes, pitch of stand-

ard screw-threads, number and letter sizes of twist drills and many other tables of use to the draftsman. These tables had been arranged and pasted on the top sides of the T-square blades, after which they were given a coat of shellac. It impressed me that the usefulness and convenience of this system could be applied generally, as it is not necessary to even look away from the board to obtain data that is in common use. It is surprising to know how much printed matter can be placed on the blade of an ordinary T-square.

Denver, Col. STANLEY EDWARDS

OIL VAPOR IN COMPRESSED AIR

I notice an inquiry by the O. B. M. Co. in the May number of MACHINERY on how to remove oil vapor from compressed air. As I have had to do with the lubrication of a great many air compressors in the work in which I am engaged, I would say that very often more oil is used in the cylinders of compressors than is necessary. The compressed air is dry and there is no moisture to wash the oil off the surfaces as in the case of oil cylinders, and but very little oil is needed to afford good lubrication. The company probably is using more oil than is necessary and it is the vapor which arises from the large amount of oil in contact with the hot surfaces that is causing the trouble. A smaller amount, just enough to give good lubrication, would not give off an appreciable vapor. The oil used should be sufficiently high in flash point so that it will not give off an appreciable amount of vapor at the temperatures ordinarily obtained in air compressors.

Two years ago while reorganizing the lubricating practice of a large corporation, I found at one plant, where several air compressors were in use, that the chief engineer used no oil whatever in his air cylinders but used soapsuds as a lubricant. The suds were made by dissolving a bar of hard soap in about five gallons of water, and were fed into the cylinder the same as oil.

Boston, Mass. WILLIAM N. DAVIS

EXAMPLES OF BELT GUARDS

The accompanying illustrations show three examples of types of belt guards which have been adopted for use in the plant of the Norwich Pharmacal Co., Norwich, N. Y. This firm has devoted a great deal of time and money to the provision of safeguards and after a thorough investigation has found that this type of belt guard gives very satisfactory results. Referring to the illustrations it will be seen that Fig. 1 shows the guard used to cover the belts of a drill press, while Figs. 2 and 3 show the application of this type of guard on woodworking machines. Guards are particularly important on woodworking machinery owing to the high speeds

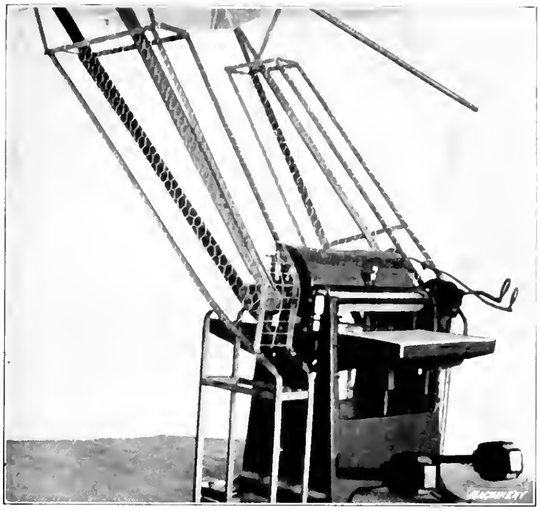


Fig. 3. Belts of a Wood Planer that are adequately guarded

at which such belts are customarily run. The construction will be evident from the illustrations.

Norwich, N. Y. GEORGE F. STACK

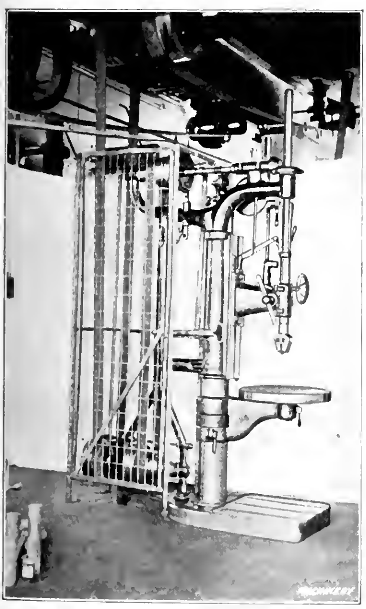


Fig. 1. A Simple Guard for Drill Press Belts

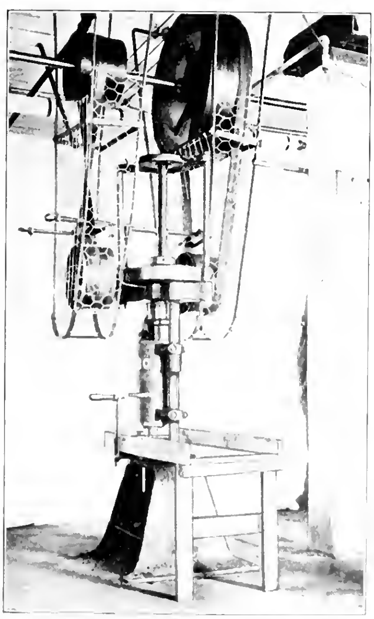


Fig. 2. Another Example of Simple but Efficient Belt Guards

ETHICS OF CONTRIBUTING TO THE TECHNICAL PRESS

Much has been written on the question of the general rights of progressive men in regard to publishing descriptions of up-to-date methods, knowledge of which they have gained in their general experience, and it is easy to see that the matter cannot be arranged satisfactorily to all. The manufacturer generally thinks he is being wronged if one of his employes, or former employes, makes public some of his general methods of manufacture. On the other hand, the employe must be allowed some rights in the matter.

Many a man may have ability and qualifications which his present employer does not recognize or appreciate, but the man often is possessed with a determination to be recognized and sits down and thinks over different ways of doing it. He desires to prove that he can do what he claims he can. What better way is there to do this than to write of what he knows for the technical journals pertaining to his particular line of business? In his experience as a workman he has seen and studied the various methods used by him and—if he has the ability to hold a position requiring brains—has either made or suggested improvements and money saving features in connection with such methods that may, or, as is often the case, may not have been accepted by the powers higher up.

So, in the desire to help others willing to study and at the same time help himself, he writes for the magazines describing his experiences and methods he has improved upon. They are published, the general trade is benefited, he gets a check which will help him in his battle for a fair living, and nobody is a loser by such publication. Of course, it will be understood that the stealing of a valuable drawing and the furnishing of the same to the

press or to a competitor is not morally right or legal, but if a man sees a machine and is then clever and competent enough to make a good drawing of it and its motions and write about it on his own time, there can be no reasonable objection sustained by anybody.

As a matter of fact, when a firm refuses to raise a man's wages above a living rate, and lets him go out of its employ, there certainly can be no claim on him or what he has learned while with this firm. If there is anything that this firm does not wish anybody else to use, and it is really an invention, the only legal protection is a patent or copyright. If such a method is not novel enough to be granted such protection there should be no objection to the publication of it. As a matter of fact there is nothing done today that could not be improved upon, and these same manufacturers who object to the publication of some insignificant improvement which may have been used by their own former employers years back will welcome the publication of an improvement if made at the works of their competitors.

Publication of a method causes no actual loss. As a general policy, any manufacturer reading of an improvement on a method that is better than his own, immediately sets to work to make a still better one and the general public is thereby benefited. Any suppression of information for the purpose of enabling a few men to make their money more easily is a menace to our national progress and should not be considered. Were it not for the books and magazines published at the present time, our national mechanical development—the highest of any country—would be seriously crippled.

Southbridge, Mass. WARREN E. THOMPSON

THE MAKING OF RACE CAMS

Some time ago the problem of cutting a race cam similar to the one shown in Fig. 1 arose. This cam had to be cut on short notice and at low cost. The standard method of doing such work required a large amount of time and money to be spent in making a master cam for the cam cutting machine. The difficulty was easily and economically overcome by making the cam as shown in Fig. 2.

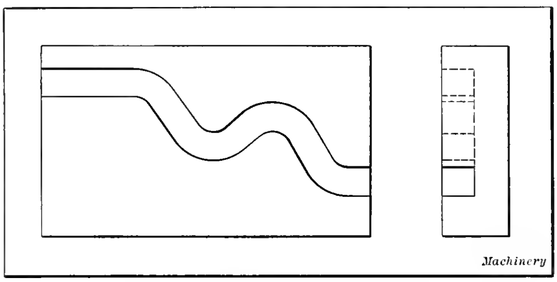


Fig. 1. Type of Race Cam to be made

Instead of using one casting, as is the usual practice, two castings were used. These were first machined so that the casting *A* in Fig. 2 had a thickness equal to the required depth of the raceway; and the other casting *B* was of such a thickness that when the two were fastened together they would have a combined thickness equal to that required for the cam. The piece *A* was cut with a surface on its upper edge which gave the outline of the lower side of the raceway. The other piece was then cut with a surface on its upper edge which corresponded to the upper side of the raceway. These two pieces were fastened together with countersunk machine screws and dowel pins, so that the two surfaces corresponded to the required surfaces of the raceway.

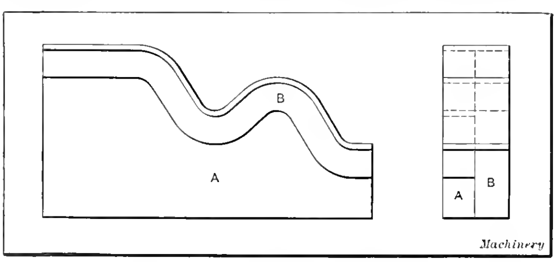


Fig. 2. How the Cam was finally made

A piece of sheet brass, 1/16 inch thick, and of a width equal to the thickness of the cam, was then bent so that it fitted perfectly with the surface of the upper side of the raceway. This piece was then fastened to the cam with countersunk machine screws. The result was a cheaper cam than could possibly have been produced by the old method, and an equally efficient one for the purpose for which it was required.

Philadelphia, Pa. SIDNEY K. EASTWOOD

DRILLING EQUI-DISTANT HOLES IN A STRAIGHT LINE

The method described in the following was used for drilling eighteen holes with a No. 48 drill through a piece of brass 7/8 by 1/8 by 24 inches in size. It was required to have the holes spaced exactly 1 inch apart and located in a perfectly straight line. Referring to Fig. 1, the edge *A* of the piece of brass *B* was filed true to a 24-inch standard steel straightedge, and the first hole *C* was then drilled 7/16 inch from the edge *A*. A 1-inch hardened scale *D* was next ground away at one corner so that it would not touch a drill in the hole *C* when the square *E* was placed against the drill with the head of the square on the edge *A*. The scale *D* was clamped to the work by means of a small hand clamp *G*.

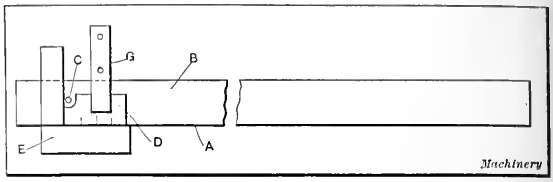


Fig. 1. One-inch Scale for obtaining Longitudinal Spacing of Holes

The work *B* with the scale *D* clamped to it was next placed against the 24-inch steel straightedge shown at *H* in Fig. 2, and a 1/16 brass strip *I* with a hole *J* drilled in it was clamped to the straightedge *H* by means of a hand clamp *K*, a thin strip *L* being placed between the strip *I* and the straightedge *H* so that the combined thickness of the straightedge and strip *L* was slightly greater than the combined thickness of the work *B* and the scale *D*. The straightedge *H* was next clamped to a board *M* by means of two parallel clamps *N*, after which the second hole was drilled in the work through the hole *J* in the strip *I*. In order to locate this hole, the drill was brought into contact with the end of the 1-inch scale *D*, this contact being determined by "sense of touch" as the drill revolved.

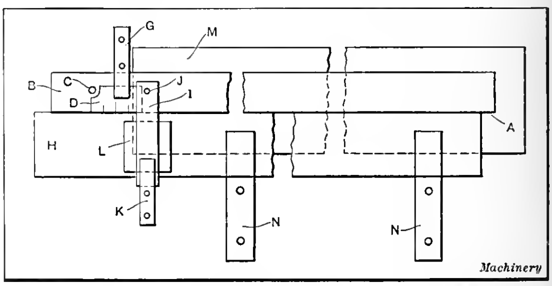


Fig. 2. Twenty-four-inch Scale and Jig for obtaining Transverse Alignment

The work *B* was next removed and the scale *D* unclamped and reclamped in the next position, while the drill was still in the hole *J*, the method of setting being the same as illustrated in Fig. 1. The work was then assembled once more—as illustrated in Fig. 2—and the third hole drilled. All of the hand clamps were so placed that they did not extend over the drilling machine table or interfere with the operation in any way. This sequence of operations was continued until eighteen holes were drilled, and when the work was completed the distance between the holes and their alignment was found to be quite accurate. G. L. C.

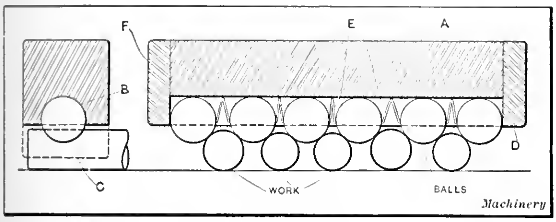
A MULTIPLE CLAMP

In certain operations where quick-acting tools are employed, a decided advantage is obtained by securing several pieces of work with a single clamp. The clamp illustrated herewith was designed with this object in view. Referring to the illustration it will be seen that the design is quite simple, there being none of the complicated floating parts which are often employed in tools of this kind.

The principle upon which this clamp operates is that of allowing the clamping members, which are hardened steel balls, to roll or slide between two fixed ends. Being free to move laterally, these balls adapt themselves to slight variations in the size of the work. The slight irregularity in the center distances caused in this way may produce corresponding inaccuracies in the work, but in most cases the error is negligible.

The main body of the clamp *A* may be made to suit the requirements of the work which is to be handled. This body is bored at *B* to receive the clamping balls. After boring the hole, the stock *C*, which is shown in the illustration by dotted lines, is milled away almost to the horizontal line passing through the center of the hole *B*. Just enough stock is left below the center to prevent the balls from dropping out. One end of the hole is next closed by a plate *D*, after which the balls are put in through the other end, spring spacing pieces *E* being used to maintain the required center distances. The plate *F* is then secured to the opposite end of the clamp.

In operation, the two end balls are held in position by the plates *D* and *F*, and the remaining balls are free to move laterally to adapt themselves to irregularities in the size of the work, the irregularity in size being considerably exag-



A Multiple Clamp which is adaptable for Differences in the Size of the Work

gerated in the illustration. When pressure is applied to the clamp, all of the pieces of work are held equally tight. Instead of using balls, a clamp of this kind could have a dovetailed slot milled in it and hardened rolls with tapered ends, or sliding dovetailed pieces, used for the clamping members.

Providence, R. I. C. KNOWLES

IMPROVED DOWELING METHOD FOR DIES

Blanks which have been punched from sheet metal are often perforated by a second operation performed in a piercing die. The blanking and piercing are sometimes accomplished in a single operation, using a gang punch and die, but when accuracy is essential a more common method is to perform the blanking and piercing operations separately.

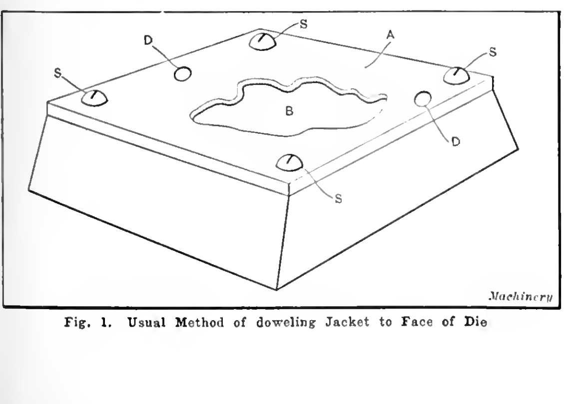


Fig. 1. Usual Method of doweling Jacket to Face of Die

The blank is usually located on the piercing die by means of a gage or "jacket" which consists of a sheet metal piece with a hole through it of the shape and size of the blank. The works fits closely into this gage, which is depended upon to locate the blank and bring it into exactly the desired position for piercing.

The gage is securely held to the die with screws, but screws cannot be depended upon to keep it accurately located; consequently the use of dowel pins is resorted to. The dowel-pin holes are drilled with the gage in place and close fitting dowel pins are driven through it into the die. This method of securing the gage is shown in Fig. 1, where *A* represents the gage with the locating hole *B* cut in it. The screws holding the gage to the die are shown at *S* and the dowel pins at *D*.

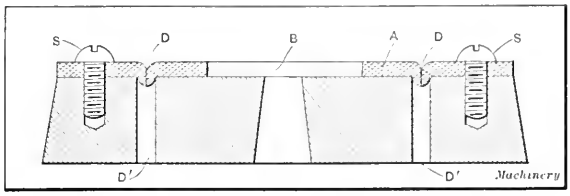
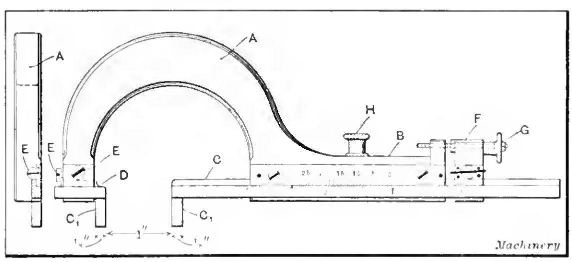


Fig. 2. Improved Method of doweling Jacket in Place

A better method of securing the gage or jacket to the face of the die is shown in Fig. 2. With the gage *A* in position, holes are drilled through it into the die at the points where the dowel pins should be. Two holes 1/16 inch in diameter are drilled in this way. The gage is then removed and the holes *D'* in the die are enlarged to a diameter of 1/8 inch. After hardening the die, the gage is replaced, and after locating it and fastening it in the required position with screws *S*, the point of a center-punch is placed in the 1/16-inch holes and the metal is driven downward into the larger holes in the die. In this way metal plugs *D* which take the place of the dowel pins project from the under side of the gage into the die. It does not take long to locate the gage in place in this way, and, as the plugs are part of it, they will always remain securely in place. F. E. C.

OUTSIDE AND INSIDE VERNIER CALIPER

The accompanying illustration shows a two-inch vernier caliper which is suitable for making both outside and inside measurements. These measurements may be made by using the tool directly or by setting ordinary outside or inside calipers. The following notation is used in marking the different parts of the instrument. *A* is the bow frame which has an extension *B* that supports the guide for the bar *C*. This bar has a projecting jaw C_1 which corresponds with the



A Two-inch Vernier Caliper for Outside and Inside Measurements

projecting jaw on the fixed jaw *D*. The fixed jaw is adjusted by means of the screws *E*. The projecting jaws C_1 are finished circular on the outside to provide for measuring internal sizes, while the inside jaws are made flat and are capable of measuring on the outside of either flat or round parts.

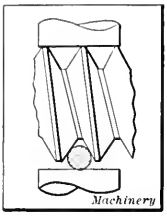
The bar *C* has forty graduations per inch, as usual, with a graduated margin extending beyond the two-inch line to cover a vernier reading in thousandths of an inch. The vernier plate is not made in accordance with the usual method, but is graduated twice the length of the ordinary plate made for a scale with forty graduations per inch. The reason for this is that the vernier plate cut to correspond with each alternate line is easier to read and also provides for getting

dimensions to 0.0005 inch. The adjusting head F is provided with a screw G for regulating the bar C, and H is a binding screw which holds the bar in place after the caliper has been set. A valuable feature of the instrument is that it is of rugged construction and not likely to get out of order. The total outside measurement of the jaws C_1 when together is 0.250 inch, so that in setting for inside measurements the vernier reading is 0.250 inch less than the true dimension. A vernier caliper of this kind could be made in different sizes to meet the requirements of various classes of work.

Springfield, Mass. FRANCIS W. CLOUGH

ONE-WIRE SYSTEM FOR MEASURING THREADS

The pitch diameter of screw threads may be measured with ordinary micrometers and one wire arranged as indicated in the accompanying illustration. If the outside diameter of the screw is large or small, allowance must be made for this in measuring. If it is over-size, one-half of the amount that it is over-size must be added to the dimension for the standard outside diameter in the formulas below. If it is under-size, one-half of the amount that it is under-size must be deducted. One wire is much easier to handle than three wires, and when the thread is of very coarse pitch, the end of the micrometer spindle will not reach from one thread to the next as is necessary with the three-wire system. If M = micrometer reading over wire, when pitch diameter is correct, then the formulas for measuring with micrometers and one wire are:



For V-thread,

$$M = 1.5 \times \text{diam. of wire} - \frac{0.866}{\text{no. threads per in.}} + \text{std. outside diam.}$$

For U. S. standard thread,

VALUES OF CONSTANTS USED IN FORMULA FOR MEASURING PITCH DIAMETERS BY THE ONE-WIRE SYSTEM

No. of Threads per Inch	V-Thread 0.866, No. of Threads	U. S. Thread 0.7577, No. of Threads	Whitworth Thread 0.8004, No. of Threads	No. of Threads per Inch	V-Thread 0.866, No. of Threads	U. S. Thread 0.7577, No. of Threads	Whitworth Thread 0.8004, No. of Threads
2¼	0.3849	0.3368	0.3558	20	0.0433	0.0379	0.0400
2⅜	0.3647	0.3241	0.3370	22	0.0394	0.0344	0.0364
2½	0.3464	0.3031	0.3202	24	0.0361	0.0316	0.0334
2⅝	0.3299	0.2887	0.3049	26	0.0333	0.0292	0.0308
2¾	0.3149	0.2755	0.2911	27	0.0321	0.0281	0.0296
2⅞	0.3013	0.2631	0.2784	28	0.0309	0.0271	0.0286
3	0.2887	0.2526	0.2668	30	0.0289	0.0253	0.0267
3¼	0.2665	0.2332	0.2463	32	0.0271	0.0237	0.0250
3½	0.2475	0.2165	0.2287	34	0.0255	0.0223	0.0236
4	0.2165	0.1895	0.2001	36	0.0241	0.0211	0.0223
4½	0.1930	0.1684	0.1779	38	0.0228	0.0199	0.0211
5	0.1732	0.1516	0.1601	40	0.0217	0.0190	0.0200
5½	0.1575	0.1378	0.1456	42	0.0206	0.0181	0.0191
6	0.1444	0.1263	0.1334	44	0.0197	0.0172	0.0182
7	0.1237	0.1083	0.1144	46	0.0189	0.0165	0.0174
8	0.1083	0.0947	0.1001	48	0.0180	0.0158	0.0167
9	0.0962	0.0842	0.0890	50	0.0173	0.0151	0.0160
10	0.0866	0.0758	0.0801	52	0.0167	0.0146	0.0154
11	0.0787	0.0689	0.0728	56	0.0155	0.0135	0.0143
12	0.0722	0.0632	0.0667	60	0.0145	0.0127	0.0184
13	0.0666	0.0583	0.0616	64	0.0135	0.0119	0.0125
14	0.0619	0.0541	0.0572	68	0.0128	0.0117	0.0118
16	0.0541	0.0474	0.0501	72	0.0121	0.0105	0.0111
18	0.0481	0.0421	0.0445	80	0.0108	0.0095	0.0100

Machinery

$$M = 1.5 \times \text{diam. of wire} - \frac{0.7577}{\text{no. threads per in.}} + \text{std. outside diam.}$$

For Whitworth thread,

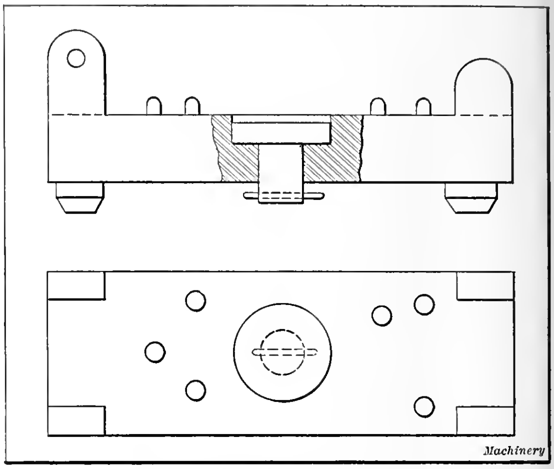
$$M = 1.583 \times \text{diam. of wire} - \frac{0.8004}{\text{no. threads per in.}} + \text{std. outside diam.}$$

The size of the wire used is governed by the pitch and form of thread. The best size to use is that nearest to two-thirds of the pitch. Mistakes can easily be made if too large a wire is used. A wire smaller than 0.6 or larger than 0.9 of the pitch should not be used. The accompanying table gives values of constants which are used in the formulas for measuring pitch diameters of screws by the one-wire system. This method of measuring the threads, of course, presumes that the thread has been cut on centers, so that it is certain to be concentric with the outside diameter of the screw.

Belvidere, Ill. IRVING BANWELL

EJECTING DEVICE FOR USE ON JIGS

The accompanying illustration shows an attachment designed for use on jigs where it is necessary to have the work a tight fit on locating pins. Where this practice is employed and the work has a flat surface in contact with the jig, difficulty is often experienced in removing the piece after the machining operation has been completed. This difficulty is easily overcome by adopting the ejector illustrated herewith. It will be seen to consist of a shoulder pin which is counterbored into the jig and pinned at the opposite side to prevent the shoulder pin from being lost. After the machining operation is completed, the pin is simply tapped up under the work, and in this way the latter is easily knocked off the locating pins.

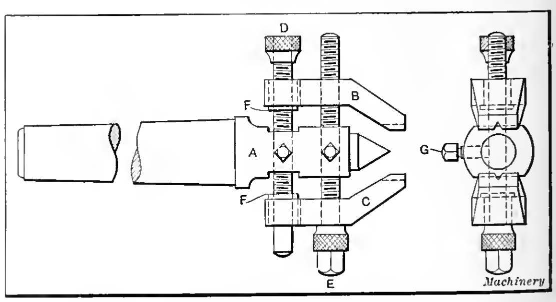


Plug for ejecting Work from Jigs and Fixtures

Montreal, Canada. HERCULES SMART

DRIVER FOR USE IN MILLING MACHINE INDEX HEAD

In the accompanying illustration is shown a driver for use in the milling machine index head for short pieces or for such work as requires to be milled on centers and close to the shank, as for example a short machine tap. Usually, the dog or driver is too much in the way on short work and this tool was made to overcome this trouble. The shank A is of tool steel and machined all over, after which the point is hardened, tempered and ground the same as any center. The jaws B and C are of machine steel, slotted at the ends to



Driver for Short Work where a Regular Dog interferes

receive the shouldered nuts. Jaw *B* is drilled and tapped for the screw *E*, while jaw *C* is drilled and reamed for the same screw. Both jaws are carbonized and hardened. Screw *D* has right- and left-hand threads with the middle portion plain, and the knurled head is a separate piece screwed and pinned on after complete assembly. The screw *E* is of one piece, with a right-hand thread of sufficient length for the extreme adjustments. Nuts *F* are drilled and tapped left and right to an easy fit on the screw *D* and are milled to an easy fit in the slots in the jaws *B* and *C*, having shoulders to take the thrust of the screw *D*. In use, the work is placed on the centers as with regular methods of driving, and the jaws *B* and *C* are brought into contact with the work; the jaws are adjusted the same as a parallel clamp is, and given the final "squeeze" with a wrench on the squared head of screw *E*. Then set-screws *G* are tightened lightly. It will be observed that the jaws are free to "float" until the set-screws have been tightened, which prevents cramping the work.

Hartford, Conn. ERNEST A. RUNGE

BABBITTING MANDRELS

The writer has given considerable time and study to the design of babbitting mandrels, and in the following article three mandrels are described which have been found satisfactory for use in babbitting bearings on a piece-work basis. The operation is satisfactory, very little defective work being produced. Fig. 1 shows assembly and cross-sectional views of a fixture for babbitting bearings of the type shown at *A*. The body of these bearings is made of malleable iron; they are rough-bored, turned and faced, and the bore recessed as shown. A very coarse feed is taken in order to produce a rough surface to which the babbitt will adhere firmly. There were a large number of these bearings to be lined and on this account it was found desirable to use a multiple fixture, the design finally developed being equipped with four mandrels as shown in the illustration. The mandrels are set in a cast-iron base *B*. It will be seen that the mandrel consists of two parts, the body *C* and a dovetailed piece *F* which has a small block *G* mounted in it. This block forms the oil groove in the bearing. The base of the fixture is bored in such a way that the mandrel and bearing are held concentric, and after the work has been set up as shown in the cross-sectional view everything is ready for pouring the babbitt. After the babbitt has been poured and given time to set the lever *D* is struck a sharp blow; this loosens the main part of the mandrel and enables it to be readily removed by inserting a wire in the screw-eye *E*. The dovetailed piece *F* is next removed by giving it a slight tap toward the center of the bearing. The bearing can then be removed from the fixture, and another casting set up in its place ready to be babbitted.

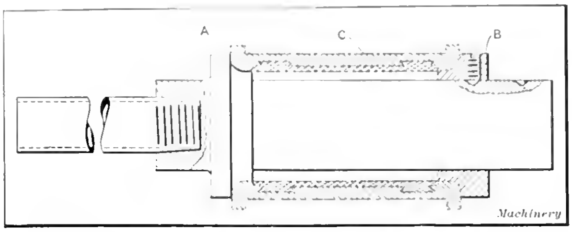


Fig. 3. Adjustable Mandrel for babbitting Plain Half Bearings

Fig. 2 shows a mandrel for babbitting bearings in which the oil grooves are set at an angle to each other as shown at *A*. This mandrel was made similar to the one shown in the preceding illustration and can be used in connection with the same base *B*.

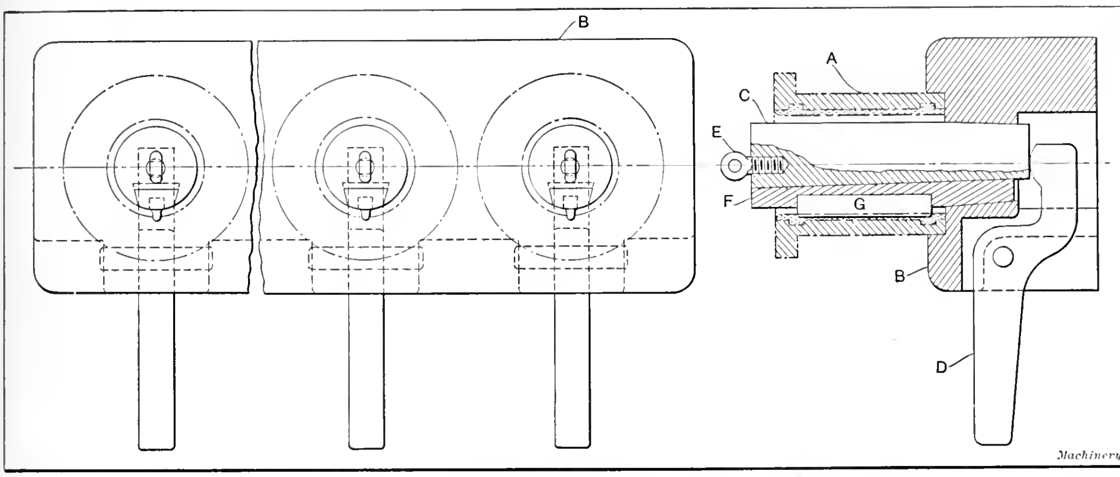


Fig. 1. Fixture equipped with Four Mandrels for babbitting Bearings with Straight Oil Groove

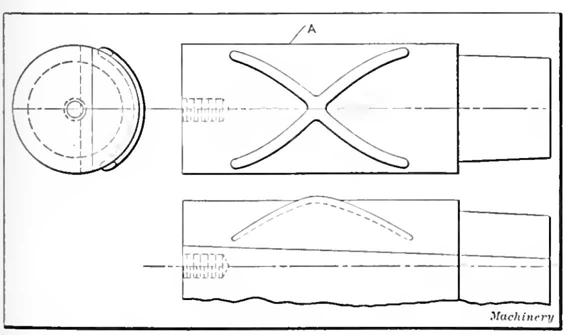


Fig. 2. Mandrel for babbitting Bearings with Crossed Oil Grooves

A mandrel is shown in Fig. 3 that is used for babbitting half bearings of the type shown at *C*, these bearings having no oil grooves. The mandrel consists of a center piece *A* which is provided with a handle made of ½-inch pipe at one end and a sliding collar *B* at the opposite end. The position of this collar can be adjusted for different lengths of bearings of a given diameter. It will be evident that the collar is held in position by a set-screw. The collars are turned to a close fit in the bearing castings so that they will not allow the metal to run out. These particular bearings were made of bronze castings and babbitted in the rough. The bearings were made in several different lengths, and by making the mandrel to suit the longest it may be used with equally good results for the shorter ones.

All three styles of bearings were babbitted on a piece-work basis with entirely satisfactory results. We generally had three or four of these fixtures set up on the bench, and by having a boy assemble the fixtures while the man did the pouring, a very satisfactory rate of production was attained. The best results are obtained by having all parts of the fixture and work at the same temperature. A good method is to lay as many of the bearing castings as possible around the top of the furnace in which the babbitt is melted.

G. E. P.

SPRING LATCH FOR JIG COVER

A hinged jig cover may be conveniently held in place by means of a spring latch of the form shown in Fig. 1, which is semi-automatic in its action. In this illustration, the body of the jig is shown at *A* and the hinged cover at *B*. This cover swings on the pivot *C*, and drops onto the latch *D* which takes the place of the locking screw arrangement shown in Fig. 2. In cases where the cover is merely used to carry bushings, a latch of this kind is entirely satisfactory, although it is not recommended for use on jigs where screws for holding down the work are carried by the cover. The method of using is evident from the illustration. To swing the cover clear of the work in the jig, the latch *D* is pushed back in the direction of the arrow. After the cover has been raised, the latch springs back into place ready to catch over the top of the cover, when it is dropped back onto the jig. When the cover is dropped, the latch catches it automatically, requiring no attention from the operator.

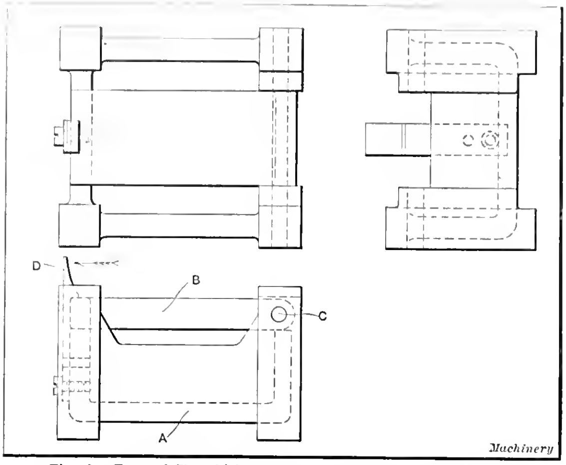


Fig. 1. Type of Jig which has Cover held down by Spring Latch

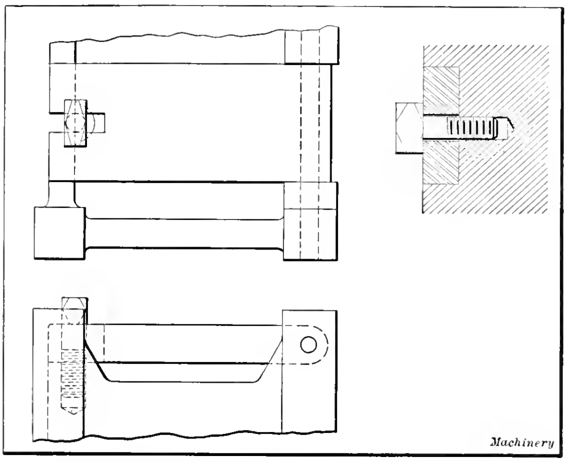


Fig. 2. Jig Cover locked by Quarter Turn Screw Buckle

F. SERVER

STRADDLE MILL KINK FOR CAST IRON WORK

When facing off the edges of a cast-iron piece with straddle mills, it will be noticed that the last corner at the end of the cut almost invariably breaks off. This condition is more marked if the edge at an angle to the face being milled has already been machined. The rounded corners on rough castings do not break as easily. Various remedies are used to avoid this difficulty, among which may be mentioned filing the corners of the work off on a bevel, supporting the work close up to the cut, or reducing the cut and feed. All of these methods, however, are but partially successful. The best "stunt" that the writer knows of is to take off the sharp corners of the cutter, *i. e.*, grind the corner off to an angle of 45 degrees, making a flat of about 1/16 inch. When this practice is followed the breaking and chipping of the work will be practically eliminated.

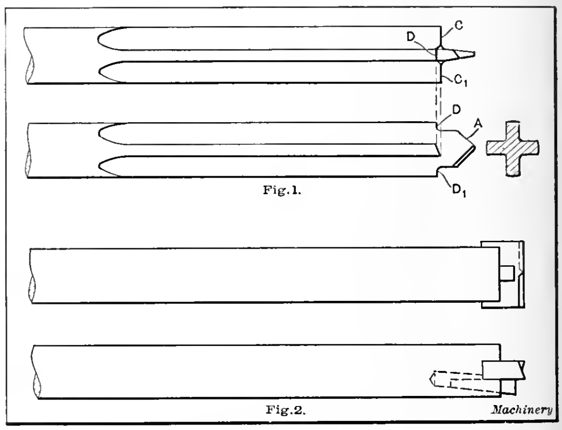
Middletown, N. Y. DONALD A. HAMPSON

[In facing a piece of work with straddle milling cutters, the stock left on the work at the time the cutters are approaching the completion of a cut is in the form of two cantilever beams. We know that the greatest stress in a cantilever is at the point of support, and by grinding off the corners of the cutters, as recommended, the cross-sectional area of this point of support is greater than that of any other cross-section. The additional strength provided in this way is sufficient to prevent the corner from breaking off.—EDITOR.]

DRILL AND BORING-BAR FOR PULLEYS

A drill for drilling holes in solid hubs of pulleys is shown in Fig. 1. The hole for which this particular drill was used is ¾ inch in diameter, which is too small to core and true by boring. We tried twist drills and flat drills, but if the drill encountered a blowhole in the casting, it would run out of true. The tool now being used is made of high-speed steel and it has drilled about one thousand pulleys and is still doing business. As the illustration shows, it is milled to a cross-shaped section which makes it very stiff.

The point of the drill *A* is ground like an ordinary flat drill and it makes a smaller hole than the main drill body. The two ends *D* and D_1 are ground below the cutting edges *C* and C_1 so that the stock left by the point *A* is removed by these two edges. Obviously, the ends *D* do not cut. If the drill is started true and fed in until the two corners *C* have entered, the hole acts as a bushing and the drill cannot run out, even though it enters a blowhole. Of course, the point *A* must be ground centrally and the edges *C* must be ground so that they both cut and do not make the hole larger than the drill body. This drill is 11/16 inch in diameter and is used in a lathe.



Figs. 1 and 2. Drill and Boring-bar for Pulleys

After a hole is drilled in a pulley, a boring-bar like the one shown in Fig. 2, is used for truing the hole. The corners of the cutter are ground square and the cutter, which is of high-speed steel, is held by a half-round key. The hole for this key is drilled on a slight angle before the slot is milled for the cutter. When a new cutter is to be inserted, the old one is driven out, which causes the key to fall out. The hole in the pulley is finished by reaming.

B. J. F.

* * *

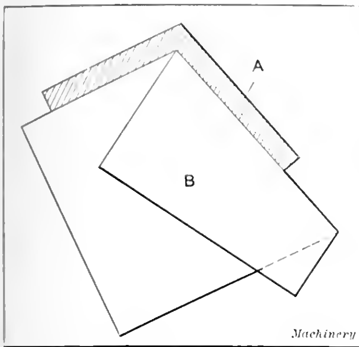
Persons who look upon the increase in gold production as chiefly responsible for the increased cost of living will regret to hear that important new deposits of gold have been found in Siberia (already one of the leading gold-producing regions of the world), and that these will rank among the richest fields in Siberia. According to that school of economists who put the blame on gold, if nature had made it as common as iron, we would all be starving.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

AN ANGLE BENDING KINK

It frequently happens that the machinist is required to bend a piece of sheet iron, brass or other stock to a certain angle, but the draftsman has omitted to give this angle on the drawing from which the machinist is working. In such cases, the time-honored method of bending a piece in the vise and then trying it on the drawing is often employed. Owing to greasy hands and to oil on the stock, the drawing soon becomes so dirty that it is unreadable.



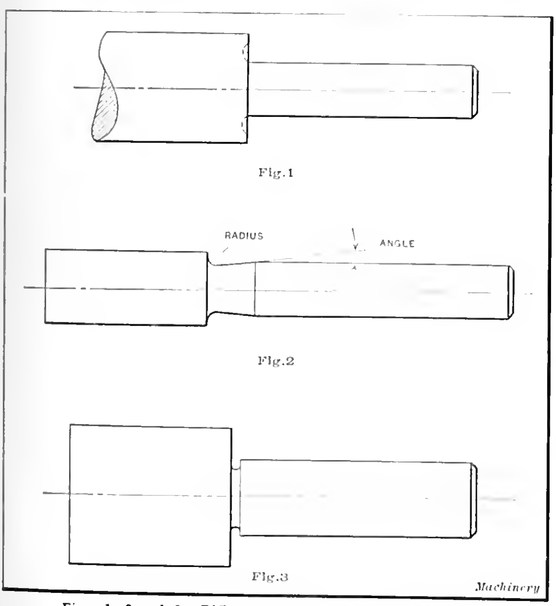
Paper Templet for bending Angles

A much cleaner method, which the writer has employed on a variety of work, consists of laying a piece of paper over the drawing with one edge coinciding with one side of the required angle. The paper is then folded as shown in the accompanying illustration, so that a templet of the required angle is formed. The stock is now bent in the usual way until it fits accurately against the templet. In the illustration, the cross-sectional view *A* represents the angle, as shown on the drawing from which the machinist is working, and *B* represents the paper templet.

East Orange, N. J. GEORGE GARRISON

A NECKING KINK

The accompanying illustrations show different methods of necking an arbor preparatory to grinding it. When there is a large shoulder at the end of the arbor, the most satisfactory method of necking is that shown in Fig. 1. Where the shoulder is relatively small, the method illustrated in Fig. 2 will give very satisfactory results. The method shown in Fig. 3 is in quite general use, but this is decidedly poor practice. It weakens the shaft or arbor very materially owing to the fact that the neck is cut in such a way that it reduces the cross-section at the point where the greatest strain is likely to be experienced.

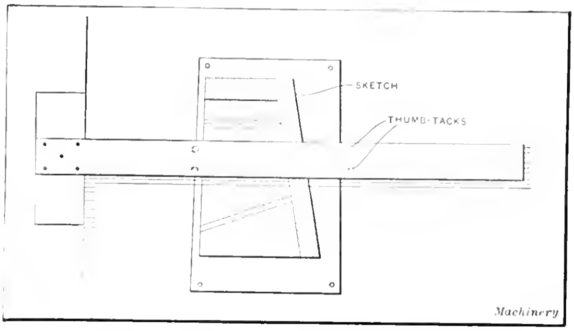


Figs. 1, 2 and 3. Different Methods of necking an Arbor preparatory to grinding

Lynn, Mass. R. F. Pohle

PROTECTING DRAWINGS

A method by which drawings may be protected against the smudging action of the T-square consists of sticking four thumb-tacks in the under side of the blade so that it will not come into contact with the portion of the drawing that it is desired to protect. This method will be found particularly useful where a pencil drawing is made, as it will prevent the pencil lines being rubbed by the T-square. It will also guard the drawing against being soiled by a dusty square, and the same arrangement will be found effective in preventing the ink from running under the edge of the square.

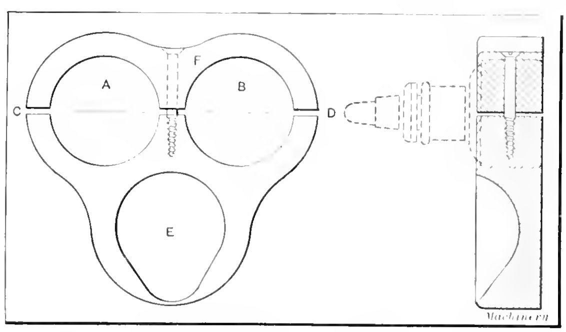


Method of raising T-square from Surface of Drawings

Washington, D. C. A. P. CONNOR

HOLDER FOR THUMB-TACKS AND INK BOTTLES

The illustration presented herewith shows a holder for a draftsman's ink bottles and thumb-tacks which can be easily made if the instructions are carefully followed. The outline, the holes *A* and *B* for the ink bottles and hole *E* for the thumb-tacks are laid out on a piece of one-inch board with the grain of the wood running parallel to the line *CD*. The holes are then cut out with a fine band-saw, the saw being first run along the line *CD*, after which the semi-circles are cut out. The hole *E* for the thumb-tacks is next made with a spoon gouge. The hole is then drilled for the screw *F* which holds the back in place, after which the parts are sandpapered and shellacked. When the shellac has dried the bottles are put in position and the back screwed up tight against them.



Tray for holding a Draftsman's Thumb-tacks and Ink Bottles

Davenport, Ia. R. H. RICHARDSON

* * *

The Massachusetts Institute of Technology has erected an aero-dynamic laboratory and has also instituted courses in the study of this science. It is the first technical institution in the country fitted to instruct students thoroughly in the subject of aeronautics.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

LIMITS IN SPECIFYING BAND, BAR AND PLATE IRON AND WIRE

A. S. H.—We have a large drafting-room, and the following questions often come up during the day. There seems to be a difference of opinion on the practice of specifying the materials mentioned and we would appreciate an opinion from the readers of MACHINERY as to limitations of these products. 1. What are the limits within which to specify band or bar iron? 2. Is there a correct thickness for specifying bar iron where the thickness of band iron stops and bar iron starts? 3. Where does the diameter of wire stop and rods begin? 4. In specifying plate how wide does iron have to be before it becomes a plate?

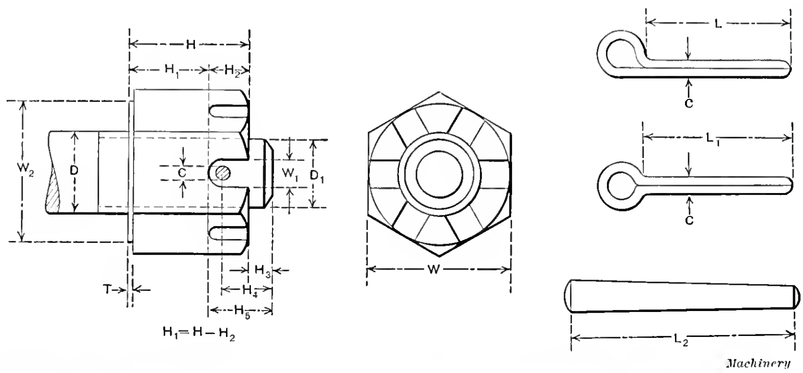
The questions are submitted for opinions of the readers.

DIMENSIONS OF CASTLE NUTS ADOPTED BY A. R. M. M. ASSOCIATION

A. L. D.—What are the dimensions of castellated nuts and thin castellated nuts adopted by the American Railway Master Mechanics' Association?

A.—Dimensions of castellated nuts and thin castellated nuts recommended by the American Railway Master Mechanics' Association at the Atlantic City meeting June, 1912, are given in the accompanying tables compiled by the Brightman Mfg. Co., Columbus, Ohio. Table II on the following page gives the dimensions of castle nuts and thin castle nuts as derived by the formulas, being closely in agreement, of course, with the data in Table I.

TABLE I. DIMENSIONS OF CASTLE NUTS AND THIN CASTLE NUTS*



Recommended Dimensions, Inches

Nut	D	Diameter of screw	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2
		No. of threads per inch U. S. standard castle and thin castle nut	13	11	10	9	8	7	7	6	6	5 1/2	5	5	4 1/2	4 1/2	4	4	3 1/2	3 1/2	3 1/4
		No. of threads per inch for special thin castle nut	13	11	10	9	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6
	W	Diameter across flats, rough size	7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8
	W_2	Diameter facing collar	13/16	1	1 3/16	1 3/8	1 9/16	1 3/4	1 15/16	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 7/16	3 13/16	4 3/16	4 9/16	4 15/16	5 5/16
	T	Thickness facing collar	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
	H	Thickness castle nut, rough	13/16	15/16	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16	2	2 1/8	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16
	H	Thickness castle nut, finished	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	1 15/16	2 1/16	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 1/4
	H	Thickness of thin castle nut, rough	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 3/8	1 7/16	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16
	H	Thickness of thin castle nut, finished	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 5/16	1 3/8	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
		Number slots in castle	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	W_1	Width of slot in castle	1/4	1/4	1/4	5/16	5/16	3/8	3/8	3/8	3/8	3/8	7/16	7/16	7/16	7/16	9/16	9/16	5/8	5/8	5/8
Bolt	H_2	Depth of slot in castle	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1/2	9/16	9/16	9/16	9/16	11/16	11/16	3/4	3/4	3/4
	C	Diameter of cotter-pin hole in bolt	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
	H_3	Projection of bolt beyond top of nut	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8
	D_1	Diameter of reduced end of bolt	3/8	7/16	9/16	11/16	13/16	7/8	1	1 1/8	1 1/4	1 5/16	1 7/16	1 9/16	1 11/16	1 7/8	2 1/8	2 5/16	2 9/16	2 3/4	3
	H_5	Length of reduced end of bolt	9/16	9/16	9/16	5/8	5/8	3/4	3/4	3/4	3/4	3/4	13/16	13/16	7/8	7/8	1	1	1 1/8	1 1/8	1 1/8
	H_4	Distance from center of cotter-pin hole to end of bolt	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1/2	9/16	9/16	5/8	5/8	11/16	11/16	13/16	13/16	13/16
Cotter	C	Nominal diameter of cotter pin	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
	L	Length of player cotter pin	7/8	1	1 1/4	1 1/2	1 1/2	1 3/4	1 3/4	2	2	2	2 1/2	2 1/2	3	3	3 1/2	3 1/2	4	5	5
	L_1	Length of common cotter pin	1 1/4	1 1/2	1 3/4	2	2	2 1/4	2 1/2	2 1/2	3	3	3 1/2	3 1/2	3 1/2	4	5	5	5	6	6
Taper Pin		No. of taper pin	2	2	2	4	4	6	6	6	6	6	6	6	7	7	8	8	9	9	9
	L_2	Length of taper pin	1 1/4	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/4	3 1/2	3 3/4	4 1/4	4 1/2	5	5 1/4	5 3/4

Machinery

* Adopted 1912 by the American Railway Master Mechanics Association

TABLE II. DIMENSIONS OF CASTLE NUTS AND THIN CASTLE NUTS

Formulas	Dimensions obtained from Formulas																			
D	Diameter of screw.....	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2
$W = \frac{3D}{2} + \frac{1''}{8}$	Diameter across flats of rough nut...........	7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8
$H = D + \frac{5''}{16}$	Thickness of castle nut 1/2" to 1 1/2" diam., rough.	13/16	15/16	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	..	..	..	..	..	..	..	..	..	..
$H = \frac{3D}{4} + \frac{11''}{16}$	Thickness of castle nut 1 1/2" to 3 1/2" diam., rough.	..	..	..	..	..	..	..	..	1 13/16	1 29/32	2	2 3/32	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16
$H = D + \frac{1''}{4}$	Thickness of castle nut 1/2" to 1 1/2" diam., finished................	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	..	..	..	..	..	..	..	..	..	..
$H = \frac{3D}{4} + \frac{5''}{8}$	Thickness of castle nut 1 1/2" to 3 1/2" diam., finished................	..	..	..	..	..	..	..	..	1 3/4	1 27/32	1 15/16	2 1/32	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 1/4
$H = \frac{D}{2} + \frac{9''}{16}$	Thickness of thin castle nut 1/2" to 1 1/2" diam., rough................	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	..	..	..	..	..	..	..	..	..	..
$H = \frac{D}{4} + \frac{15''}{16}$	Thickness of thin castle nut 1 1/2" to 3 1/2" diam., rough................	..	..	..	..	..	..	..	..	1 5/16	1 11/32	1 3/8	1 13/32	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16
$H = \frac{D}{2} + \frac{1''}{2}$	Thickness of thin castle nut, 1/2" to 1 1/2" diam., finished.............	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	..	..	..	..	..	..	..	..	..	..
$H = \frac{D}{2} + \frac{7''}{8}$	Thickness of thin castle nut, 1 1/2" to 3 1/2" diam., finished.............	..	..	..	..	..	..	..	..	1 1/4	1 9/32	1 5/16	1 11/32	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
$W_1 = \frac{D}{8} + \frac{3''}{16}$	Width of slot in castle.	1/4	17/64	9/32	19/64	5/16	21/64	11/32	23/64	3/8	25/64	13/32	27/64	7/16	15/32	1/2	17/32	9/16	19/32	5/8
$H_2 = \frac{D}{8} + \frac{5''}{16}$	Depth of slot in castle..	3/8	25/64	13/32	27/64	7/16	29/64	15/32	31/64	1/2	33/64	17/32	35/64	9/16	19/32	5/8	21/32	11/16	23/32	3/4
$C = \frac{D}{8} + \frac{1''}{8}$	Diam. of cotter-pin and diam. of hole in bolt.	3/16	13/64	7/32	15/64	1/4	17/64	9/32	19/64	5/16	21/64	11/32	23/64	3/8	13/32	7/16	15/32	1/2	17/32	9/16
$L = \frac{19D}{16} + \frac{1''}{4}$	Length of player cotter-pin..................	27/32	1	1 9/64	1 19/64	1 7/16	1 37/64	1 47/64	1 7/8	2 1/32	2 3/16	2 21/64	2 15/32	2 5/8	2 59/64	3 7/32	3 33/64	3 13/16	4 7/64	4 13/32
$L_1 = \frac{3D}{2} + \frac{1''}{2}$	Length of common cotter-pin...............	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8	5 3/4

Machinery

THE SOCIOLOGICAL SIDE OF INDUSTRY

Evidence accumulates that America is awakening to a better sense of social justice and the need of economic reform. Great trusts and private monopolies of public utilities are being dissolved or regulated by public commissions, and while competition in business may be wasteful, the need of equal opportunities for all requires the strengthening of laws aimed at methods which interfere with freedom in trade and manufacture.

For many years the unfair and inadequate "fellow servant" rule in law made society practically helpless in many states to protect labor from the risks of life and limb incident to railroading, mining, building and manufacturing. The labor compensation law passed by the New York State Legislature last year is but one of several enacted by the states to place the burdens on the industry affected, making it responsible for the maintenance of its injured and the families of its killed. The ultimate effect should be to reduce preventable accidents to a minimum. Machinery will be safeguarded and dangerous manufacturing conditions eliminated. Much progress has already been made, and men are being taught to be careful of themselves and of their fellow workmen.

Another source of encouragement to the social worker is the more liberal spirit of employers toward labor. The example of the Ford Motor Co., unwise perhaps in some respects, must have a tremendous influence on the betterment of relations of capital and labor. Libraries, free and otherwise, are useful to inform the mind and stimulate ambition; but better food and clothes and houses as a result of faithful daily toil are of still greater value to the mass of workers.

Welfare work pays when rightly directed. Decent living conditions are necessary for the healthful condition of mind and body essential to good working efficiency. In places where very little in the way of healthy recreations and amusements is available to the people, it is decidedly to the interest of local manufacturing concerns to provide them in such manner as to conserve the independence and self-respect of those benefited. The whole modern movement tends to elevate the ideals of society and to place labor on a higher plane by recognizing human rights and abolishing injustices rooted in antiquated legal practices. That the conditions which have developed in America during the past thirty years are out of place in, and probably dangerous to, a democratic form of government, the thoughtful and unprejudiced observer will admit. A brighter day has dawned for industry. The new social spirit and the new freedom will give heart to American inventors and workers generally, and will encourage the enterprising spirits on every level to make for themselves a place in the industrial and commercial world.

* * *

In experiments undertaken by the Technical Institute of Berlin, Germany, it has been ascertained that the most suitable angle of clearance back of the cutting edge on twist drills, for drilling steel and cast iron, is 6 degrees at the circumference of the drill, this angle increasing, in general, to from 20 to 24 degrees toward the center of the drill. Such an angle can generally be obtained by commercial twist drill grinding machines.

ANNUAL CONVENTIONS M. C. B. AND A. R. M. M. ASSOCIATIONS

The forty-eighth annual convention of the Master Car Builders' Association and the forty-seventh annual convention of the American Railway Master Mechanics' Association were held in Atlantic City, June 10-12 and June 15-17, respectively. Simultaneously, the Railway Supply Manufacturers' Association exhibited machinery and tools covering an area on Young's New Pier of nearly two acres or 82,000 square feet. The exhibits comprised railway supplies in general, including locomotive, car, track and shop materials, tools, machines, etc. The machine tool exhibit was an important part of the show and it attracted much attention. Each year this showing of machines, tools, cutters, etc., for locomotive repair shops becomes of greater and greater diversity and importance. Railway shops in general are large potential markets for machine tools and allied products, and the growth in size and power of locomotives requires the best and most efficient machine tools.

The Master Car Builders' Association convention program was made up, as usual, of technical papers, topical discussions and reports of committees, being in part as follows:

June 10. Revision of Standards and Recommended Practice; Train Brake and Signal Equipment; Brake Shoe and Brake Beam Equipment; Car Wheels.

June 11. Coupler and Draft Equipment; Safety Appliances; Rules for Loading Materials; Interline Inspection; Car Trucks; Train Lighting and Equipment; Tank Cars.

June 12. Damage to Freight by Unloading Machines; Specifications and Tests for Materials; Car Construction; Retirement of 40,000 and 50,000 Pound Capacity Cars from Interchange Service.

The following officers were elected for the Master Car Builders' Association: F. F. Gaines, president; E. W. Pratt, first vice-president; William Schlafge, second vice-president; F. H. Clark, third vice-president; Angus Sinclair, treasurer; C. F. Giles, M. K. Barnum and John Purcell, executive committee.

The program of the American Railway Master Mechanics' Association included the following technical papers and discussions:

June 15. Mechanical Stokers; Revision of Standards; Safety Appliances; Dimensions for Flange and Screw Couplings for Injectors, by O. M. Foster; Motors for Railway Shops, by B. F. Kuhn.

June 16. Locomotive Headlights; Design, Construction and Maintenance of Locomotive Boilers; Standardization of Tinware; Superheater Locomotives; Use of Special Alloys and Heat-treated Steel in Locomotive Construction; Review of the Work done by Other Mechanical Organizations, by Dr. Angus Sinclair.

June 17. Smoke Prevention; Revision of Standard Efficiency Tests of Locomotives; Revision of Air Brake and Train Signal Instructions; Train Resistance and Tonnage Rating; Fuel Economy; Tests of Schmidt Superheater and Brick Arch, by H. W. Coddington.

The following officers were elected for the American Railway Master Mechanics' Association: D. F. Crawford, president; D. R. MacBain, first vice-president; R. W. Burnett, second vice-president; C. E. Chambers, third vice-president; John S. Lentz, treasurer; R. E. Smith, J. C. Fritts and H. T. Bentley, executive committee.

The exhibitors comprised two hundred and sixty-nine concerns, among whom were the following showing machine tools, taps, cutters, steel and other machine shop supplies:

Acme Machine Tool Co., Cincinnati, Ohio. Cincinnati-Acme 3¼-inch by 36-inch flat turret lathe; 18-inch geared head universal turret lathe.

Alston Saw & Steel Co., Folcroft, Pa. Alston hacksaw blades.

American Tool Works Co., Cincinnati, Ohio. "American" 36-inch heavy pattern, high duty lathe; 16-inch tool-room lathe; 6-foot radial drilling machine; 2-foot radial drilling machine; 24-inch crank shaper.

Armstrong-Blum Mfg. Co., Chicago, Ill. "Marvel" high-speed hacksaw machines.

Baker Bros., Toledo, Ohio. Baker high-speed, heavy duty drilling machine.

Baush Machine Tool Co., Springfield, Mass. New design 5-foot radial drilling machine; Lassiter staybolt turning and threading machine; automatic staybolt drilling machine.

C. H. Besly & Co., Chicago, Ill. Besly patternmaker's disk grinder; motor-driven disk grinder; forged taps; pressed steel ring wheel chucks; spiral circles; etc.

Hermann Boker & Co., New York City. "Novo" and "Novo Superior" high-speed steels, etc.

W. L. Brubaker & Bros., Millersburg, Pa. Screw plates, taps, dies, reamers, etc.

C. & C. Electric & Mfg. Co., Garwood, N. J. Electric arc welding outfit in operation.

Carborundum Co., Niagara Falls, N. Y. Carborundum and aloxite wheels and abrasives.

Cayuta Mfg. Co., Sayre, Pa. Ball bearing screw jacks, etc.

Celfor Tool Co., Buchanan, Mich. "Celfor" drills, reamers, countersinks, cutters, etc.

Cincinnati Bickford Tool Co., Cincinnati, Ohio. "Cincinnati-Bickford" 24-inch upright drill with tapping attachment; 5-foot plain radial drilling machine.

Cincinnati Milling Machine Co., Cincinnati, Ohio. "Cincinnati" high power milling machine equipped with stream lubrication; high power vertical milling machine; cutter and tool grinder.

Cincinnati Planer Co., Cincinnati, Ohio. "Cincinnati" 36-inch by 36-inch by 8-foot heavy pattern planer with four heads and reversible motor drive.

Davis Boring Tool Co., St. Louis, Mo. Boring bars for car wheels and boring tools and reamers.

Duff Mfg. Co., Pittsburg, Pa. Hydraulic jacks, etc.

Eagle Glass & Mfg. Co., Wellsburg, W. Va. Steel oil cans, oilers, oil carriers, etc.

Earle Gear & Machine Co., Philadelphia, Pa. "Lea-Simplex" cold saws.

Electric Controller & Mfg. Co., Cleveland, Ohio. Lifting magnets and automatic machine tool controllers and starters.

Goldschmidt Thermit Co., New York City. Thermit and samples of thermit welding.

Edwin Harrington Son & Co., Inc., Philadelphia, Pa. Multiple-spindle drilling machine, hoists and travelers.

Hollands Mfg. Co., Erie, Pa. Machinists' vises.

Independent Pneumatic Tool Co., Chicago, Ill. "Thor" pneumatic tools.

Ingersoll-Rand Co., New York City. "Little David" pneumatic tools.

International Oxygen Co., New York City. Oxy-hydrogen welding and cutting equipment.

Jones & Lamson Machine Co., Springfield, Vt. Flat turret lathes.

Landis Machine Co., Waynesboro, Pa. Motor-driven bolt cutters, die heads, etc.

Landis Tool Co., Waynesboro, Pa. Self-contained plain grinding machine.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Motor-driven 25-inch heavy-duty engine lathe; heavy-duty plain milling machine; 21-inch quick change engine lathe, three-step cone and double friction back gears; universal cutter and tool-room grinder; 16-inch portable fitting lathe for locomotive roundhouses.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. 16-inch selective head universal tool-room lathe; 18-inch selective head universal manufacturing engine lathe; 30-inch heavy forge lathe; 48-inch selective head engine lathe.

Lutz-Webster Engineering Co., Inc., Philadelphia, Pa. Lutz universal compression ratchet, compression lathe dog, drilling press or "old man" with fixed and swivel arms.

Newton Machine Tool Works, Inc., Philadelphia, Pa. Locomotive link grinding machine; cold metal sawing machine.

Niles-Bement-Pond Co., New York City. Niles combined journal turning and axle turning lathe; P. & W. 10-inch vertical shaper.

R. D. Nuttall Co., Pittsburg, Pa. Cut gears and pinions and demonstration of heat-treatment of steel.

Henry Pels & Co., New York City. Punching and shearing machines for I-beams, channels, angles, etc.

Reed Mfg. Co., Erie, Pa. Machinists' vises, etc.

Reliance Electric & Engineering Co., Cleveland, Ohio. Adjustable speed and constant speed direct current motors and alternating current constant speed motors.

Joseph T. Ryerson & Son, Chicago, Ill. "Ni-chrome" steel and high-speed twist drills.

William Sellers & Co., Inc., Philadelphia, Pa. Car wheel boring machine with automatic chuck; lineshaft hangers and bearings.

Warner & Swasey Co., Cleveland, Ohio. Universal hollow hexagon turret lathes.

Watson-Stillman Co., Aldene, N. J. Hydraulic jacks, etc.

Wiener Machinery Co., New York City. "Oeking" combination punch, shear and bar angle cutter; universal radial drilling machines.

Wiley & Russell Mfg. Co., Greenfield, Mass. Taps, dies and screw cutting tools and machinery.

T. A. Wilson & Co., Reading, Pa. Safety glass spectacles for machine shop and foundry works, etc.

Wilmarth & Morman Co., Grand Rapids, Mich. "New Yankee" drill grinders.

Yale & Towne Mfg. Co., New York City. Hoists, chain blocks, trolleys, etc.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

SCHUCHARDT & SCHUTTE ENGRAVING MACHINE

Schuchardt & Schütte, Cedar and West Sts., New York City, are now building a machine for engraving trademarks, name-plates, letters, numbers, etc., on steel stamps, dies and other products. The machine operates on the pantograph principle; a pattern of the required design is slipped into a slot in the pattern table and strapped in place. At one end of the pantograph there is a guiding point which is brought into contact with the pattern and run over it; and the engraving tool is carried by a spindle at the opposite end of the pantograph. The movement of the guiding point over the pattern, causes the engraving tool to follow exactly the same course. Three of the arms on the pantograph are provided with scales by means of which the relation between the lengths of the arms can be adjusted to obtain any desired size for an engraved design, the limit of the machine being from a ratio of 1 to 1 between the size of the work and the pattern down to a ratio of 1 to 10 between the work and the pattern. Where only a few pieces are to be engraved, the design drawn on Bristol board can be used for a pattern.

In addition to having the engraving tool guided over the work by means of the pantograph, it is necessary to have the tool rotated. A brief consideration will suffice to show that the movement of the tool by means of the pantograph makes it necessary to provide a flexible system for supporting the driving pulleys. The way in which this is arranged by three sets of pivoted arms is very clearly shown in Fig. 2. One of the difficulties which has been experienced with en-

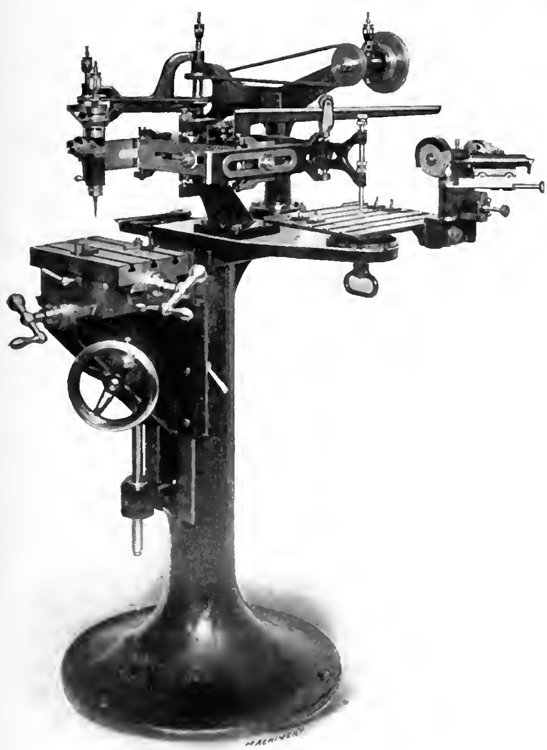


Fig. 1. Schuchardt & Schutte Engraving Machine

graving machines working on the pantograph principle, is that the bearings supporting the tool spindle become worn through the belt pull, thus causing a serious inaccuracy in the work produced by the machine. In the new Schuchardt & Schütte engraving machine, this difficulty has been overcome by employing the extended sleeve construction which has been successfully applied in various classes of machine design, for eliminating unnecessary strain on the bearings. This sleeve extends up from the main spindle housing, between the spindle and the driving pulley so that the belt pull is supported by the sleeve rather than the spindle bearing, and, in this way, unnecessary wear of the bearing is avoided.

In Fig. 1 a small grinding attachment is shown bolted to the pattern table. This attachment is used for grinding the

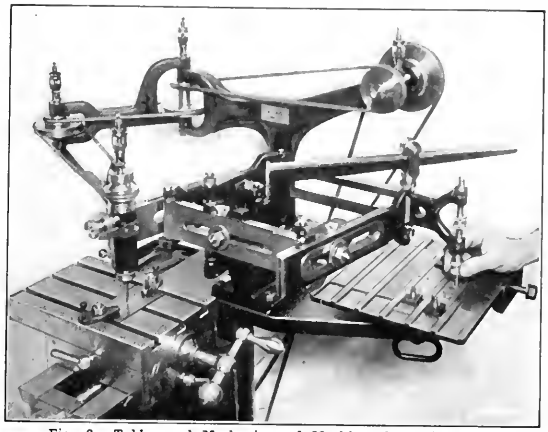


Fig. 2. Tables and Mechanism of Machine shown in Fig. 1

engraving tool. It will be seen that there is a two-step cone pulley at the right-hand side of the machine, which is not shown with a belt running over it. One of the steps on this pulley is connected to the source of power which drives the machine, and the other is used for carrying the belt which transmits power to the grinding attachment. One of the engraving tools is shown set up in the horizontal chuck, with its point in contact with the grinding wheel. In setting up this tool ready for grinding, the first step is to have it accurately centered. This is done by bringing the point of the tool into contact with an index point on the end of a pin, which is set up in the bed of the grinding attachment. The engraving tool is cylindrical in shape, and for about 1½ inch at its lower end a flat is ground which removes about one-half of the metal. The tool is not ground, however, by merely rotating it about its axis, with the tool in contact with the wheel. Experience has shown that the best results are obtained by having the ground surface of the tool of an elliptical section instead of circular, and this special form is obtained by controlling the motion of the tool when in contact with the grinding wheel, by means of a cam located at the far end of the tool-holder. The grinding attachment is bolted to a lug on the under side of the pattern table and may be quickly removed by simply loosening one bolt.

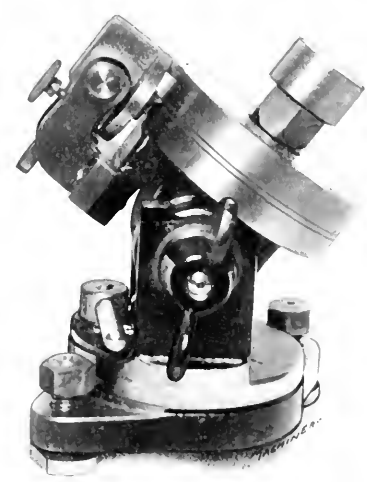


Fig. 3. Dividing Head for Use on Schuchardt & Schutte Engraving Machine

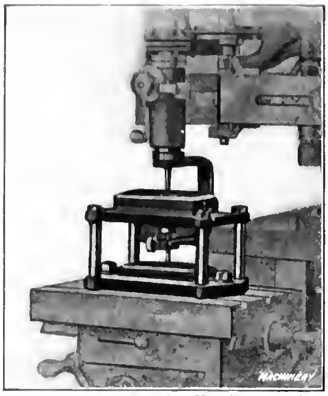


Fig. 4. Attachment for Use in engraving on Convex or Concave Surfaces

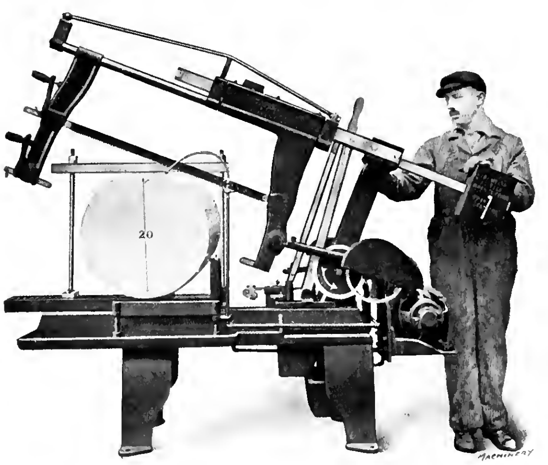
Fig. 3 shows an attachment for use on this machine, which provides for engraving on cylindrical or conical surfaces, or on flat dials on which it is required to engrave at equal intervals. This attachment consists essentially of an arbor on which the work can be mounted, and the provision of means for rotating this arbor through any required angle between successive engraving operations. For engraving on cylindrical or conical surfaces, it is obviously necessary to have the element of the surface on which the engraving is to be done held in a horizontal position. This is done by loosening the wing nut and then swinging the arbor down to the required angle. In most cases, where engraving is to be done on such surfaces, the pattern itself is flat and strapped to the pattern table in the usual way.

Another useful attachment for use on this machine is illustrated in Fig. 4. This attachment is for use in engraving on concave or convex surfaces. For work of this nature, it is necessary to have the engraving tool work to a constant depth, but the tool must also follow the contour of the work. This is done by having a master blank of the required form located on the lower support of the attachment. A guide point runs over this master blank and controls the movement of the engraving tool, which is in contact with the work carried on the upper support of the attachment.

The design of the machine has been carefully worked out to give it the necessary rigidity for withstanding hard service. When desired, three different styles of pattern letters and pattern numbers can be supplied with the machine. Many manufacturers, however, prefer to use some other style of patterns, and these can be made direct on the machine. Of course, the same statement applies to the production of patterns for trademarks, name-plates and similar designs. The operation of this engraving machine is so simple that it has been found that a boy or girl of average intelligence can be taught to use it and to do very satisfactory work.

ROBERTSON 20-INCH HACKSAW

In the May, 1914, number of MACHINERY, the No. 7 power hacksaw built by the W. Robertson Machine & Foundry Co., 32 Greenwood Place, Buffalo, N. Y., was illustrated and described. Those who read this description will remember that the capacity of the No. 7 machine is for work up to 10 inches in diameter. Since that time, a machine of quite similar design has been brought out by this company, the change consisting of the application of a special saw frame which increases the capacity up to work 20 inches in diameter.



Robertson Hacksaw for cutting Stock up to 20 Inches in Diameter

In order to cut work of the maximum size which comes within the range of this machine, without raising the frame to an extreme angle, the first ten inches of the cut is made by inserting a blade in the middle of the frame, as shown in the illustration. When the first half of the cut has been completed in this way, the blade is mounted at the bottom of the frame, after which the cut is completed.

BESLY DOUBLE-SPINDLE, MOTOR-DRIVEN GRINDER

A recent product of Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., is the double-spindle, motor-driven ring-wheel grinder, front and rear views of which are shown in the accompanying illustrations. This machine is equipped with 21-inch vitrified wheels and is driven by direct-connected motors. The double-spindle design brings the two grinding wheels into contact with the work so that two parallel surfaces can be ground simultaneously.

The motors are bolted onto sub-plates which are mounted on ways planed on the main bed casting and clamped in position, the arrangement being similar to that of the head- and tailstocks of a lathe. The left-hand head of the grinding machine is stationary while the right-hand head can be moved along the bed by means of a rack and pinion, and clamped to grind the work to any desired length or width within the capacity of the machine. The motors are rated

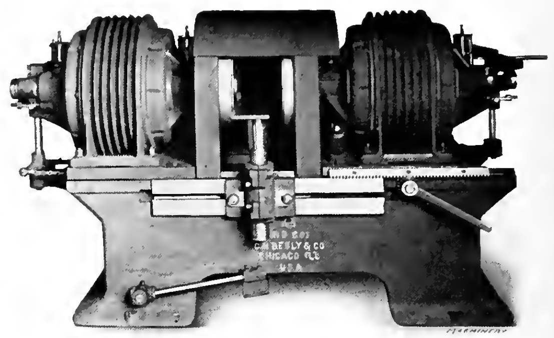


Fig. 1. Front View of Besly Double-spindle Motor-driven Ring-wheel Grinder

at 10 horsepower, run at 900 revolutions per minute, and are intended for operation on 60-cycle alternating-current circuits. When motors are provided for operation on 25-cycle circuits, the machine is equipped with ring wheels 24 inches in diameter, in order to get the required peripheral speed when running at 750 revolutions per minute. Each motor is controlled by a starting compensator with low voltage and overload release; these starting compensators are mounted on the back of the grinder. Grinding machines of this type are not built to operate on direct-current circuits.

The ring wheels are held in "Helmet" pressed steel, ring wheel chucks which are so constructed that the ring wheels may be adjusted to compensate for wear. The design has been worked out in such a way that this adjustment may be made without removing the chuck from the spindle of the grinder. To bring the grinding wheels into contact with the work, the rotor shaft or spindle of each motor has a longitudinal feed of 1 inch. This feed is actuated by a hand lever or foot treadle, the motion being transmitted through a pinion and rack on each of the outer bearing bushings. The spindles are geared together by a connecting-rod at the back of the machine, so that their motion toward and away from the work is simultaneous and uniform. Either spindle may be thrown out of gear and locked so that the opposite wheel may be moved toward the work by means of the hand lever or foot treadle. This causes the rotor of the motor to be displaced ½ inch from magnetic balance during

the grinding operation. Careful tests have shown that this displacement only reduces the motor efficiency from 1 to 2 per cent, while the maximum output remains approximately the same as when the motor is running in magnetic balance. The longitudinal movement of each sliding spindle is limited by an adjustable micrometer stop which is graduated to read to 0.001 inch, so that the work may be accurately ground to size and duplicate pieces produced at high efficiency.

The work-rest has a vertical adjustment and is supported from a slotted pad on the front of the bed casting. The regular equipment includes nine work-rests of varying widths from 7/16 to 5 15/16 inches. An automatically telescoping dust hood is provided, which is hinged at the back in order to provide access to the ring wheels for changing them when necessary. This hood has an air-tight connection at the back of the machine to provide for exhausting the grindings. It will be noticed that the motor rotors are mounted directly on the grinding spindles which are of hard machine steel and supported in inserted bearing bushings lined with bearing metal. The motors are equipped with special end castings to receive the inserted bearing bushings, and the end thrust on the spindles is taken by hardened and ground tool steel thrust collars. The end play of each spindle is controlled by an adjustable collar which is held in place by a lock-nut at the end of the spindle. Both bearing bushings slide with the spindle and completely encase it so that it is thoroughly reinforced when under load and adequately protected from damage by emery dust.

The geared hand lever on the sliding spindle affords a leverage of 36 to 1, so that the operator may force the machine to the limit of its driving power without undue effort. The lever is clamped to the pinion stud, which is a desirable feature of the grinder because the lever may be clamped to

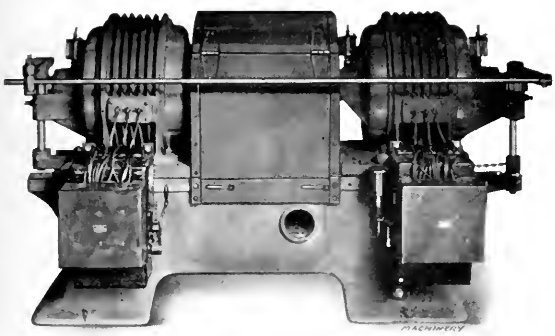


Fig. 2. Opposite Side of Machine shown in Fig. 1

this stud in the position which makes it most convenient for the workman. The principal dimensions of the machine are as follows: Diameter of spindles at inner bearings, 3 inches; diameter of spindles at outer bearings, $2\frac{1}{2}$ inches; height of the machine to the center line of the spindles, 38 inches; combined length of four bearing bushings, 42 inches; maximum opening between ring wheels, 11 inches; floor space occupied by the bed casting, 28 by 72 inches; shipping weight of the machine, 6000 pounds.

DRILL SPEED REGULATOR

The Drill Speed Regulator Co., 516 Free Press Bldg., Detroit, Mich., is placing a device upon the market which provides for driving different sizes of drills at approximately the correct speed. In addition to the obvious advantage of securing the most suitable speed, the device is provided with a quick-change chuck so that different sizes of drills which are required may be inserted and removed with a very small loss of time. A different collet is provided for each different size of drill which is used, and this makes it impossible for the most inexperienced operator to use the wrong speed for a given size of drill. It is merely necessary for the operator to insert the drill in the chuck and it will be driven at the right speed.

The speed changes are accomplished by having the drivers

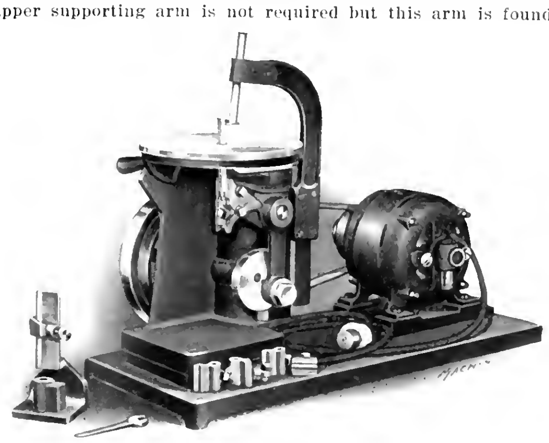
Device for obtaining Proper Speed for Different Sized Drills

on each different collet located in a different position so that each one engages the proper gears in the head. This device also increases the power of the drill press, as large drills are driven through back-gears; and it can be used for tapping when applied to drill presses equipped with a reverse mechanism. The illustration shows the complete speed regulator and also two collets; one of these collets has a 5/16-inch taper shank drill in it and the shank of the collet is No. 1 Morse taper. The other collet carries a ¾-inch taper shank drill and its shank is No. 2 Morse taper. Two pieces are also shown in this illustration which are typical of the classes of work for which this speed regulator is particularly useful. These speed regulators are made to fit any drill press of standard design.

COCHRANE-BLY PORTABLE FILING MACHINE

In shops where large numbers of dies, gages, templets and similar parts are made, there is a lot of light filing to be done at different benches. For handling work of this kind the Cochrane-Bly Co., Rochester, N. Y., has been making a belt-driven bench filing machine. In order to adapt this machine for portable service, an aluminum motor base to support a ⅛-horsepower standard type, General Electric motor has been added. A motor for use on either alternating or direct current of 110 or 220 volts can be supplied and the entire equipment weighs only 75 pounds, so that it can be easily moved about from bench to bench. The motor is provided with a chord and plug for connection with an ordinary lamp socket.

One of these motor-driven equipments is shown in the accompanying illustration where it will be seen that the motor and filing machine are equipped with two-step cone pulleys. The slower speed is for use in filing and the higher speed is employed for lapping operations. As a general rule, the upper supporting arm is not required but this arm is found



Cochrane-Bly Motor-driven Filing Machine for Portable Service

particularly valuable in cases where lapping stones are used, and also for classes of work where rather coarse files are required. The file holder is for round file shanks, and a fixture is provided for babbitting ordinary file shanks to fit this file holder. The principal dimensions of the machine are as follows: Height from bench to top of table, 11 inches; diameter of table, 8 inches; face width of pulleys, 1¼ inch; speed of pulleys for filing, 500 R. P. M.; speed of pulleys for lapping, 600 R. P. M.; stroke, ¾ or 1½ inch.

SELLEW ADJUSTABLE DRILL HEAD

The accompanying illustrations show an adjustable spindle drill head which is a recent product of the Sellew Machine Tool Co., Pawtucket, R. I. Fig. 1 shows the head with the gear guards in place ready for use; and in Fig. 2, the guards are removed in order to show the gearing and construction of the head. Referring to this illustration, it will be seen that there is a ring or plate located at the top of the head, and an interchangeable sleeve for connecting the head to the quill of the drilling machine is bolted to this ring. Different sleeves may be bolted to the ring to provide for mounting the head on different drill presses. There is a circular T-slot on the under side of the ring which receives the T-bolts for clamping the intermediate gear sleeves which support the spindle heads after the spindles have been adjusted to the required positions.

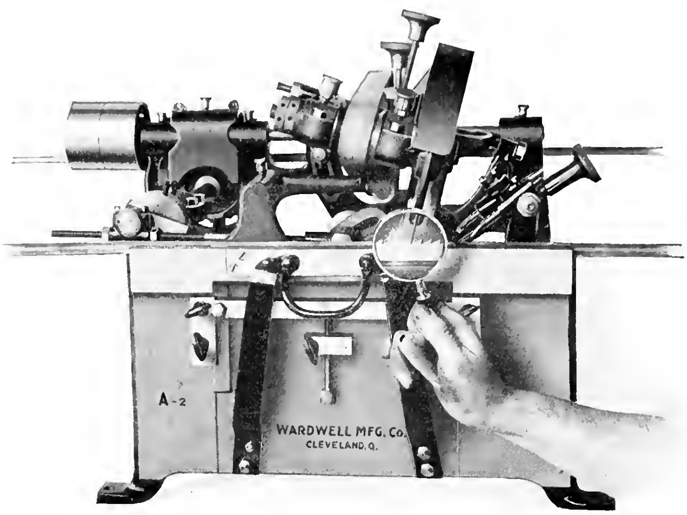
The construction of the spindle heads—alternating short and long, as shown in the illustration—provides for making close adjustments with ease and rapidity. Each alternate spindle can also be brought directly under the clamping bolt of the spindle head nearest to it, either inside or outside of the intermediate circle. The gears supported by the intermediate spindle sleeves are driven by a central gear which has a taper shank entering the drilling machine spindle. All of the gearing and spindles are of heat-treated nickel steel, and the spindles have bronze-bushed bearings. Ball-thrust bearings, mounted outside of and below the spindle bearings, carry the end-thrust. Ample provision is made for lubricating each spindle bearing by means of individual grease chambers. The head shown in the illustrations is fitted with adjustable chucks, but sleeves for taper shank drills can be provided, if so desired. These heads are made in three sizes which range from a head having five spindles which can be distributed over a 1½-inch circle to twelve spindles which may be distributed over a 15-inch circle.

Fig. 1. Sellew Multiple Adjustable Spindle Drill Head

Fig. 2. Sellew Drill Head with Gear Guards removed

WARDWELL BAND-SAW SHARPENING MACHINE

The development of band-saw machines for cutting metal has been followed by a serious loss in certain plants, where it has been the practice to throw away the saws used for this purpose, after they have become dull. As such saws cost from $0.90 to $1.25 each, it will be readily understood that a serious "leak" results from this practice. In order to provide for resharpening metal cutting band-saws, the Wardwell Mfg. Co., Cleveland, Ohio, has recently designed and placed upon the market a grinding machine which is described in the following. By using this machine it is possible to resharpen saws at a cost of from 3 to 5 cents each.



Wardwell Grinding Machine for resharpening Metal-cutting Band-saws

The operation of the machine is extremely simple. From the main driving shaft, which extends across the back of the machine, a belt transmits power to the shaft which drives the grinding wheel. This shaft is supported on a pivoted arm which swings over a segment, and the adjustment provided in this way enables the grinding wheel to follow the face of a tooth no matter what its angle may be. After the grinding wheel has reached the bottom of the tooth, a cam causes it to move up the back of the tooth, this cycle being repeated over and over for each tooth on the saw. Power is taken from the main shaft through a worm and worm-wheel, to a shaft at the left-hand side of the machine, on the end of which there is an eccentric which governs the feed of the band-saw.

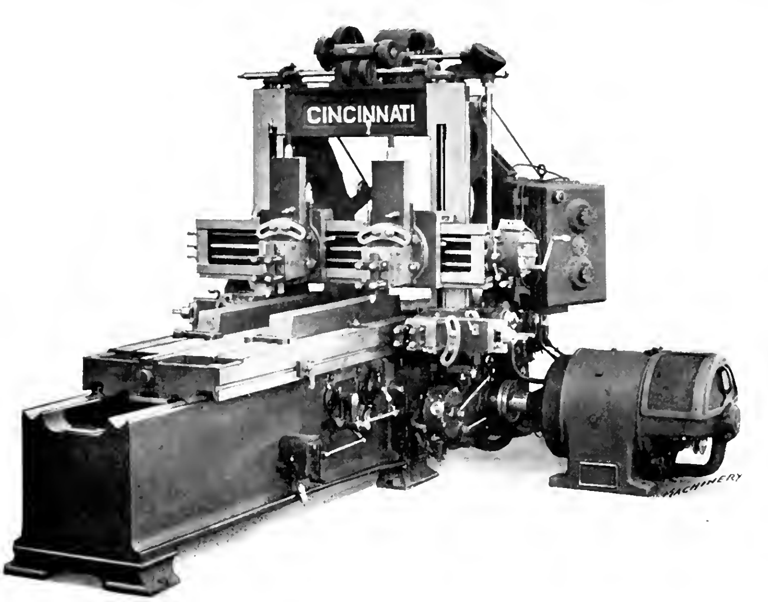
A secondary adjustment provides for making a more delicate regulation of the feed. An adjustment at the right-hand side of the machine permits the saw to be fed in such a way that the grinding wheel cuts exactly the required amount of metal from the face of each tooth. The proper combination of these adjustments enables the grinding wheel to be perfectly timed so that when the wheel has traveled all the way down the face of the tooth, the cam comes into action and raises the wheel as it travels up over the back of the tooth.

The operation of the machine is so

precise that saws having teeth as fine as twenty to the inch can be accurately resharpened. It will be understood from the preceding description that the machine is automatic in action, and after it has once been started it requires no further attention until the saw is completely sharpened. The saw is positively fed through the machine at the rate of from fifty to sixty teeth per minute. There is an adjustment on the front of the machine for raising the saw in the vise, thereby permitting a slightly heavier cut to be taken without changing the other adjustments. All of the adjustments are provided with lock-nuts, so that when they are once set and the nuts tightened, they cannot work loose. Band-saws resharpened on this machine are said to cut with practically the same efficiency as when they were new.

CINCINNATI HEAVY PATTERN PLANER

The Cincinnati Planer Co., Cincinnati, Ohio, is now building a 36 by 36 inch by 8 foot heavy pattern planer which is equipped with four heads and reversible motor drive. There are ten cutting speeds which cover a range of from 25 to 60 feet per minute and ten return speeds, the maximum return being 100 feet per minute. To adapt the machine for heavy classes of work, all the gears and also the rack under the table are of steel. A noteworthy feature of the design is the rapid power traverse to the heads, which relieves the operator and is the means of making a material increase in production. The mechanism is extremely simple, absolutely "fool proof" and ready for use at any time. The motor shown at the top of the arch delivers power through spur gears to the rail elevating device and thence to the horizontal rapid traverse shaft. This shaft carries a bevel gear meshing with a gear on the vertical rapid traverse shaft at the side of the housing. This shaft transmits power to a pair of spur gears located at the end of the rail.



Cincinnati 36 by 36-inch by 8-foot Heavy Pattern Planer

The regular feed is transmitted to the heads in the usual way from a friction on the end of the pinion shaft to the trigger or feed gears at the end of the rail, power being transmitted through a segment and rack. The feed and rapid power traverse gears on the rail screws and rod are free to revolve until clutched by a spool located between them. There is a neutral position in which neither of the gears is engaged. This arrangement makes it impossible to engage both the rapid power traverse and feed at the same time. Provision is also made to protect the mechanism against all accidents, making the entire control absolutely "fool proof." The three small handles at the end of the rail control the clutch spools while the handle just below them engages the rapid power traverse. Moving this handle to the right causes the heads to follow in the same direction, and *vice versa*. The rail and side heads are taper gibbed throughout and the heads on the rail are provided with micrometer adjustment. The housings are extended right to the bottom of the bed, to which they are securely bolted, doweled and locked. All gears are covered to prevent the operator from being injured.

SCHUCHARDT & SCHUTTE SCREW TESTING MICROSCOPE

The demand for a high degree of accuracy which has followed in the wake of interchangeable manufacture has led to the development of many ingenious methods for insuring the attainment of a high degree of precision. One of the latest of these is the Schuchardt & Schütte precision measuring and screw testing microscope which forms the subject of the present article. This instrument is intended for making absolutely accurate measurements of small objects, and it is particularly adapted for measuring and checking micrometer screws, dividing scales, standard gages, dies and a great variety of other parts where precision is a prime requisite. An idea of the accuracy of the instrument may be gained from the fact that it will give the length and pitch of a screw to within 0.00004 inch; the maximum and minimum diameters, and depth of the thread to within 0.0004 inch; and the angle of the thread to within 5 minutes. In making any or all of these measurements it is unnecessary to change the position of the screw after it has been set up.

The illustration shows a screw set up in the instrument where it will be seen that the object to be examined is held in a chuck *A*. In the field of the microscope there are cross hairs which are used as reference points. In measuring the pitch of the screw, the vertical cross hair is first brought exactly over the high point of the thread, after which the reading of the scale *D* and micrometer head *E* is taken. The screw *C* is then manipulated to move the object across the field of the microscope until the cross hair comes into contact with the next point on the thread, after which the reading of the scale *D* and micrometer head *E* is taken again. The difference represents the pitch of the thread. Similarly, in measuring the depth of the thread, a horizontal cross hair is first brought into contact with the top of the thread, after which the reading of the scale and vernier *G* is taken. The screw *F* then moves the work until the horizontal cross hair reaches the bottom of the thread, after which the reading is again noted, the difference being the depth of the thread.

The field of the microscope can be rotated to provide for measuring the angle between the lines or surfaces on the work. For making such measurements the field is rotated to bring one of the cross hairs into contact with one of the angular sides, after which the reading of the scale and vernier *K* is noted. The field is then rotated until the same cross hair comes into contact with the opposite angular side, after which a reading is again taken. The difference represents the included angle between the sides and the result is accurate within 5 minutes. The field is rotated by screw *H*.

The object under examination may be inclined to the optic axis of the instrument and the angle of inclination read on the scale and vernier *M*. As the object remains in the same plane as the axis of rotation, it is not thrown out of focus owing to the inclination of the instrument. In measuring the pitch of a screw it should be inclined the same number of degrees as the angle at which the thread crosses it. This angle can be approximated or else accurately measured by

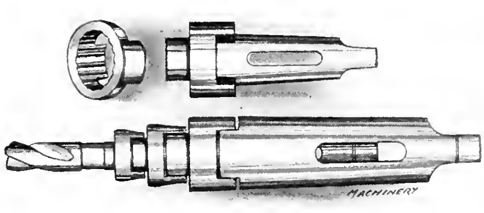
the scale provided for that purpose. The microscope is focused by means of the usual rack and pinion for coarse adjustment and a micrometer screw is provided for making fine adjustments. The dividing head *N* of the micrometer screw is used for obtaining the correct position for viewing the profile of the screw thread or other object which is being examined. This is accomplished by focusing the top of the thread on the cross hairs in the field of the microscope and then lowering the body by means of the fine adjustment an amount equal to the secant of the angle through which the screw is tilted multiplied by one-half the maximum diameter of the thread. The object under examination is illuminated by means of a mirror which will be seen near the base of the instrument. The iris diaphragm used in connection with the mirror can be quickly swung aside or brought back into position, according to the requirements of individual cases. For measuring large objects such as milling cutters, hobs, etc., a special bracket with adjustable centers is provided. This instrument is sold by Schuchardt & Schütte, Cedar & West Sts., New York City.

Schuchardt & Schutte Precision Measuring and Screw Testing Microscope

"DRIVE-EM-ALL" DRILL SOCKET

As its name implies, the "Drive-em-all" drill socket made by the Dazie Mfg. & Supply Co., Inc., 103 Park Ave., New York City, is applicable for driving all styles of taper shank drills and other taper shank tools. Referring to the illustration, it will be seen that there is a serrated ferrule which is driven over the shank of the drill. This ferrule constitutes one member of a clutch, the corresponding clutch member being formed by the end of the socket; and in this way a positive drive is secured. As the socket will drive drills either with or without a tang, one of its important advantages is for using up drills with broken tangs.

In using this socket, the first step is to press the ferrule down onto the shank of the drill. If the drill has a tang, the ferrule is placed in such a position that the tang enters the slot in the socket. The ferrule should be forced far enough onto the shank so that there is a small opening between the ferrule and the socket, the purpose being to provide for wear which may develop when the tool has been in use for some time. When a drill is worn out, the ferrule can be removed from its shank and used on another tool. These sockets and ferrules are made in twelve different styles for various combinations of inside and outside tapers.



"Drive-Em-All" Drill Socket

TUCKER OIL HOLE COVERS

Four styles of oil hole covers which constitute a recent addition to the line of W. W. & C. F. Tucker, Hartford, Conn., are illustrated herewith. These are known as Styles D, E, F and G, and they are so marked in the illustrations in order to provide a ready means for reference. Fig. 1 shows each style of oil hole cover open ready for oil to be introduced into the port, while the covers are shown closed in Fig. 2, these illustrations making the design so clear that only a brief description will be necessary.

It will be seen that the Style D cover is threaded at the bottom in order to be screwed into the oil hole which is tapped to receive it, and that there is a slot for a screwdriver at the top of the cover. The port is normally closed by means of a sleeve which is held down through a compression spring. In order to open the cover to give access to the port, this sleeve is raised with the point of the oil can, which is then pushed into the port and the necessary amount of lubricant supplied. These covers were particularly designed to meet a demand for an oiling device provided with means for excluding dirt and grit from the bearing. They are particularly adapted for use in connection with spring hinge bolts and other parts of motor cars, and can be mounted in a horizontal or vertical position or at an angle. A little experience will enable the oiler to raise the sleeve over the port with the point of his oil can so that only one hand is required for the purpose. It will be seen that the Style G cover is quite similar to the Style D, except that a flat is provided on each side of the body to enable the wrench to be used in screwing the cover down into the tapped oil hole instead of having a slot to be engaged by a screwdriver.

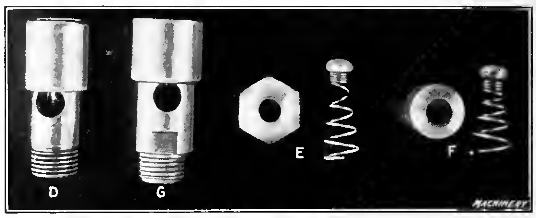


Fig. 1. Styles D, E, F and G of Tucker Oil Hole Covers shown Open

It will be seen that the Styles E and F oil hole covers are the same in general respects, the point of difference being that the Style E is threaded at the bottom to be screwed into a tapped oil hole, while the Style F is tapered so that this cover is driven into the hole. The top of both covers is slightly rounded so that a clean wiping surface is provided, and there are no sharp corners to hold the dirt. It is claimed that the valve or ball check which closes the port of these covers is exceptionally small, thus providing a greater open space for the oil to enter. In the illustration Fig. 1, the spring and ball which keep the port closed is shown beside the cover.

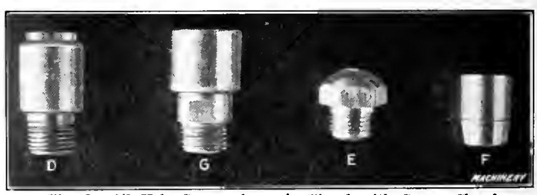


Fig. 2. Oil Hole Covers shown in Fig. 1 with Covers Closed

SCHUCHARDT & SCHUTTE GAGE STANDARDS

For machining work where a very high degree of accuracy is required, the use of gage blocks as the ultimate standard to which all of the gages and measuring instruments used in the shop are referred has come to be recognized as one of the most satisfactory methods of securing the desired degree of precision. Schuchardt & Schütte, Cedar and West Sts., New York City, are now making gage standards of

this type in several different sets, one of which is shown in the accompanying illustration. The No. 9 set, which is the most complete, is intended for use in checking the accuracy of measuring tools such as standard gages, limit gages, micrometer calipers, etc. The blocks may be combined to give intervals of 0.0001 inch and the individual blocks are so accurate that any combination of four or five blocks will have a total error which does not exceed 0.00004 inch. The No. 8 set of gage blocks is similar to the No. 9 except that there are not as many blocks in this set, and it is only capable of combinations for intervals of 0.001 inch. For shops where the English system of fractions is used on work requiring great accuracy, three sets of gage blocks known as Nos. 6, 7 and 7A are provided. The blocks in these sets are graded in 1/16-inch steps, 1/32-inch steps and 1/64-inch steps, respectively. While there is a smaller number of blocks in these sets, they are of the same accuracy as the more complete sets previously referred to.

By referring to the illustration, it will be seen that these gage blocks are prismatic in shape and the distance is marked between the parallel surfaces of each block. It is a well-known fact that hardened steel products are subject to variations in their shape and dimensions for some time after conducting the heat-treatment. This difficulty is eliminated in the Schuchardt & Schütte gage standards through the use

No. 8 Set of Schuchardt & Schutte Gage Standards

of a special tempering process which relieves the excessive internal strains without softening the metal. The gages are non-magnetic when they leave the factory and particular care should be exercised to prevent them from becoming magnetized. If this precaution is not observed, very fine particles of metal will be picked up by the gages, and although these particles may be too small to be visible, they will introduce appreciable errors when several gage blocks are used in combination. In using the blocks the surfaces are first wiped with a piece of chamois leather to remove any grease or dirt, after which the gages which are to be in contact are placed edge to edge and the contacting surfaces slid across one another with the application of a moderate pressure. The surfaces are so smoothly finished that molecular attraction causes the blocks to be held together. As the size is stamped on each block, all the knowledge a workman requires in using these gage standards is the ability to make a simple arithmetical addition in order to determine when he has obtained the required dimension. This is done by adding the size of each gage block as it is combined with the blocks already selected, until the required combination is obtained.

AUTOMATIC DRILL CHUCK

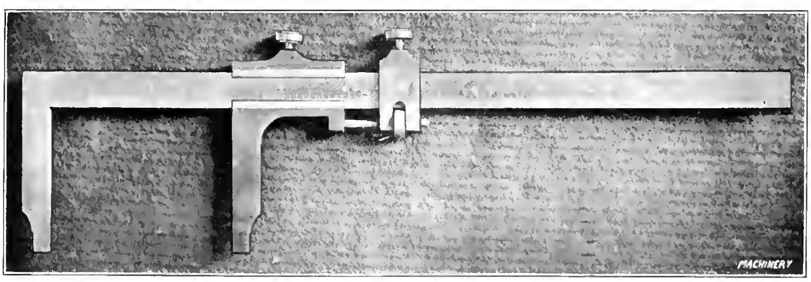
The "Quictite" drill chuck, which forms the subject of this article, is the latest product of the Automatic Drill Chuck Corporation, Majestic Bldg., Detroit, Mich. The most important feature of this chuck is the rapidity with which drills can be inserted or removed. For this purpose it is merely necessary for the operator to grasp the knurled collar and hold it back against the rotation of the drill-press spindle. This opens the jaws of the chuck so that the drill may be pushed up until it comes into contact with a hardened thrust plug. The knurled collar is then released and the jaws spring forward and take a firm grip on the shank of the drill. These chucks are made in three different sizes. The illustration shows the No. 6 size which has a capacity for drills from No. 40 up to 3/8 inch; this chuck can be opened by hand when the drill-press spindle is running at speeds up to 4000 R. P. M. This type is also made in a No. 8 size which has a capacity for drills ranging from 3/16 to 1/2 inch in diameter, and in a No. 5 size having a capacity for drills from ½ to 1 inch in diameter. All sizes of drills operate in the same way.

The "Quictite" Automatic Drill Chuck

The two most important features of the rotary cam type of jaws used in these chucks are the powerful gripping action which is secured and the smooth contact surface which is provided. The driving power provided by the chuck jaws increases in direct proportion to the resistance offered by the cut, and there is no tendency for the jaws to damage the shank of the drill. There are three jaws, each of which has a triple set of grips, so that a total of nine contact points engage the shank of the drill. The action of the jaws is self-centering, no matter what the size of the drill, so that all drills are always accurately centered in the chuck. Particular attention has been paid to the construction of the chuck along lines which provide ample strength and durability.

SMITH OPEN-FACE CALIPER

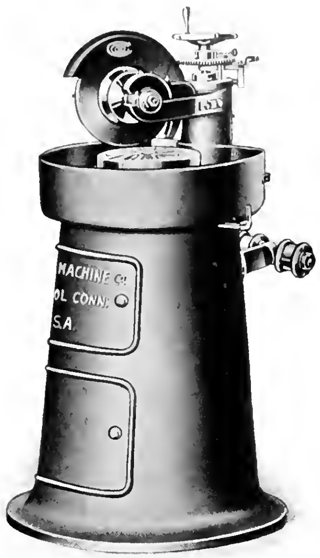
A vernier caliper of the beam or sliding type, which is a recent product of E. G. Smith, Columbia, Pa., is illustrated herewith. This tool differs from the general style of Columbia sliding calipers in that it has a so-called "open face" which is a great convenience in reading the measurement. At present this tool is only made in the 8-inch size, with the lower scale graduated to fiftieths and provided with a vernier to read to 0.001 inch; and with the upper scale graduated in sixteenths, with a vernier to read to 1/128 inch. The construction and shape of the jaws provides as much strength as in other styles of Columbia calipers. The jaws are hardened and accurately ground.



Smith Open-face Caliper with Scales reading to 0.001 Inch and to 1/128 Inch

GARRIGUS PRECISION GRINDER

The C. G. Garrigus Machine Co., Bristol, Conn., is now building a 12-inch rotary surface grinder which is particularly adapted for precision work. The design of this machine is marked by its simplicity and durability, and as the grinding operation is continuous, the rate of production is very satisfactory. The range is from very small pieces up to anything that will come within a 12-inch circle, and pieces can be finished within 0.0004 inch of the required dimension.



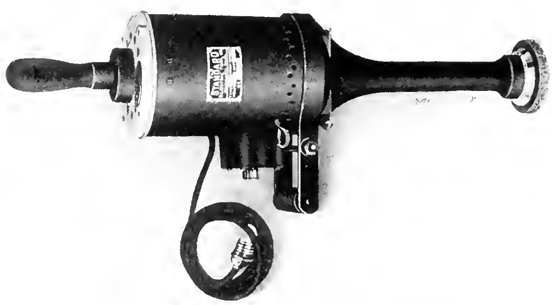
C. G. Garrigus 12-inch Rotary Surface Grinding Machine

The head is supported on a vertical oscillating column which is attached to the feed-shaft and actuated by a ratchet and pawl. Each tooth of the ratchet lowers the grinding head 0.000125 inch. The magnetic chuck is mounted on a spindle that is operated by a cone clutch pulley and connected by gearing to the cam which operates the wheel column. The stroke of the oscillating wheel is regulated by the adjusting cam roll. The movement of the head and rotation of the chuck are controlled by the action of a lever at the side of the machine.

When this grinding machine is equipped for grinding cast-iron parts, such as piston rings, a special wheel cover with an opening to which a flexible tubing is connected, is mounted on the machine. A different style of pan is also used which makes the machine more accessible for the operator when grinding single pieces. For wet grinding, a tank connected with a pump affords a continuous supply of water to the work held on the chuck. The chuck has two speeds and is operated by hardened steel gears. The principal dimensions of the machine are as follows: Size of grinding wheel, 12 by ¾ inch; greatest distance from center of wheel to top of chuck, 12 inches; vertical adjustment of head, 8 inches; diameter of magnetic chuck, 12 inches; and weight of machine, 1400 pounds.

STANDARD UNIVERSAL ELECTRIC GRINDER

The Standard Electric Tool Co., Cincinnati, Ohio, has placed a new grinder on the market which is intended for such work as surfacing rough castings and also for performing buffing operations. This tool is provided with a universal motor which operates on either alternating or direct current with equal efficiency. It is especially adapted for use on low-frequency circuits of 25, 30 or 40 cycles. The motor is form wound and impregnated with "Bakelite," which effectually prevents short circuits, grounds and other troubles incident to high-speed operation.



Standard Grinder equipped with a Universal Motor

The motor is designed to run at 6000 revolutions per minute, and the armature spindle is extended and has a 4-inch emery wheel mounted directly upon it. Imported ball bearings are employed throughout the tool. The motor has a capacity for ½ horsepower and is said to be exceptionally durable. The efficiency is unusually high when operating on alternating current, owing to the high speed at which it is required to operate. The grinder is equipped with a spring for suspending it from the ceiling and it can be used in connection with a traveler and counterbalance. The motor may be attached to either a lamp socket or a power circuit.

AURORA 20-INCH DRILLS

Two improved 20-inch drills which are recent products of the Aurora Tool Works, Aurora, Ind., are illustrated in Figs. 1 and 2. These machines are of exceptionally heavy construction, with the column and base well ribbed and the head fitted on the column with a tongue and groove joint, and securely bolted by three ½-inch cap-screws. Power is transmitted to the spindle by four-step cone pulleys which carry a 2½-inch belt. The tight and loose pulleys are 9 inches in

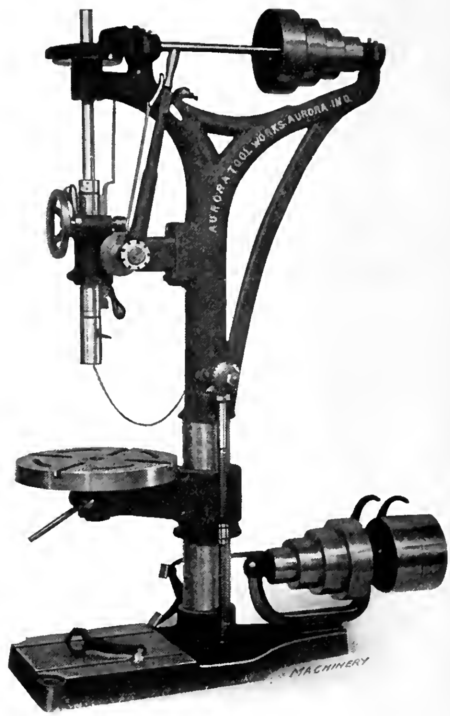


Fig. 1. Aurora 20-inch Drill equipped with Wheel and Lever Feed

diameter and carry a 3-inch belt; these pulleys run at from 550 to 600 revolutions per minute. Ample power is provided for driving a 1½-inch drill to the limit of its capacity.

The table rests on a large flat bearing in addition to being supported by the usual pivot bearing, this construction insuring perfect alignment even when holes are being drilled at points near the edge of the table. The spindle is fitted with a ball-thrust bearing and has a travel of 8 inches. On the plain wheel and lever feed drill, shown in Fig. 1, the worm is engaged or disengaged by means of an eccentric bushing. The feed lever is operated by a ratchet and pawl which automatically disengages when in the vertical position. On the drill equipped with power feed, which is illustrated in Fig. 2, the feed gears are of hardened steel and run in an oil-tight case. Three changes of feed can be instantly obtained without requiring the machine to be stopped. Each change of feed is clearly marked so that there is no excuse

for the operator making a mistake. The spindle sleeve is graduated and equipped with an automatic stop collar which disengages the feed when the tool has reached any required depth. The table and also the base of the machine are furnished with T-slots. The weight of the plain wheel and lever feed drill is 735 pounds, while the drill equipped with power feed weighs 900 pounds.

Fig. 2. Aurora 20-inch Drill equipped with Power Feed

HARRINGTON MULTIPLE-SPINDLE DRILLS

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., are now building a line of multiple-spindle drill presses which includes machines with circular heads ranging from 15 to 36 inches in diameter; and with rectangular heads ranging from a spindle area of 15 by 24 inches up to a spindle area of 20 by 40 inches. The number of spindles varies from 12 to 32, depending on the size of the head and the size of the drills which are to be used, the design of each machine having been worked out in such a way that it may be equipped with any size of spindle unit. The smaller machines are built to provide for movement of the head on the column by hand, but in the three larger sizes, the movement of the head is controlled exclusively by a power-driven screw. The illustrations show three different sizes of these machines from which an idea of the general design may be obtained.

No. 51-A and 51-B Machines

These are the smallest sizes of the Harrington multiple-spindle drills and the design of the two machines is essentially the same. They are made with two sizes of heads, each of which has a different spindle area and maximum number of spindles. The maximum area covered by the spindles of the head of the No. 51-A machine is over a circle 15 inches in diameter, and the machine has a capacity for driving twelve ½-inch drills. The No. 51-B machine is equipped with a head whose maximum spindle area is a 20-inch circle, and this head will drive sixteen ½-inch drills. Provision is made in the gear chest of each size head for the maximum number of spindle pinions so that the machine purchased with less than the full complement of spindles can be brought up to a full equipment at any time. Both machines have sufficient power for driving the rated number of drills in cast iron, at a peripheral speed of 65 feet per minute and a feed of 0.010 inch per revolution.

The head frame is cast in one piece with the saddle and is provided with heavy gibs and a long bearing on the column. A full counterbalance weight inside the column is connected to the head by two chains. There are two T-slots in the lower flange of the head for clamping the cast steel radius bars in which the bronze spindle sleeves are carried. The adjusting screw is arranged so that the spindle sleeves can be regulated up and down for different lengths of drills without moving the positions of the radius arms; the spindles have a long bearing in bronze sleeves and are provided with steel and bronze thrust washers. A telescopic shaft with universal joints at each end connects each spindle and its pinion. The drive is through a quarter-turn belt from a pulley mounted on the base of the machine to a pulley carried by a bracket at the top of the column; this drives the splined vertical shaft. A pinion on the lower end of this shaft transmits power to the upper gear of a pair of spur gears; and the lower gear of this pair drives the spindle pinions. All gears are made of heat-treated alloy steel except in cases where one gear of a pair is steel and the other bronze. All the gears have cut teeth. In belt-driven machines, a four-step cone pulley is driven from an overhead countershaft, and in motor-driven machines the lower cone pulley is replaced by a spur gear which meshes with a rawhide pinion on the motor spindle.

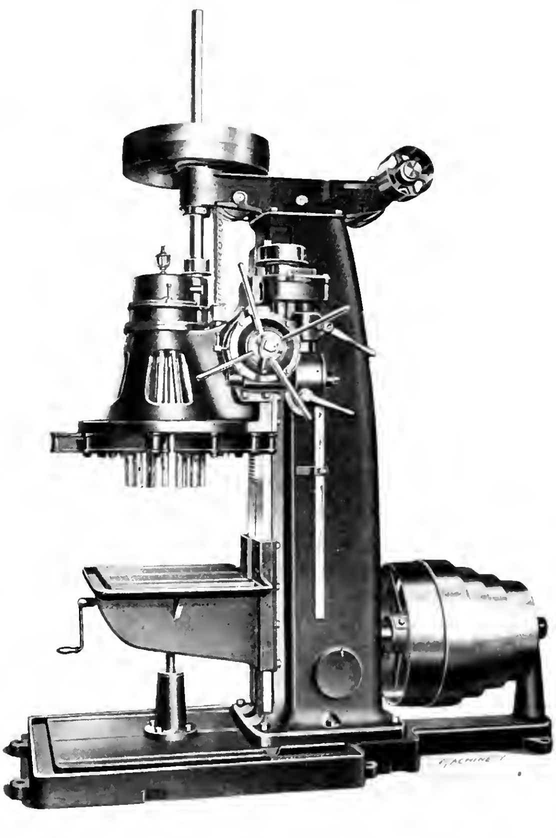


Fig. 1. Harrington No. 51 Multiple Spindle Drilling Machine

Power for the feed is taken by belt from the vertical shaft and thence through spur gears. The motion is then transmitted through bevel gears to a horizontal worm and worm-wheel. The planetary train of spur gears between the worm-wheel and rack pinion reduces the strain on the worm-wheel teeth. Both hand and automatic trip are provided on the worm in addition to a saw-tooth disengaging clutch. The frame of the machine is exceptionally massive, the base being

heavily ribbed and provided with T-slots, an oil channel, and a settling tank. An extension is bolted to the rear of the base and the cone pulley or motor is mounted on this extension. The table has a long bearing on the column and an elevating screw under the center of the drilling area. If desired, three T-slots can be planed in the table. In addition to the dimensions already given, the following figures give an idea of the capacity of both the 51-A and 51-B machines, to both of which these dimensions apply. Shortest distance between spindles, 1⅜ inch; vertical adjustment of each individual spindle, 1¼ inch; vertical traverse of head, 24 inches; vertical movement of table, 15 inches; floor space occupied, 7 feet 6 inches by 3 feet 2 inches; weight of No. 51-A machine, 5000 pounds, and weight of No. 51-B machine, 5400 pounds.

Fig. 2. Harrington No. 62 Multiple Spindle Drilling Machine

No. 62-A and 63-A Machines

These machines are of the same design except for the heads, which are of different sizes. The maximum area covered by the spindles of the head of the No. 62-A machine is a circle 20 inches in diameter, and this head has a capacity for driving twelve 1-inch drills. The head of the No. 63-A machine has a capacity for driving sixteen 1-inch drills and the maximum area over which the spindles can be distributed is a circle 25 inches in diameter. They have a powerful drive and easily operated rack feed. Provision is made for the full rated number of spindle pinions so that if purchased with less than the full complement of spindles, the remainder can be added at any time. All spindle dimensions refer to regular equipment of 1 inch capacity. Lighter spindle units for smaller drills can be used or the machine can be equipped with a smaller number of spindles of greater capacity than 1 inch, depending on the size. The driving power is sufficient to handle the rated number of drills in cast iron at a peripheral speed of 65 feet per minute.

The head is a solid casting rigidly braced to prevent springing and is fully counterbalanced, being connected by two chains. The radius bars are cast steel, clamped to the head by bolts through the flange. Each spindle runs in a bronze bushing, is driven by a heat-treated pinion, two hardened universal joints and a telescoping shaft, and has ball thrust bearings. Quick vertical adjustment for different drill lengths is made in any layout without moving the radius arms. The drive is by belt and bevel gears to the head, with a compact train of spur gears driving the spindles. The top shaft is mounted on roller bearings and the provision for lubrication is complete. Belt driven machines, with 7-inch or wider belts, are provided with an eccentric sleeve within the lower cone for decreasing the center distance when shifting the belt. In motor driven machines, a variable-speed motor drives directly to the upper pulley. Belt drive can be provided through a change gear box when required.

The feed is driven by belt from the vertical shaft, and there are three geared changes. A strong planetary train of spur gears on the rack pinion shaft reduces the strain on the worm gear teeth. The worm has both hand and automatic trip, besides a quick operating clutch for rapid hand movement of the head. The frame of this machine is very heavy. The base is heavily ribbed and provided with T-slots, oil gutter, and settling tank. An extension is bolted to the rear of the base for the cone pulley bracket or the motor as required. The table is of the open box type with large planed top surface and has three T-slots. An oil pump with distributing piping can be provided, and is driven by belt from the cone shaft. The principal dimensions of these machines are as follows: Minimum distance between spindles, 2¼ inches; vertical adjustment of individual spindles, 1¾ inch; vertical traverse of head, 34 inches; area of table, 24 by 24 inches for the No. 62-A machine, and 28 by 28 inches for the No. 63-A machine; weight of the No. 62-A machine, 8200 pounds, and weight of the No. 63-A machine, 8800 pounds.

No. 71-A, 72-A and 72-B Machines

These machines are all of the same type but vary in the size of frame and drilling area. Movement of the head in both directions is exclusively by power, the return stroke being automatically controlled. The drive is very simple but extremely powerful, and all of the feed and quick return control mechanism is carried in the bracket on top of the column. Provision is made in the gear chest of each for the maximum number of spindle pinions so that a machine purchased with less than the full complement of spindles can be brought to full equipment at any time. All machines have sufficient power to handle the rated number of drills in cast iron at a peripheral drill speed of 65 feet per minute and a feed of 0.010 inch per revolution. The head frame is

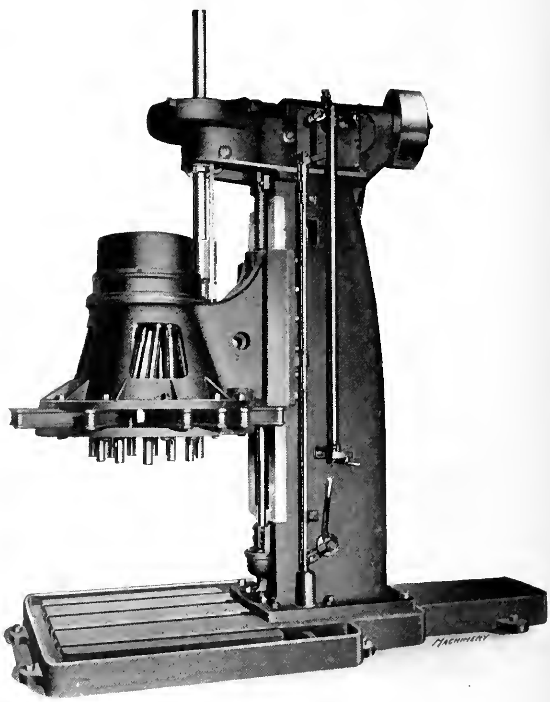


Fig. 3. Harrington No. 72 Multiple Spindle Drilling Machine

cast in one piece with the saddle and has heavy gibs and a long bearing on the column. A counterbalance weight inside the column, connected to the head by two chains, relieves the pressure on the feed-screw. Bolts through the head flange and the slots of the radius bars hold them in position. These radius bars are steel castings, in the inner end of which is a bored hole, carrying the bronze spindle sleeve.

The adjusting screw is arranged so that this sleeve can be regulated up and down for different lengths of drills without moving the position of the radius arms. The spindles have a long bearing in the bronze sleeves and are provided with ball thrust bearings. A telescopic shaft, with universal joints at each end, connects each spindle and its pinion.

The drive is by vertical belt to the pulley on the top bracket, which is provided with a roller bearing and mounted on an extended sleeve so that the belt strain does not come on the driven shaft. A pair of bevel gears transmits the power to the vertical shaft which carries a pinion on its lower end meshing with the upper of a pair of spur gears in the top of the gear chest, the lower gear, in turn, driving the spindle pinions. All pinions are made of heat-treated alloy steel. All have accurately cut teeth and bearings at both ends of their shafts, with ample provision for constant lubrication. The type of drive recommended is from a variable speed motor on the rear extension of the base, by belt to the pulley overhead. Regular belt drive from an overhead countershaft can be provided, in which the lower cone is mounted on an eccentric shaft to slacken the belt when shifting. For belt drive without the use of a countershaft, or for constant speed motor drive, a change speed gear box is placed on the rear base extension. Both the feed and return of the head are obtained from a large screw in the face of the column and a unit gear box in the top bracket. The screw is in tension and has a ball thrust bearing at the bottom. Three changes of feed by positive gearing are provided, and quick movement of the head in either direction is obtainable through a friction clutch. The clutches are so arranged that when the drills have reached full depth, the head automatically returns to the top of the stroke ready to be started on the next drilling operation. The frames of these machines are very heavy and the base is heavily ribbed and provided with T-slots, oil gutter and settling tank. The table is of the open box type with large planed top surface having three T-slots and gutter. An oil pump with distributing piping can be located on the rear of the column, and is driven by belt from the shaft below.

Fig. 1. Improved Type of "Old Man" or Drilling Post made by Lutz-Webster Engineering Co.

The principal dimensions of the No. 71-A machine are as follows: Capacity, for drilling sixteen 1¼-inch holes; maximum area covered by spindles, a circle 25 inches in diameter; shortest distance between spindles, 2½ inches; vertical adjustment of individual spindles, 1½ inch; vertical traverse of head, 31 inches; weight, 22,000 pounds. The dimensions of the 72-A machine are: capacity, for drilling twenty 1¼-inch holes; maximum area covered by spindle centers, a circle 32 inches in diameter; shortest distance between spindles, 2½ inches; vertical adjustment of individual spindles, 1½ inch; vertical traverse of head, 40 inches, and weight of machine, 28,000 pounds. The dimensions of the No. 72-B machine are: capacity, for drilling twenty 1½-inch holes; maximum area covered by spindle centers, a circle 36 inches in diameter; shortest distance between spindles, 2½ inches; vertical adjustment of individual spindles, 1½ inch; vertical traverse of head, 40 inches; and weight of machine, 29,000 pounds.

LUTZ-WEBSTER "OLD MAN"

The drilling post or "old man," as it is commonly called in the shop, has been successfully used for many years in certain classes of drilling which cannot be handled on a drill press. Various forms of these tools have been made by different manufacturers, each of which has certain points of merit. The Lutz-Webster Engineering Co., Inc., 31st St. and Gray's Ferry Road, Philadelphia, Pa., has recently added to its line the equipment which forms the subject of the present article. This tool, used in connection with the Lutz compression wrench, makes a particularly serviceable outfit. It will be seen that two arms are shown, one of these being a plain arm while the other is a swivel arm, which provides for drilling holes at an angle. A detail of the swivel arm is shown in Fig. 2, from which the construction will be readily understood.

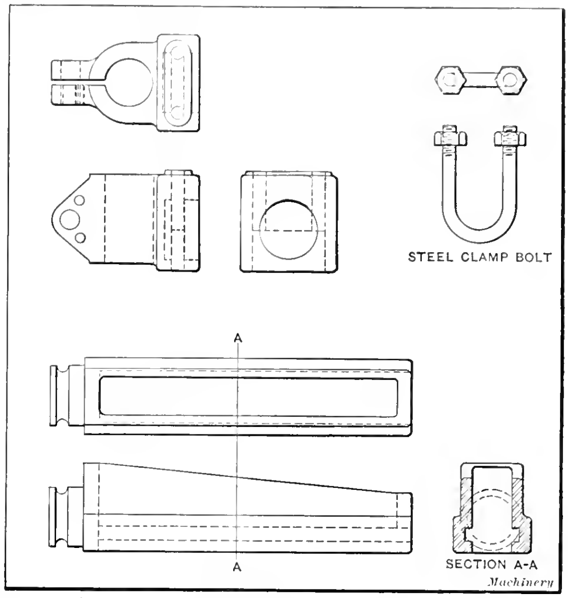
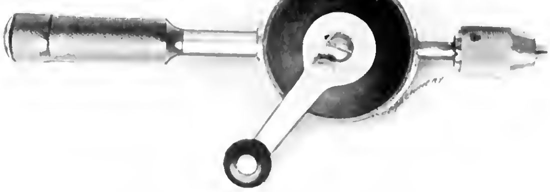


Fig. 2. Detail of Adjustable Arm for Lutz-Webster "Old Man"

The features of this improved style of "old man" may be briefly outlined as follows: The ratchet is a single piece, and even a straight shank drill may be used in place of the ratchet, where the Lutz compression wrench is used to drive the drill. Under such conditions, the wrench affords the necessary grip for turning through part of a revolution, and it may then be released and moved back to secure a fresh grip ready for the next forward movement. In addition to the usual feed arrangement, an auxiliary feed movement can be obtained by means of a pin fitting in the hole in the supporting screw which is turned by means of this pin. These drilling posts are made in 16-, 20-, and 26-inch sizes and can be made entirely of steel or of malleable iron.

MILLERS FALLS HAND DRILL

One of the recent products of the Millers Falls Co., Millers Falls, Mass., is a No. 353 hand drill which is made entirely of metal with the exception of the enameled wood crank handle. The knurled handle at the top of the drill is provided with a screw cap which may be removed to give access to the socket in which extra drills can be carried. It will be seen that there are two pinions engaging the driving gear, the purpose of this double pinion arrangement being to support the gear on both sides, thus relieving the bearing from

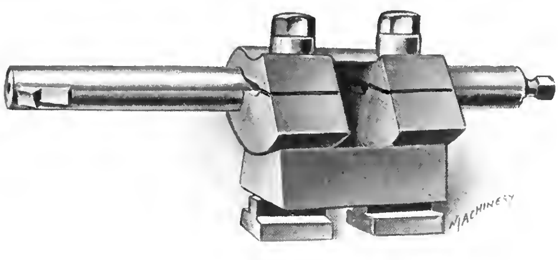


No. 353 Hand Drill made by the Millers Falls Co.

undue strain. The small knurled knob on the crank controls a ratchet which may be set to work either right- or left-hand, or to provide positive drive in both directions. The spring pawl connected to the knurled knob engages square holes in the driving gear. The pawl is tapered on one side and may be set so that the taper engages the holes to run back either right- or left-hand; and by setting the pawl edgewise with the holes, positive drive in both directions is secured. This ratchet mechanism is particularly convenient for use in cramped places. The capacity of the three-jawed chuck is for drills up to 3/16 inch in diameter.

RED-E BORING-BAR HOLDER

A recent addition to the line of tool-holders manufactured by the Ready Tool Co., 654 Main St., Bridgeport, Conn., consists of a boring-bar holder for supporting bars of the larger sizes. Reference to the illustration will make the method of using this tool clear without requiring an extensive description. It will be seen that the bar is mounted on the lathe by



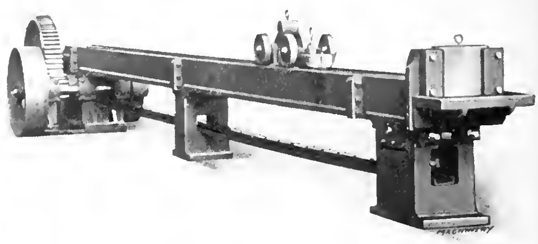
Ready Tool Co.'s Heavy Boring-bar Holder

first removing the toolpost and then inserting the T-bolts which secure the holder, in the T-slots in the carriage. Tightening up two nuts on the end of these bolts not only clamps the holder in place but also serves to secure the boring-bar in the holder. By rocking the upper part of the holder on the base, it is possible to adjust the bar for various heights that are required in different makes of lathes.

WATERBURY-FARREL CHAIN DRAW-BENCHES

For use in the manufacture of tubing, solid bars and similar products, the Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn., has brought out a line of chain draw-benches which supersedes preceding machines for the purpose, built by this company. The new machines are built in three sizes having pulling capacities of 10,000, 20,000 and 30,000 pounds on the chain. Several noteworthy improvements have been made in their construction. The chain drive is of the "two-in-one" type, having drop-forged center links, and the outer links are made of bar stock; this gives exceptionally good wearing properties, a feature which is accentuated by the fact that there is a large wearing surface between the chain and the sprocket. The hook and chain are so designed that there is less danger of accidents resulting from the refusal of the hook and chain to disengage at the end of the drawing stroke, than was the case in some of the older type machines. The compact and self-contained drive is arranged with an outboard bearing on the sprocket shaft which maintains the alignment of the gears while setting up or erecting the machine. This makes the labor and expense of manufacture, installment and up-keep less than it would otherwise be. The main pinion is also mounted between bearings on the shaft instead of being overhung, and this is a feature which gives additional rigidity. The improved type of wheel tongs is used which has been applied on chain benches built by the Waterbury-Farrel Foundry & Machine Co. during the past three years. These tongs relieve the operator of a fatiguing part of the work and they are returned more quickly than the sliding type of tongs, so that an increase in output is effected through their use.

These draw-benches are adapted for motor drive. The ratio of the gearing and the pulley sizes is so worked out that an ordinary commercial motor can be belted to the driving pulley without requiring any alteration in the design of the bench. As a rule, but little variation is required from the standard motor pulley size. These draw-benches are designed so that they may be assembled either right-hand or left-hand, as desired, without requiring any change in castings or any special machine work. Another useful feature is that the bed is so constructed that it may be lengthened



Waterbury-Farrel Chain-driven Draw-bench for Tubing and Solid Stock

out at any time to suit the requirements of special work. Sight-feed oil cups are provided on all bearings in the driving mechanism, and the cut teeth of the drive and main sprockets do away with the majority of the noise incident to operating machines of this type. A steel channel is provided underneath the bed for supporting the chain instead of allowing it to drag on the floor. In addition to the three sizes of machines previously referred to, four small sized machines are built which have pulling capacities of 1000, 2000, 3500 and 6000 pounds, respectively; two larger machines are also built, which have pulling capacities of 40,000 and 60,000 pounds. These six machines provide for handling the same class of work as the three standard machines, but their capacities make them particularly well suited for exceptionally large or small work.

BEMIS WORK-HOLDING HEAD

Edgar W. Bemis, 92 West St., Worcester, Mass., is the manufacturer of a work-holding head for use on the milling machine, lathe or drill press. This head consists of a frame in which a hollow spindle is mounted. Inside the hollow

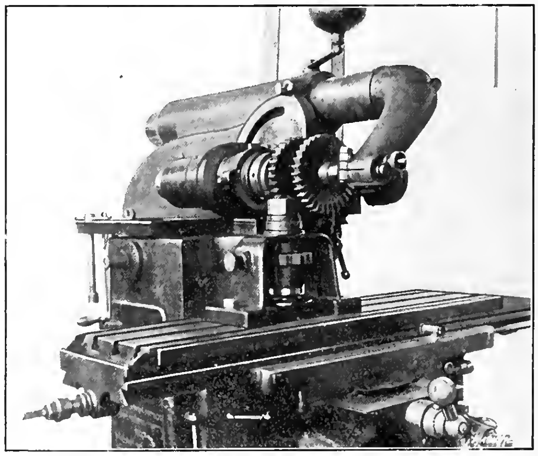


Fig. 1. Bemis Auxiliary Head set up on the Milling Machine

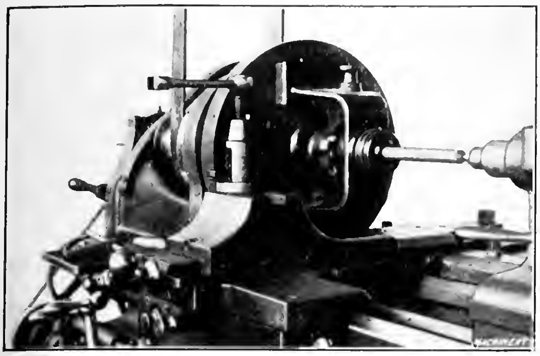


Fig. 2. Application of Bemis Auxiliary Head to Lathe Work

spindle there is a sliding spindle in which different sized collets can be mounted. At the opposite end from the collet, the sliding spindle is threaded into a handwheel which provides for drawing in the collet to grip the work. An index wheel is keyed to the outer or so-called hollow spindle. This index wheel has notches cut in its periphery which provide for indexing angles of 45 and 60 degrees, a spring plunger

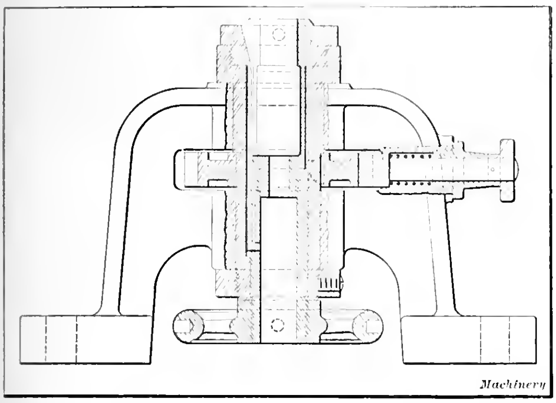


Fig. 3. Type A Bemis Work-holding Head

fitting into the required notch to locate and hold the spindle and work in the required position.

This head is made in two different styles which are known as the Type A and Type B heads. The Type A head, which is illustrated in Fig. 3, is equipped with a draw-in collet of standard design for holding pieces from 1/64 to 7/8 inch in diameter. Type B head is provided with a plug adapter on which threaded pieces can be mounted. These heads can be used on a milling machine for use in straddle milling such work as nuts of all kinds, and for various classes of tool-room and model work. The head is shown in Fig. 1 set up for milling a hexagonal nut. Fig. 2 shows the application of this head to the faceplate of a lathe, where the work is held by a draw-in collet. A typical application of the head for lathe work consists of cutting a multiple thread. After the first thread has been cut, it is required to index the work through 180 degrees (in the case of a double thread) ready for starting the next thread, and this can be easily done with the work held in this type of head. A particularly convenient feature is that after a piece has been put in the chuck, the head can be transferred back and forth between the lathe, drill press and milling machine for performing successive operations, without any serious loss of time in resetting the work, which would otherwise result in making such change.

VOLCANO NO. 3-C HAND TORCH

The Volcano Torch & Mfg. Co., Erie, Pa., is now making a No. 3-C hand torch which has an unusually high heating capacity for an equipment of this type. Instead of depending upon an air pump for generating the pressure, an auxiliary burner has been applied for this purpose, which heats the gasoline in the containing cylinder to give a pressure of from 125 to 250 pounds per square inch. In addition to the increased pressure secured in this way, the necessity for maintaining the required pressure by pumping at frequent intervals is avoided.

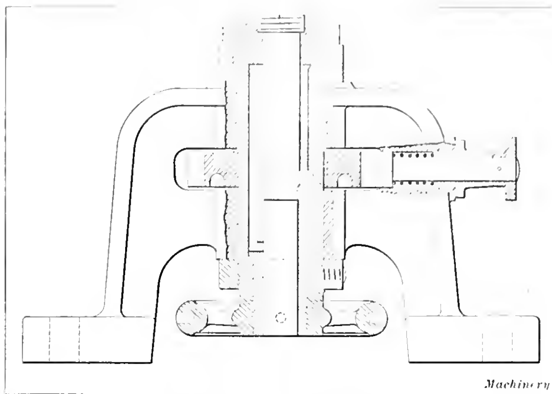


Fig. 4. Type B Bemis Work-holding Head

Referring to the illustration of the torch Fig. 1, the throttle or main valve which feeds the nozzle is controlled by the handle seen at the extreme right. The smaller handle below and to the left, is used for controlling the auxiliary burner which develops the pressure in the cylinder. This auxiliary burner is located inside the outer cylinder below the perforated section. A gaging device, seen on the right-hand side of the cylinder in Fig. 2, provides for regulating the amount of gasoline delivered to the auxiliary burner for use in pre-heating the gasoline in the main reservoir to generate the required pressure. A relief valve is provided for reducing the pressure when required, and there is also a safety valve to guard against the pressure being raised beyond a safe limit. Fig. 2 shows the pressure gage which enables the workman to see at a glance just what pressure has been developed in the cylinder.

One of the features of this torch is that it is unnecessary to stop the heating operation when it is required to replenish

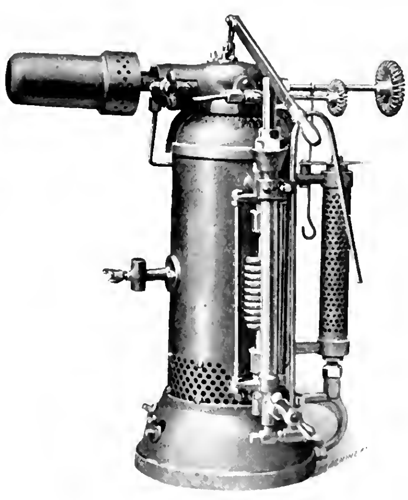


Fig. 1. Front View of Volcano No. 3-C Hand Torch

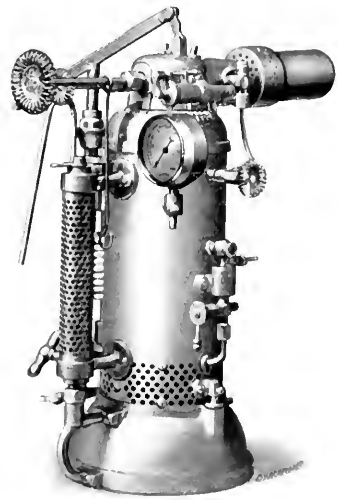


Fig. 2. Opposite Side of Torch shown in Fig. 1

the supply of gasoline in the main reservoir. It will be seen that there is a horizontal lever pivoted at the top of the torch and this lever operates a pump secured to the side of the torch. The small bent tube extending from this pump is provided for making connection with the supply of gasoline from which the required amount is pumped into the reservoir. The shut-off for the gasoline pump will be seen at the bottom of the pump in Fig. 1. The nozzle can be set in any required direction by means of an adjustment and then locked by a wing nut. An idea of the heating capacity of this torch may be gathered from the fact that a 9-inch solid round shaft can be heated red-hot for a distance of 12 to 16 inches in 30 minutes or to a brazing temperature in 1 hour 15 minutes, assuming that the heat is properly confined. This does not represent the maximum capacity of the torch, however, as larger work can be heated with it. The torch can be used out-of-doors in any kind of weather, and it will work with equal satisfaction in any position.

HEALD MAGNETIC CHUCKS

In the October, 1913, number of MACHINERY, rotary and planer types of magnetic chucks made by the Worcester Magnetic Chuck Co., were illustrated and described. This business has recently been taken over by the Heald Machine Co., 20 New Bond St., Worcester, Mass., and a number of noteworthy improvements have been made in the design and construction. In addition to incorporating refinements which make the chucks more efficient, new sizes and types have been brought out to cover a wider range of work. Two sizes of rotary chucks are illustrated in Fig. 1; the chuck shown at the left-hand side of this illustration is the 8-inch size, while the one to the right is a 12-inch chuck. The Heald Machine Co. is also making rectangular or planer type

Fig. 1. 8- and 12-inch Sizes of Heald Rotary Magnetic Chuck

chucks as shown in Fig. 2, which are particularly designed for use on planers, milling machines, surface grinders and similar tools.

The most important feature of these new chucks is their great holding power, which exceeds one hundred pounds per square inch. The holding power is also very uniform over the face of the chuck, the claim being made that the variation does not exceed 5 per cent over the entire faceplate. The design is so worked out that the body of the chuck is free from magnetism, and this is a point of considerable importance as it eliminates the tendency to magnetize the machine on which the chuck is used. The poles are closely spaced with very little dead surface between them; and this enables a great range of work to be handled. Small and large pieces are held with equal efficiency. The chucks are water-proof and non-heating, all the coils being carefully proportioned and thoroughly protected from dampness. The faceplate is of unusual thickness which gives long life and provides for frequent truing. It is an easy matter to replace the faceplate, however, when it is worn out. The unit coil system is adopted, which makes each coil independent of other coils in the chuck, so that the failure of one or more coils does not put the entire chuck out of commission.

A cross-sectional view of the rotary type of chuck is shown in Fig. 3, from which the construction will be readily understood. Referring to this illustration, it will be seen that the chuck is composed of a steel body *A* to which the faceplate *B* which carries the pole pieces is attached. The body has projections *C* cast integral with it which receive the coils *D* and carry the magnetism to the pole pieces *E* in the faceplate of the chuck. The coils slip over the projections and the top faces of these projections are finished even with the sides or walls of the chuck body. The pole pieces, one of which is indicated at *E*, are insulated from the remainder of the faceplate by means of non-magnetic metal, this insulation being shown at *F*. The faceplate casting is also insulated from the main body of the chuck by means of a ring of non-magnetic metal *G* which prevents the magnetism from passing into the body of the chuck.

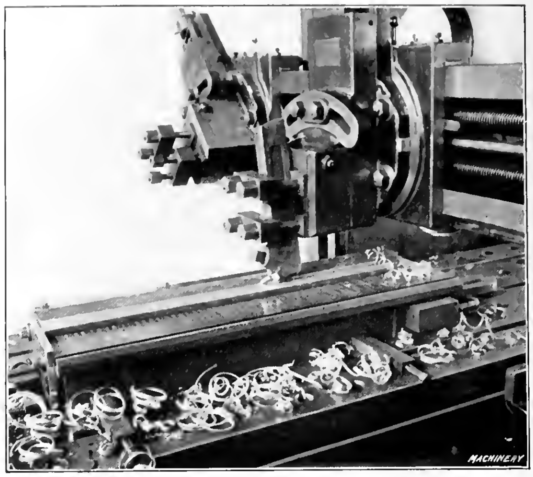


Fig. 2. Rectangular or Planer Type of Magnetic Chuck

In the rotary type of chuck, the current is delivered to a set of brushes which contact with two rings *H* and *I* of conducting metal, which are attached to the lower side of the chuck body. These rings are insulated from the body of the chuck by non-magnetic rings. A consideration of this cross-sectional view will show that the coils and wiring are readily accessible by simply removing the faceplate of the chuck. This plate is held in position by fillister head screws that pass up through the body and enter the under side of the plate. This construction eliminates difficulty arising from grinding away the heads of the screws, which results when these heads are placed in the faceplate of the chuck. The construction will be better understood by referring to Fig. 4 which shows the under side of the chuck with the fillister head screws in place.

A rotary chuck is shown in Fig. 5 with the top plate removed so that the inside of the chuck and the unit system of coils are plainly visible. The individual coils used for different sizes of Heald magnetic chucks have been stand-

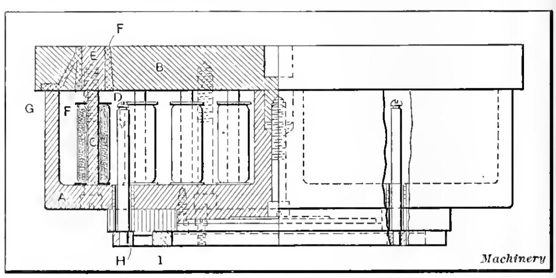


Fig. 3. Cross-sectional View of Heald Rotary Magnetic Chuck

ardized and can be supplied on short notice; they are easily inserted without making it necessary to return the chuck to the factory for repairs. After winding, the coils are carefully taped and thoroughly impregnated so that they will resist water and operate satisfactorily under temperatures as high as 500 degrees F. The insulation is so thoroughly protected that it is claimed the coils will operate when immersed in water.

It has already been stated that the holding power of these chucks is uniform within 5 per cent at all points on the faceplate. This uniformity has been determined by the use

of two one-inch steel cubes, one of which is placed near the center of the chuck and the other close to the periphery, a 16-inch chuck being used for the purpose. Two spring balances were then used to determine the holding power of the chuck, the balances being secured to rings on the upper side of the steel cubes. It was found that the holding power was the same at both places on the face of the chuck, and that the intensity was 112 pounds per square inch. This was by no means a record, however, as many of the chucks tested have shown a holding power as high as 125 pounds per square inch. It is claimed that this high power is due to the unit system of coils that is employed, and to the fact

Fig. 4. Rear View of Chuck showing Method of securing Faceplate from Back

Fig. 5. Chuck with Faceplate removed to show Arrangement of Windings

that the chucks are made of steel instead of cast iron. As the current is delivered direct to each coil in the chuck, it works at maximum efficiency.

Another important feature which was briefly referred to in a preceding paragraph, is that the body of the chuck is entirely free from magnetism. This result is secured by the perfect insulation of the body from the faceplate of the chuck. Referring to the cross-sectional view shown in Fig. 3, it will be seen that a ring of non-magnetic metal *G* is placed between the top of the chuck body and the faceplate, which effectually prevents the magnetization of the body of the chuck and the machine on which it is mounted. This

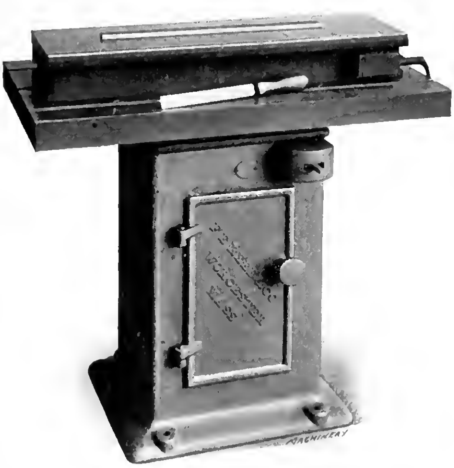


Fig. 6. Application of Heald Chuck for Scraping Operations

does away with the annoyance frequently caused by having particles of metal adhere to the body of the chuck and to the machine, due to their magnetic attraction.

One of the strong objections to magnetic chucks has been due to the fact that, as they were not perfectly insulated, the electric current passed down into the machine itself and resulted in the operator frequently receiving a shock. The Heald chuck is carefully insulated so that this source of annoyance is avoided. Freedom from residual magnetism is another feature. Upon shutting off the current from the chuck, it is almost entirely demagnetized, making it easy to remove the work from the faceplate of the chuck without requiring the use of a demagnetizing switch for this purpose. This result is obtained by perfect insulation as well as the use of carefully selected material for each member.

The arrangement of the poles in these chucks makes it possible to hold all classes of work from small washers up to pieces of sufficient size to cover the entire faceplate of the chuck. The arrangement of the poles is such that there is very little "dead" surface on the faceplate, so that when used for grinding small washers or other comparatively small parts, there is no need of using special devices for locating the pieces on the chuck. It is only necessary to cover the chuck with the washers and they will all be held securely in place. The water-proof feature is obtained by having all joints so tight that it is practically impossible for water to find its way into the windings. In fact, there is only one chance for water to get through, which is at the edge of the faceplate, and that chance has been made practically nil through having the joint ground to a very close fit. Even if moisture should get into the chuck, the coils are so thoroughly taped that they are practically water-proof.

These chucks may be used on either 110 or 220 volt current. Alternating current cannot be used, and in plants where only alternating current is available, a small generator may be installed to furnish the required current. An idea of the current consumption may be gathered from the fact that a 1/4 horsepower generator will supply sufficient current to run

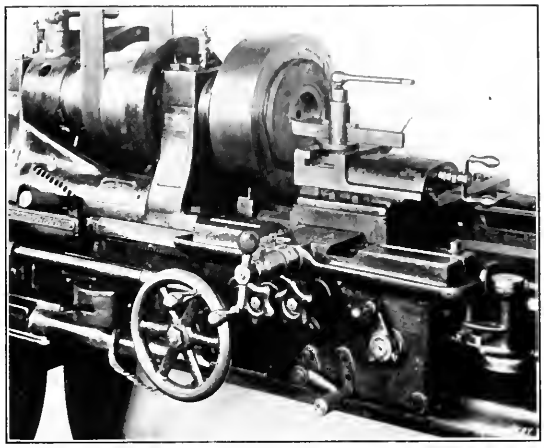


Fig. 7. Rotary Chuck set up on a Lathe

six of the 8-inch rotary chucks. An idea of the current required for different sizes of chucks may be gathered from the fact that a 12-inch rotary chuck requires only 0.6 ampere of current and the 8-inch rotary chuck requires 0.4 ampere. The 10 by 32-inch rectangular chuck takes 1.2 ampere.

The convenience of operation of the Heald magnetic chuck has led to its use in other classes of work than those for which it was originally designed. A typical example is shown in Fig. 6 which illustrates a 10 by 22-inch chuck which is being used as a scraping stand. The chuck is demagnetized for the removal of the work and the method is said to be far superior to that of holding the piece on a scraping stand. Fig. 7 shows a chuck mounted on a lathe and holding a cast-iron flange without the use of a center stud or side blocks. A facing cut 3/32 inch deep is being taken with a feed of 0.027 inch per revolution. The most striking application of the use of these magnetic chucks is illustrated in Fig. 2, which shows the chuck set up on a planer. A strip of machine steel is being held while a cut 5/16 inch deep is being taken with a feed of 5/32 inch. The cutting speed is 60 feet per minute and there is no tendency for the work to lift or move. The only support which the work received, aside from the holding power of the chuck, was from the guide strips at the end and on one side of the chuck. The same chuck was used on a milling machine for holding a cast-iron plate on which a 1-inch end milling cutter was fed to a depth of 5/16 inch, at a feed of 6 7/8 inches per minute.

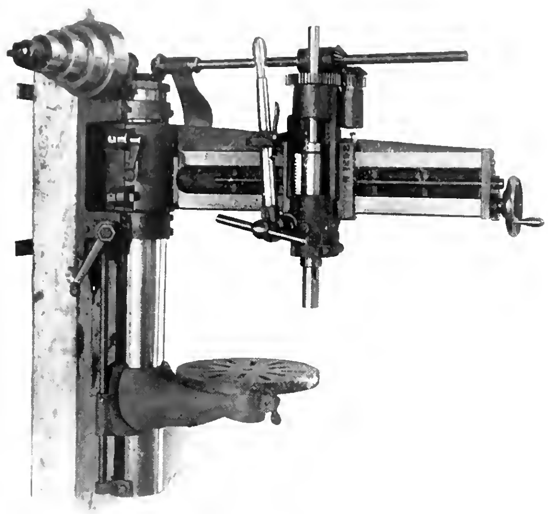
CANEDY-OTTO RADIAL DRILL

To meet the requirements of shops where a radial drill is needed, but where the price of a standard equipment of this type is prohibitive, the Canedy-Otto Mfg. Co., Chicago

Heights, Ill., has brought out the post type radial drill which is illustrated herewith. This is a powerful and accurate machine which is particularly adapted for use in machine shops, garages, blacksmith shops and bridge and boiler shops, where a wide range of drilling is done.

The drive is from a countershaft equipped with a four-step cone pulley and self-oiling bearings. This countershaft is customarily attached to the ceiling. The arm can be swung against the wall and it may be securely tightened in any position. The spindle head is traversed along the arm by means of a screw and handwheel. When the head has been brought to the desired position, means are provided for clamping it in place. The spindle has quick return by means of a hand lever, in addition to the regular hand feed which is provided by an independent lever.

The principal dimensions of the machine are as follows: Height, 56 inches; capacity for drilling to the center of a circle outside of the column 64 inches in diameter; maximum distance from center of spindle to column, 32 inches; minimum distance from center of spindle to the column, 7 inches; maximum distance from spindle to table, 18 inches; traverse of spindle, 9 inches; capacity for drills up to $1\frac{1}{4}$ inch in diameter; and net weight of machine, 800 pounds.



Canedy-Otto Post Type Radial Drill

UNION TWIST DRILL CO.'S GROUND HOBS

For several years makers of gear cutting hobs have been trying to manufacture one-piece ground hobs, that is, those on which the sides and tops of the teeth are ground accurately to shape. Only by grinding hob teeth all over is it possible to eliminate all the changes of shape developing in the hardening operation. The Union Twist Drill Co., Athol, Mass., succeeded in solving the problem commercially some time ago and is now prepared to furnish hobs with all faces accurately ground to shape.

The ordinary commercial hob is ground only in the bore except, of course, grinding on the faces of the teeth in the gashes, to sharpen them. The grinding of the bore, however, does not take care of any of the errors due to hardening except the distortion of the hole. At best, it merely averages the total errors, of which there are four classes, namely: changes of lead, distortion of individual teeth, varying distance between gashes, and distortion of the hob to an out-of-round shape. The Union Twist Drill Co. states that the shortcomings of the unground commercial hob cannot be fully realized until the corrections made by the all-over grinding process are observed.

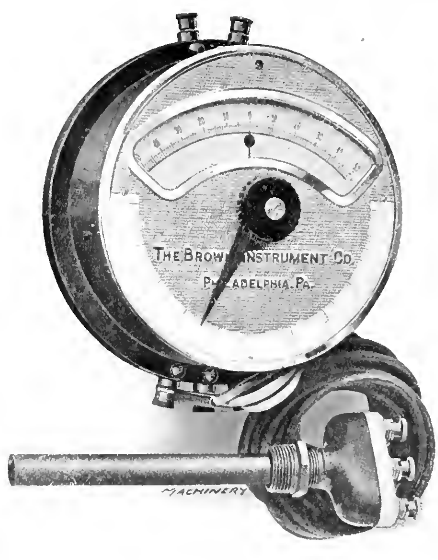
The advantages of the ground hob are not simply producing more nearly perfect gear teeth in the hobbed gears. The hob can be set up in the hobbing machine without reference to any particular tooth. When using unground hobs, it has been found necessary to center by some particular tooth in order to get the best results, but with the ground hob, the gears produced are equally good no matter what part of the hob is used for centering when setting up. Also, it is possible to use the end section of the hob and when this has become worn, the hob is moved along successively until all the teeth are dulled, when, of course, grinding the faces of the teeth to sharpen them is necessary.

To get the best results from ground hobs it is necessary that the gear cutting machine be in the best possible condition; in fact, it is more essential than ever that the machine be accurately adjusted and in perfect order. If end play in the spindle is present, or if the arbors are not true, the advantages of the ground hob will not be realized to the fullest possible extent. The superiority of ground hobs will not be so apparent on the general run of gear work as on the highest grade automobile gears and other constructions requiring smooth and noiseless action. The Union Twist Drill Co. furnishes the ground hobs at prices from 25 to 40 per cent higher than for the ordinary type of unground hob, the operation of grinding the sides of the teeth being a long and tedious one. At the present, the finest ground hobs that can be furnished are twelve diametral pitch.

BROWN RESISTANCE THERMOMETER

The Brown Instrument Co., Philadelphia, Pa., has recently brought out a new resistance thermometer for measuring temperatures from 200 degrees below zero to 1800 degrees Fahrenheit. This instrument is capable of great accuracy and is particularly adapted for measuring low temperatures which cannot be readily determined with the thermo-electric pyrometer. It is particularly suitable for determining the temperatures of driers and ovens, of the bearings of machines which may overheat, of the windings of motors and transformers, of refrigerating machines, and of furnaces used for the heat-treatment of steel where the temperature comes within the range of the instrument.

This thermometer consists of a bulb or coil of wire, the resistance of which changes with a change of temperature; and bulbs of this type can be located on various equipments in a plant, where information concerning the temperature of such equipments is desired. A three-wire cable connects these bulbs with the indicating instrument and switchboard which can be placed in any desired position. To determine the temperature, it is simply necessary to switch the proper bulb onto the indicating instrument. If a constant temperature is to be maintained, the pointer of the indicating instrument can be adjusted to the required temperature and



Brown Resistance Thermometer for Temperatures from — 200 to + 1800 Degrees F.

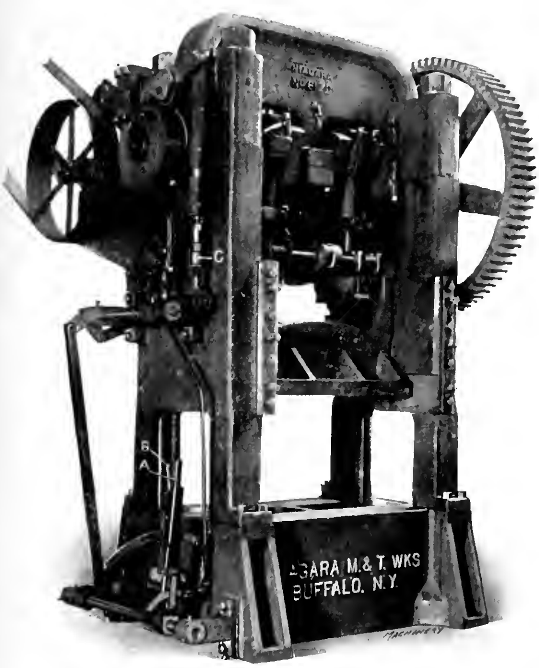
the deflection of the pointer on the upper scale of the instrument will show the increase or decrease in temperature from the required point. This new thermometer operates on either dry cells or storage batteries, or it may be connected with 110 or 220 direct current lighting circuits.

The chief advantages of the resistance thermometer are its suitability for use in determining moderate temperatures from one central location, eliminating the necessity of going about from one point to another to read the temperature as indicated by individual thermometers. As the bulbs used in connection with the new Brown thermometer are made entirely of metal, they are not likely to be broken. The indications of the instrument are guaranteed to be within 1 per cent of accurate.

NIAGARA DOUBLE CRANK PRESS

The accompanying illustration shows a large double crank press built by the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is equipped with a device for controlling the clutch and the motion of the slide, which permits of engaging or disengaging the friction clutch at any time during the downward motion of the slide. The slide may also be automatically stopped at its highest position by this device, instead of by the treadle-actuated clutch that causes the crankshaft to make a complete revolution. The clutch is "non-repeating," as the controlling lever returns automatically to the starting point and is locked in position after the slide reaches its highest point.

In order to engage the clutch, the operator grasps the lever *A* and at the same time disengages locking lever *B*. The lever *A* is then pulled forward to the outer end of the segment and thus engages the clutch. The locking lever *B*

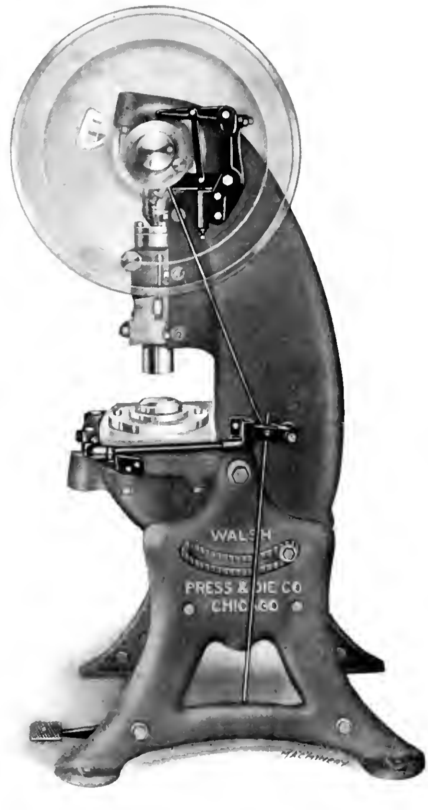


Niagara Double Crank Press equipped with Device for controlling Motion of the Slide

controls the action of a plunger engaging the connecting-rod *C*; *i. e.*, when the lever *B* is disengaged the connecting-rod *C* is also released, and the clutch lever *A* is free to be moved forward to engage the clutch. The return motion of the clutch lever is accomplished by means of a cam fastened to the outer end of the crankshaft. This improved feature can be applied to other presses equipped with a friction clutch. The present machine has the usual convenient features of adjustment that are found on all large Niagara presses. The driving mechanism is arranged overhead, thus making the machine accessible from all sides.

WALSH POWER PRESS SAFEGUARD

Among the various principles which have been applied in the design of safeguards to protect the operators of power presses from injury, one of the most successful is that in which the operator is required to use both of his hands in tripping the press. This principle has been applied to various forms of safeguards, one of the most recent of which is that manufactured by the Walsh Press & Die Co., 4709-4715 W. Kinzie St., Chicago, Ill. A Walsh inclinable press equipped with one of these guards is illustrated herewith. Referring to this illustration, it will be seen that there are two push buttons at the front of the die bed, and in order to trip the press, the attendant is required to push both of these buttons. The buttons are operated as easily as the keys of



Power Press Safeguard that requires the Operator to use both Hands to trip the Press

a typewriter, and they are placed at such a distance apart that it is impossible for both buttons to be pressed with one hand. In this way, it is impossible for a careless workman to have his hands on the die when the ram descends. The latch is automatically returned after each stroke of the press, so that it is impossible for the operator to only release the treadle enough to have it just draw the clutch bolt sufficiently to engage the edge of the latch—a practice which has been responsible for nine-tenths of the accidents where the claim has been made that the press "repeated." The entire mechanism can be locked back by means of a special key when the press is operated on ribbon stock. It is also possible to lock one of the two finger buttons, thus leaving one of the operator's hands free for feeding the press.

* * *

The effects of persistent advertising were never more forcibly felt than in the case of instructing workmen in the "safety first" movement. By the use of bulletins, lectures, printed warnings on pay envelopes and actual exhibitions, the need of caution on the part of the working-man is being emphasized. That it is having its effect is noticeable from the report of accident companies and industrial records.

NEW MACHINERY AND TOOLS NOTES

Draw-over Tool: J. Morrison Gilmour, 90 West St., New York City. A tool which takes the place of the hammer and chisel for drawing over holes which have run out at the starting point in drilling.

Portable Shear: The Canton Foundry & Machine Co., Canton, Ohio. A shear which is motor-driven and entirely self-contained; it is mounted on a truck so that it can be moved around the shop to any required position.

Gear Guards: Consolidated Expanded Metal Companies, New York City. Gear guards made of expanded mesh, which are known as the "steelcrete" mesh guards. They are made of cold-drawn mesh fabricated from basic open-hearth steel.

Surface Gage: W. P. Kirk, 336 W. 4th St., Cincinnati, Ohio. A surface gage of simple design which is particularly adapted for rapid manipulation. This gage is suitable for use on a wide range of work where accurate dimensions are required on interchangeable parts.

Hydraulic Press: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. A hydraulic press built for drawing steel barrels in the plant of the Hydraulic Pressed Steel Co., Cleveland, Ohio. This is said to be one of the largest equipments of this type which has ever been built.

Axle Turning Lathe: Niles-Bement-Pond Co., 111 Broadway, New York City. A lathe designed for use in railway shops for turning and truing axles. The machine may be used for turning axles before the wheels are pressed in place and also for truing the journals after they have become worn.

Portable Arbor Press: Brickell Mfg. Co., Boston, Mass. A portable arbor press designed for pushing pulleys off shafts and for similar operations. As the pressure is applied directly to the member to be removed—close to the point where it hugs the shaft—an unusually high efficiency is secured.

Planers: Cincinnati Planer Co., Cincinnati, Ohio. A line of light planers built in 24-, 26-, 28- and 30-inch sizes. The notable features of the design of these machines consist of an extremely simple belt-shifting mechanism and a bed constructed in such a way that all of the gears are completely enclosed.

Gap Lathe: Summitt Machine Works, Worcester, Mass. A 10-20 inch gap bed engine lathe. The machine is also built with a plain bed. The carriage is arranged for the use of a taper attachment which can be applied at any time. The swing is 7½ inches and the weight of the machine with a 4-foot bed is 550 pounds.

Self-lubricating Bushings: The Graphite Metallizing Corp., Yonkers, N. Y. Bushings made of a product known as "graphalloy." This consists of graphite impregnated with molten metal, and it is said that the material makes excellent bushings for use on light duty machines, these bushings being self lubricated.

Slotter: Newton Machine Tool Works, Inc., Philadelphia, Pa. A crank slotter in which the speed-gear change mechanism is located in the head. The cutter bar carries a relief tool apron with vertical and horizontal clamping faces. The face of the bar is serrated to relieve the adjusting screw from strain when the tool is under cut.

Shaper Feed Mechanism: John Steptoe Co., Cincinnati, Ohio. An improved feed mechanism applied to the line of shapers built by this company. The mechanism is so designed that it may be employed as either a vertical or a cross feed. Previous machines built by this company have been equipped with only power cross feed.

Universal Woodworking Machine: Crescent Machine Co., 56 Main St., Leetonia, Ohio. A machine consisting of five units which comprise a band saw, a saw table, a jointer, a shaper and a boring machine. All of these are so mounted that any f them can be used independently, and the machines which are not in use do not have to be driven.

Engraving Machine: Alfred H. Schütte, Cedar and West Sts., New York City. A precision engraving machine which operates on the pantograph principle. The pantograph has four arms, three of which are adjustable by means of scales furnished with the machine. By means of these adjustable arms, it is possible to obtain any reduction between the limits of 1 to 1 and 10 to 1.

Fuel Oil Burner: Bellevue Furnace Co., Detroit, Mich. A burner designed to operate on a low pressure of air which is the means of greatly reducing the tendency toward scaling. The oil control is effected by means of a regular needle valve. The air controller consists of a central tube which carries the oil through the jet nozzle where it is mixed with the air and thus atomized.

Milling Machine: Gooley & Edlund, 581 S. Clinton St., Syracuse, N. Y. A manufacturing milling machine which is styled a Type-B Briggs miller. The distance between the housings is 17 inches; the working surface of the table, 54 by 11 inches; the traverse, 34 inches; and the maximum distance from the table to the center of the arbor, 15 inches. The weight of the machine is 4500 pounds.

Circular Saw Guard: L. F. Grammes & Sons, Allentown, Pa. A guard consisting of a number of shields suspended from a horizontal bar which, in turn, is supported by a rod connected to the ceiling. The bar from which the shields are suspended is supported in such a way that it will not vibrate. As the work is advanced to the saw, the shields are raised to provide the necessary clearance.

Conversion Chart for Money Values: S. C. Carpenter Drafting & Engineering Co., Hartford, Conn. In the March, 1914, number of MACHINERY, the Nos. 1, 2, 3 and 4 conversion charts made by this company were described. Since that time a No. 10 chart has been brought out which affords an easy method of converting the value of various foreign moneys into the equivalent in United States money.

Roll Grinding Machine: A. Garrison Foundry Co., Pittsburg, Pa. This company has recently redesigned the machine of its manufacture used for grinding chilled rolls. The special feature of the new machine consists of a mechanism for grinding tapered rolls. The capacity is for rolls up to 32 inches in diameter with necks which are not more than 9 inches smaller than the body of the roll.

Air Compressors: Clayton Air Compressor Works, 115 Broadway, New York City. Three types of air compressors which are particularly adapted for use in industrial plants requiring small amounts of compressed air. One of these is a portable motor-driven unit. The other two units are also motor-driven, one being a two-stage compressor and the other an automatic outfit designed to operate either continuously or intermittently.

Horizontal Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A duplex horizontal milling machine which has a table 20 inches in width. The table has positive geared feed and reversing fast power traverse. The spindles are driven by solid bronze worm-wheels and hardened steel worms. The spindle saddles are counterweighted and provided with hand vertical adjustment. The minimum distance between the spindles is 3 inches and the maximum distance 28 inches.

* * *

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The spring or semi-annual meeting of the American Society of Mechanical Engineers was held in St. Paul and Minneapolis, Minn., June 16-19. Several of the papers presented dealt with the great engineering developments of the Northwest, with moving pictures showing ore handling on the Great Lakes. Opportunity was afforded the members to visit the milling district of Minneapolis, with its daily output of 84,000 barrels of flour, and to see the water power developments of the Mississippi River. Three professional sessions were held at which the following papers were presented:

"Pulverized Coal Burning in the Cement Industry," by R. C. Carpenter.

"Pulverized Coal for Steam Making," by F. R. Low.

"Industrial Service Work in Engineering Schools," by J. W. Roe.

"Classification and Heating Values of American Coal," by William Kent.

"The Railroad Track Scale," by W. W. Boyd.

"Gear Testing Machine," by Wilfred Lewis.

"The Flow Metering Appliance," by A. M. Levin.

"Power Development of the High Dam between Minneapolis and St. Paul," by Adolph F. Meyer.

"The Handling of Coal at the Head of the Great Lakes," by G. H. Hutchinson.

"Minneapolis Flour Milling," by Charles A. Lang.

* * *

A Curtiss aeroplane driven by two 100-H.P. eight cylinder motors is being built at Hammondsport, N. Y., to cross the Atlantic. Lieut. John C. Porte proposes to make the trip starting from St. Johns, Newfoundland, and landing at the Azores to rest and replenish the supply of gasoline. Thence he will go to Vigo, Spain, and thence to Plymouth, England. The estimated distance from St. Johns to the Azores is 1199 miles; from the Azores to Vigo, 963 miles; and from Vigo to Plymouth, 523 miles, making a total of 2685 miles. The estimated speed is sixty miles an hour and the total elapsed time for the flight is to be fifty-five hours, which gives an allowance of ten hours at the stopping places for replenishing fuel and resting.

BAR STOCK GUARD FOR TURRET LATHES

BY S. H. EARL*

The accompanying illustrations show a bar stock guard for turret lathes which has recently been installed in the Gleason Works, Rochester, N. Y. Referring to these illustrations it will be seen that the portion of the bar extending out from the spindle of the machine is completely enclosed so that it is impossible for the operator or those working in the vicinity of the machine to be injured.

The pipe which surrounds the stock is about one inch larger in diameter than the hole through the spindle of the machine. This pipe is mounted on brackets which are permanently fitted to the stock support standards at a sufficient distance below the stock support crotches to allow the crotches to be adjusted for various sizes of stock without adjusting the pipe. It will thus be evident that the stock is supported by the standard crotches provided with the machine and not by the pipe, which is merely employed to cover the stock to provide for the safety of employes. The pipe is split and the two halves hinged together, so that the guard may be easily opened to provide access in handling short bars. Fig. 1 shows the guard with the pipe open and in Fig. 2 the guard is shown closed ready for operation. Fig. 3 shows one of the supporting brackets in detail, together with the way in which the stock support crotch may be adjusted independently of the guard.

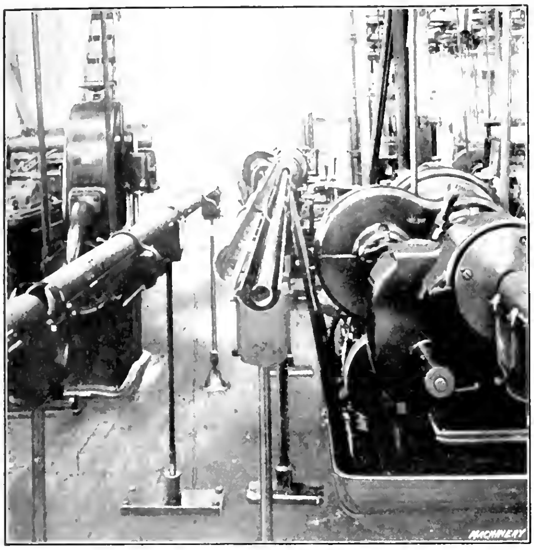


Fig. 1. Bar Stock Guard for Turret Lathes with the Pipe Open

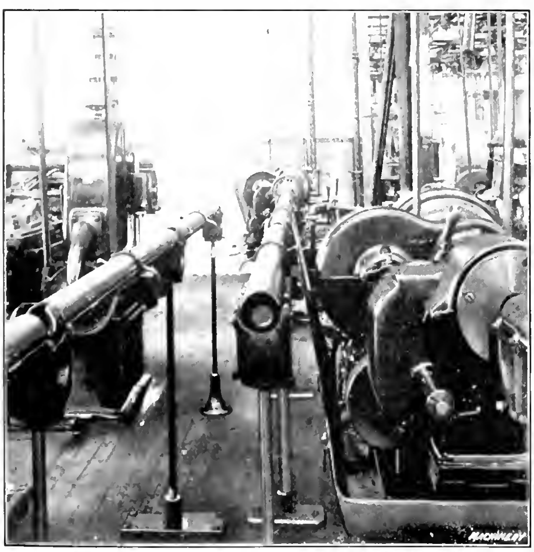


Fig. 2. Guard shown in Fig. 1 with the Pipe closed

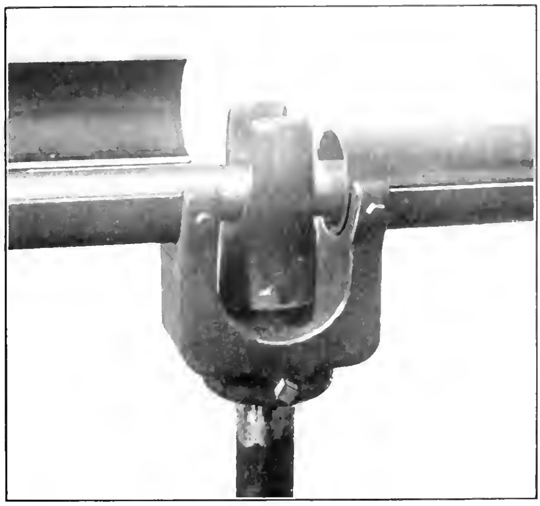


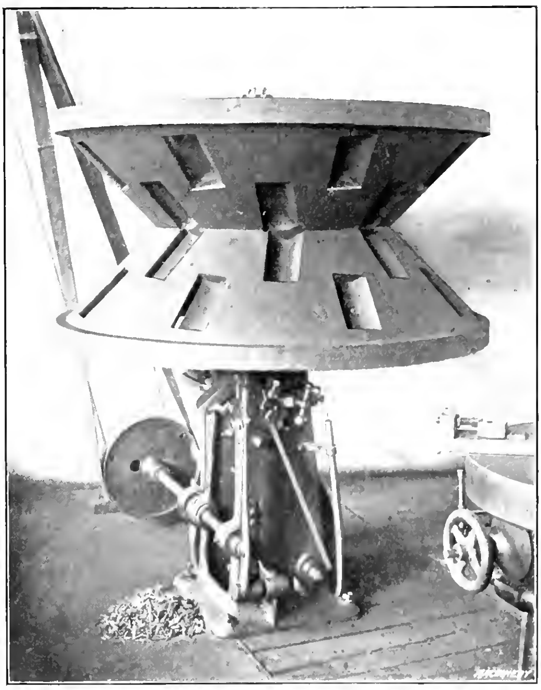
Fig. 3. Method of supporting Guard on Brackets independently of Stock Crotch

* Address: Gleason Works, Rochester, N. Y.

* * *

AN UNUSUAL KEYSEATING OPERATION

A No. 3A keyseating machine of 25-inch stroke, built by Mitts & Merrill, 843 Water St., Saginaw, Mich., is shown in the accompanying illustration, working on a decidedly unusual job. The work is a cylinder for an edging grinder which is used for grinding up refuse in saw mills. The capacity of this machine is 20 cords of wood per hour. The bore in the cylinder is 7 inches in diameter by 28 inches long, with a hub on each end which is 12 inches long. It is required to cut two keyways for tapered keys in this bore, the keyways being located 90 degrees apart; and they are $1\frac{1}{2}$ inch wide by 11/16 inch deep at the deep end. The deep end of one keyseat is at one end of the bore and the deep end of the other keyseat is located at the opposite end of the bore. This keyseating operation was performed without re-



Unusual Keyseating Operation on a Mitts & Merrill No. 3A Keyseater

quiring the cylinder to be reversed. As the combined length of the keyseats is longer than the stroke of the machine, the cutter and feed wedge had to be shifted. The keyways were cut in one hub at a time. Despite the conditions under which it was necessary to do the work it was found that the keyways were as accurately aligned as though they had been machined by a continuous cut.

* * *

GUARDS FOR GEARS AND DRIVING BELTS

In view of the stringent legislation enacted by various states in regard to the guarding of gears and belts in manufacturing shops, this subject has become of general interest.

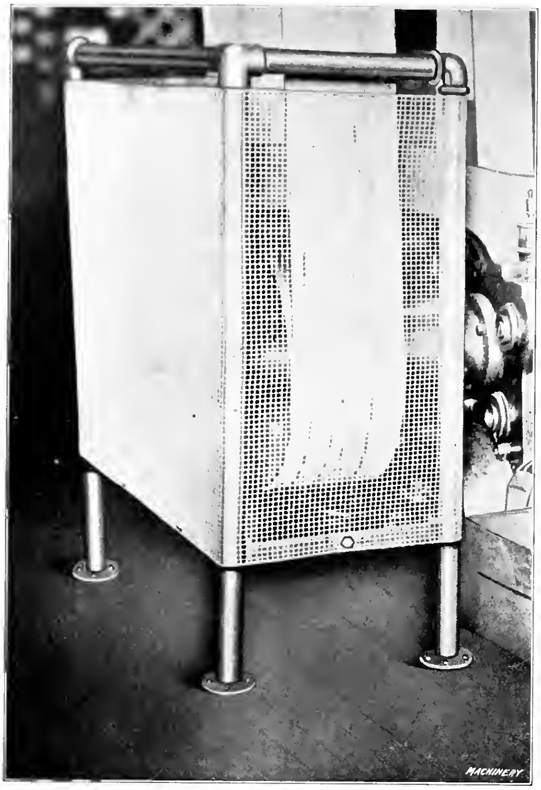


Fig. 1. Efficient Type of Guard for Gears or Driving Belts

An efficient belt guard is used in the shop of the Hays Mfg. Co., Erie. Pa. The illustration Fig. 1 gives a general idea of the way this guard is installed to protect a driving belt. The guard is composed of piping with the wire screening wrapped around. The most interesting feature, however, is the method by which the guard may be removed for shifting the belt, oiling or repairs. This is shown in the line illustration Fig. 2. The three uprights, composed of pipes, are not made fast to the floor, but are slipped over

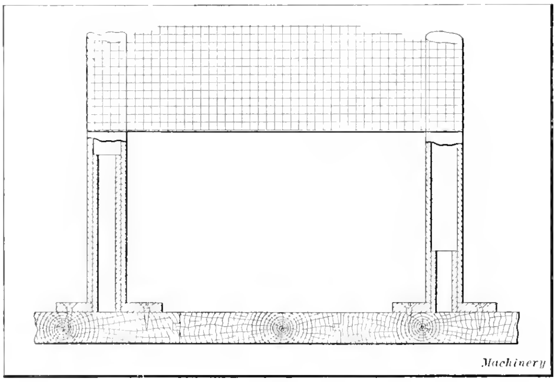


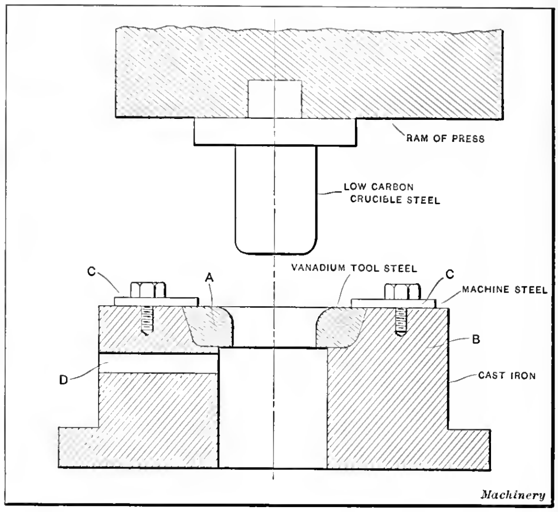
Fig. 2. Showing Removable Feature of Guard

short lengths of flanged pipes that are screwed into the floor in the correct locations. One of the flanged pipes is about six inches in height. The others are short sections of approximately three inches, as shown at the right of the illustration Fig. 2. To remove the guard for oiling, it is simply necessary, therefore, to lift it three inches to clear the short lengths of flanged pipe, and swing it around on the pivot of the longer section at the outer corner. If necessary the guard may be raised entirely from connection with the flanged part. Guards of this type are cheap and strong, yet at the same time they are effective. C. L. L.

* * *

MOUNTING DRAWING DIE RINGS IN CAST-IRON SHOES

In the March number of *American Vanadium Facts*, the mounting of a die ring in a cast-iron shoe, a practice of the Acklin Stamping Co., Toledo, Ohio, was illustrated and described. The ring, which was made from a special brand of "Ceswic" vanadium tool steel, was turned to the form shown in the accompanying illustration and tapered 1½ degree on the sides. This die ring was used for blanking a cup from ¼-inch sheet steel, and produced 10,000 of these cups without any indication of wear. To draw up a cup of the following



Mounting Light Die Rings in a Cast-iron Shoe

dimensions—3½ inches in diameter by 1¼ inch deep—from ¼-inch stock requires that the die be rigidly supported.

Referring to the illustration it will be seen that the vanadium tool steel die ring *A* is held in a cast-iron shoe *B* by heavy steel plates *C*. In some cases these plates take the form of a continuous ring instead of individual plates. The three holes *D*, only one of which is shown, are utilized in operating dogs that remove the cup from the punch. The machine steel plates *C* also act as a gage for locating the blank when drawing. The taper on the edge of the die, which is shown greatly exaggerated in the illustration, is not over 1½ degree, and it has two advantages: First, it enables a close contact between the supporting cast-iron shoe and the light steel die ring to be secured. The outside of the die ring is ground so that it will be perfectly true with the hole, and to such dimensions that when it is dropped into place in the die shoe it will stand up about 1/64 inch above the top surface, resting only on the tapered sides. Pressure is then applied to force it down to the bottom, seating it in the die shoe; this puts a strain on the cast iron and insures the desired contact between the shoe and ring.

Another reason for the taper is that after the die ring has been in use for some time and it is necessary to redress it, it is much easier to chuck the ring up for machining than it would be to chuck up both the ring and shoe together, and the slight taper on the sides allows the ring to be easily driven out, whereas if the hole were straight and the die ring wedged in with the same pressure, considerable difficulty

would be experienced in removing it. For drawing heavy sheet metal 1/4 inch thick, very little, if any, float of the die is necessary, so this forms a very satisfactory means of holding the die ring. It also increases its life considerably, as the cast-iron shoe takes all the strain.

The heat-treatment given to drawing dies made from "Ceswic" special vanadium tool steel is as follows: The steel, which generally comes in flat disks 6½ inches in diameter by 1¼ inch thick, is annealed before it leaves the mill. After being machined the dies are heated to a temperature of about 1450 to 1500 degrees F. in a muffle furnace and are then quenched in cold water, a current of water being forced down to the center hole. The object in thus directing the water is to harden the surface of the hole, leaving the balance of the die ring comparatively soft and as tough as possible. The die blanks are then drawn to a light straw color, just enough to remove the hardening strain. The life of a die made from this brand of steel was found to be over twice as long as that of one made from any other steel that the Acklin Stamping Co. tested for this job.

* * *

A NEW ARC WELDING MACHINE

A wide field has been opened up to electric arc welding within the last few years. For boiler repairs in particular, this form of welding has been extensively adopted. There are three different systems of arc welding, the oldest of which is the Bernardos. In this system a carbon electrode is connected to one pole of a source of supply, the article to be welded being connected to the other. In this manner an arc can be formed between the carbon and the work which corresponds to the flame in autogenous welding. The workman manipulates the carbon rod similarly to an autogenous welding burner; he has the advantage of only having to use one hand, however. As soon as he touches the work with the carbon electrode, current passes; when he removes the electrode a few millimeters a welding arc is formed which causes the surface of the work to melt on account of its heat. If fresh metal has to be added, a bar of metal is held in the arc, where it reaches a molten condition and drops onto the part to be welded. In place of the Bernardos process that of Slavianoff is frequently employed. In this latter process, in place of the carbon electrode, a metal rod similar in composition to the article to be welded is employed. This rod melts gradually.

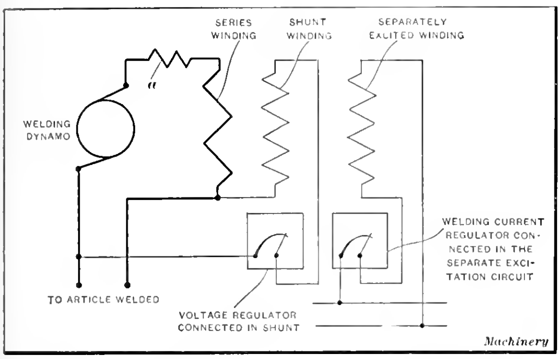


Fig. 1. Wiring Diagram of Kramer Electric Welding Machine

The third welding process is Zerener's. By this method, two carbon electrodes are fixed in a suspended armature at an angle to each other. The arc formed between them is blown against the article to be welded by an electro-magnet. Both carbon rods are connected through the armature and brought over the work together, thus forming a substitute for an electric welding burner. Direct current is used in all three processes. The arc requires pressures from 45 to 65 volts. The special properties of the arc welding process make it necessary to employ special dynamos for generating the welding current. It is impossible to avoid the constant lengthening of the arc, and therefore the alteration of its resistance while welding. When the electrodes touch, for example, a short circuit is set up, and on moving them backward and forward the length of the arc can be varied within wide limits. In consequence of the considerable changes of resistance thus brought about the current can only be taken from a direct-current network or shunt generator after special series resistances have been connected in circuit, which occasions a great loss of energy.

The Allgemeine Elektricitäts-Gesellschaft, Berlin, Germany, developed methods some time ago for utilizing the welding energy without losses. Further progress has now been made in this direction by the use of a welding dynamo connected in accordance with the Krämer patent. This machine generates energy at the required voltage directly, and always supplies current of the same strength, notwithstanding considerable resistance fluctuations in the welding circuit. At the same time a perfectly steady arc is obtained. The heat flowing to the article welded is therefore quite constant, a matter of cardinal importance for satisfactory welding. The peculiar property of the new Krämer welding dynamo of giving a

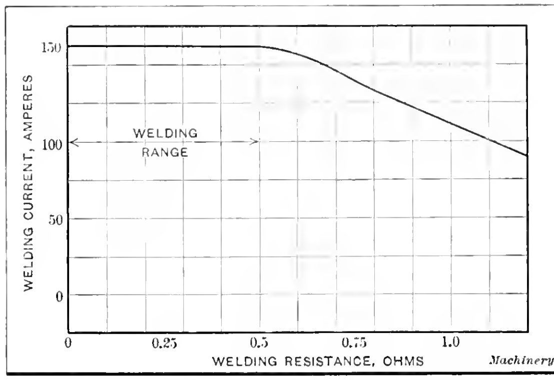


Fig. 2. Diagram of Current in Relation to Resistance

constant current with a variable resistance is obtained by means of a three-fold field excitation, as may be seen from the diagram of connections in Fig. 1, reproduced from *The Mechanical Engineer*. One field winding is a differentially connected series winding, the second is a shunt, and the third a separately excited winding which receives current from a special network with a constant voltage. Any given welding current most suitable for the work can be obtained by adjusting the regulator for the separate excitation. The voltage of the machine may be altered by the regulator for the shunt excitation. Thus a finely graduated adjustment of the current and voltage may be obtained by suitably arranging the two regulating resistances, so that the machine can be adapted within wide limits to the requirements for the welding work in hand. Fig. 2 illustrates the value of the current for a Krämer machine adjusted for a welding current of 150 amperes. It clearly shows that the welding current remains constant even when the arc resistance varies from zero (*i. e.*, short circuit) to 0.5 ohm. Only after attaining a still higher resistance does the current begin to fall gradually.

* * *

PERSONALS

Augustus Teuchter, of the Cincinnati Bickford Tool Co., Cincinnati, Ohio, sailed June 16 for a European trip.

James O. Smith, formerly domestic sales manager of the American Emery Wheel Works, Providence, R. I., has been elected vice-president.

Erik Oberg, associate editor of MACHINERY, sailed with his wife and son, May 13, for a two months' trip to England, France, Germany, Denmark, Sweden and Belgium.

Henry Dreses of the Dreses Machine Tool Co., Cincinnati, Ohio, builder of drilling machines, sailed June 16 on the *Kronprinzessin Cecilie* for a three months' business trip in Europe.

H. P. Fairfield, instructor in shop engineering with the Worcester Polytechnic Institute, Worcester, Mass., has been promoted to an assistant professorship of machine construction.

R. S. Alter, secretary of the American Tool Works Co., Cincinnati, Ohio, left on Saturday, June 13, for a combined business and pleasure trip through Great Britain and the Continent.

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Elmer E. Metzger recently resigned the position of works manager with the Esterline Co., Indianapolis, Ind., and has been appointed works manager by the Geometric Tool Co., New Haven, Conn.

M. J. O'Neill, general manager of the Industrial Press, sailed with his family, June 25, for a two months' trip in Europe, visiting England, Holland, Belgium, Germany, Switzerland and France.

Dr. Robert Grimshaw of Dresden, Germany, a well-known contributor to technical journals and a former resident of the United States, was married to Miss Marta Scharfstein at the home of the bride, Schleswig-Holstein, May 15.

R. Poliakoff, assistant professor and lecturer in mechanical technology in the Imperial Technical Institute of Moscow, Russia, is visiting manufacturing plants in the United States to study their methods of manufacturing, management, etc. Prof. Poliakoff expects to be in the United States about ten weeks.

J. L. Bender, recently sales manager of the Grant-Lees Gear Co., Cleveland, Ohio, has taken charge of the sales department of the Yuster Axle Co. of Cleveland. Mr. Bender has been in the automobile field for years and has the benefit of long training in the organizations of two companies in the automobile axle field, the American Ball Bearing Co. and the Timken Roller Bearing Co.

William A. Bole has been elected by the directors of the Westinghouse Machine Co. vice-president in charge of production and erection for the plants at East Pittsburg and Trafford. Mr. Bole has been in the continuous employ of the company since August, 1882, having successively filled the positions as general shop foreman, superintendent, manager of works and consulting engineer. He has therefore taken part in the growth and development of the company since the time when it employed less than one hundred men until the present, when the total forces run up into the thousands.

Richard Ward Baker, for fifty years an employe of the Watson-Stillman Co. of Aldene, N. J., and New York City, was presented with a substantial check and a month's vacation in recognition of his long term of service. Mr. Baker began his apprenticeship in a small factory in Grand St. June 2, 1864, and has been continuously identified with the Watson-Stillman Co. and its predecessor ever since. The board of directors of the company passed a special resolution expressing its high esteem of Mr. Baker's long and loyal service, which was presented to him in the presence of the employes, officers and directors at its Aldene plant.

OBITUARY

Paul L. Heroult, who developed the electric furnace process of manufacturing aluminum in 1887-8, simultaneously with C. M. Hall in America, converting it from a laboratory curiosity into a common household article, died in Paris May 9, aged fifty-one years.

COMING EVENTS

July 15-22.—Second International Congress of Consulting Engineers, to be held in Berne, Switzerland.

September 5-11.—Foundry and machine exhibition, showing machinery, tools, equipment and supplies for the foundry and machine shop, Chicago, Ill. C. E. Hoyt, secretary, Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 15-18.—Twenty-second annual convention of the Traveling Engineers' Association at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Central Car Shops, East Buffalo, N. Y.

September 17-22.—Autumn meeting of the Iron and Steel Institute in Paris, France. Offices of secretary, 28 Victoria St., London, S. W., England.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal. In connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

University of the State of New York, Albany, N. Y. Bulletin 569 containing list of helpful publications concerning vocational instruction, prepared by Lewis A. Wilson, specialist in industrial schools. 41 pages, 6 by 9 inches. Published by the University of the State of New York, Albany, N. Y.

Williamson Free School of Mechanical Trades, Williamson School P. O., Delaware County, Pa. Bulletin 15 containing record of graduates. This bulletin gives a summary of replies sent in answer to a letter of inquiry addressed to 863 former students. The annual income of 664 graduates is a little over $1,000,000, or an average of $1512 yearly each.

NEW BOOKS AND PAMPHLETS

Mine Signboards. By Edwin Higgins and Edward Steidle. 13 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 67.

Abstracts of Current Decisions on Mines and Mining. By J. W. Thompson. 140 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 79, Law Serial 2.

Problems of the Petroleum Industry. By Irving C. Allen. 20 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 72, Petroleum Technology 17.

Safety and Efficiency in Mine Tunneling. By David W. Brunton and John A. Davis. 271 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 57.

Physical and Chemical Properties of the Petroleums of California. By Irving C. Allen, Walter A. Jacobs, A. S. Crossfield and R. R. Matthews. 38 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 74, Petroleum Technology 18.

Hydraulics. By Ernest H. Sprague, 184 pages, 4½ by 7¼ inches. 89 illustrations. Published by Scott, Greenwood & Son, London, England, and sold in the United States by D. Van Nostrand Co., 25 Park Place, New York City. Price $1.25 instead of $1, as quoted in the review notice which appeared in the May number.

Tests of Bond between Concrete and Steel. By Duff A. Abrams. 238 pages, 6 by 9 inches. 86 illustrations. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 71.

This bulletin furnishes one of the most exhaustive studies of the amount and distribution of the bond stress between concrete and steel that has been published. It records the results of tests of about 1500 pull-out specimens and 110 large reinforced concrete beams. The tests covered a wide range of ages, mixes, size of bar, length of embedment, condition of storage, method of supplying the load, etc. Both plain and deformed steel bars were used.

Official Report of the National Machine Tool Builders' Association. 161 pages, 6 by 9 inches. Illustrated. Published by the National Machine Tool Builders' Association, Charles E. Hildreth, general manager, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

This report contains the proceedings of the semi-annual convention of the National Machine Tool Builders' Association, held at the Hotel Bancroft, Worcester, Mass., April 23-24. The papers presented were: "What Features of Electric Motors can be Standardized for Machine Tools," by Charles Fair of the General Electric Co., Schenectady, N. Y.; "How May We and Our Men Earn More Money," by J. C. Spence, superintendent, Norton Grinding Co., Worcester, Mass.; and "Safety as applied to Grinding Wheels," by R. G. Williams, safety engineer of the Norton Co., Worcester, Mass.

Modern Methods of Waterproofing. By Myron H. Lewis. 40 pages, 6 by 9 inches. Illustrated. Published by Norman W. Henley & Son, New York City. Price, 50 cents.

The efficiency and durability of ordinary concrete work are detrimentally affected in many instances by the fact that it is not waterproof. Permeable concrete is likely to be seriously damaged in winter by freezing and in many instances it is absolutely necessary that the seepage of water be prevented, especially in cellars and other places where goods are stored. The pamphlet which forms a chapter of the author's new book, "Popular Handbook for Cement and Concrete Users," treats of the necessity for waterproofing; method of conducting the work; methods of waterproofing, which are designated as three, these being the membrane, integral and surface coating method. The composition of some of the waterproofing compounds in use is given and an outline of the methods available for various structures. The approximate cost of waterproofing is included, a feature that will be generally appreciated by builders.

Fan Engineers' Handbook. Edited by Willis H. Carrier, chief engineer. 581 pages, 4¼ by 6¾ inches. Illustrated. Bound in leather with rounded corners and gilt edges. Published by Buffalo Forge Co., Buffalo, N. Y. Price $3.

This work, containing tables, charts and data on the application of centrifugal fans and fan system apparatus, including engines and motors, air washers, hot blast heaters and systems of air distribution, is essentially a handbook for the heating and ventilating engineer. It is divided into five parts, the contents of which are as follows: Part 1, Properties of Air; Part 2, Applications—Heating, Ventilation, Air Washing, Cooling, Humidifying, Drying, Mechanical Draft, Exhaust Systems and Miscellaneous Applications; Part 3, Air Ducts; Part 4, Apparatus, Fans, Fan Testing, Fan Capacities, Fan Dimensions, Heaters, Air-conditioning Apparatus, Steam Engines, Practical Applications and the Selection of Apparatus for Heating and Ventilating; Part 5, Specifications, Miscellaneous Engineering Data. This valuable compilation of data edited by Mr. Carrier should be welcomed by engineers generally concerned with any of the problems incident to the movement of air.

Standard Gear Odontographs. By Warren E. Thompson. 37 pages, 8½ by 11 inches. Illustrated. Published by Warren E. Thompson, 42 Sayles St., Southbridge, Mass. Price $2.

The book is issued in a small edition, the illustrations and tables being blueprinted and the text "multigraphed." It describes the method of laying out 14½-degree and 20-degree pressure angle gears, giving odontograph tables for both which agree closely with the tables used by the principal manufacturers of so-called "involute" gear cutters. Contrary to the general impression, commercial form cutters do not produce true involute teeth; the curves are modified to eliminate the interferences that are developed in a set of interchangeable gears ranging from a 12-tooth pinion to the rack. The diagrams show exactly how to lay out the empirical curves, giving all the required data. A feature of the book that will be of great interest to all toolmakers is the description of making the forming tool. Probably the making of tools for forming gear cutters is the most highly developed toolmaking practice. The block templet system is described which enables the toolmaker to produce forming tools of any required circular or diametral pitch for a given number of teeth from one pattern.

NEW CATALOGUES AND CIRCULARS

Kales-Haskel Co., Detroit, Mich. Folder giving dimensions of card-holders and pipe and wire clips.

Link-Belt Co., Chicago, Ill. Book 195, 40 pages, 6 by 9 inches, treating of Link-Belt newspaper conveyors.

W. W. & C. F. Tucker, Hartford, Conn. Circulars of self-closing oil hole covers, styles D, E, F and G.

M. H. Fischer & Sons Co., Inc. 41 Park Row, New York City. Circular of Fischer's automatic press guard.

C. G. Garrigus Machine Co., Bristol, Conn. Circular of 12-inch rotary precision surface grinder with magnetic chuck.

Buckeye Engine Co., Salem, Ohio. Bulletin 111-B descriptive of the "Buckeye-mobile" engine for which a very low fuel consumption is claimed.

Chambersburg Engineering Co., Chambersburg, Pa. Calendar for June, 1914, to June, 1915, illustrating a Chambersburg 10-ton steam drop-hammer.

Sterling Grinding Wheel Co., Tiffin, Ohio. Circulars and price lists of "Seneca" hacksaw blades and "Sterling" and "Advanced Safety" grinding wheels.

Manufacturing Equipment & Engineering Co., Boston, Mass. Leaflets of sanitary bubbling fountain, sanitary washbowls and metal and fire-proof equipment for shop and office use.

Volcano Torch & Mfg. Co., Erie, Pa. Circular supplementing catalogue 17, describing "Volcano" torch No. 3-C. This torch generates its own pressure and no air pump is required.

Walworth Mfg. Co., maker of brass and iron valves and fittings, Boston, Mass., is issuing a monthly publication entitled "The Walworth Log" devoted to the interests of the company.

H. G. Smith & Co., Plantsville, Conn. Leaflet illustrating the "Gittatit" off-set combination slip joint plier, illustrating its use as a cotter-pin extractor, wire cutter and off-set handle wrench.

Pawling & Harnischfeger Co., Milwaukee, Wis. Bulletin 3018 on the applications of electric hoists, showing one- and two-ton hoist installations handling paper, bar iron, pipe, plates, boxes, machinery, etc.

Bury Compressor Co., Erie, Pa. Catalogue 44, 40 pages, 6 by 9 inches, on air and gas compressors and vacuum pumps. A number of installations of Bury air compressors in various plants are shown.

W. L. Brubaker & Bros., 50 Church St., New York City. Illustration and list of hexagon bolt

COLD CHIPS

450 FEET CUTTING SPEED

Feed, 30½"; depth, ⅛"; width, 5"; length, 18"; material, machinery steel; 55,000 pounds tensile strength.

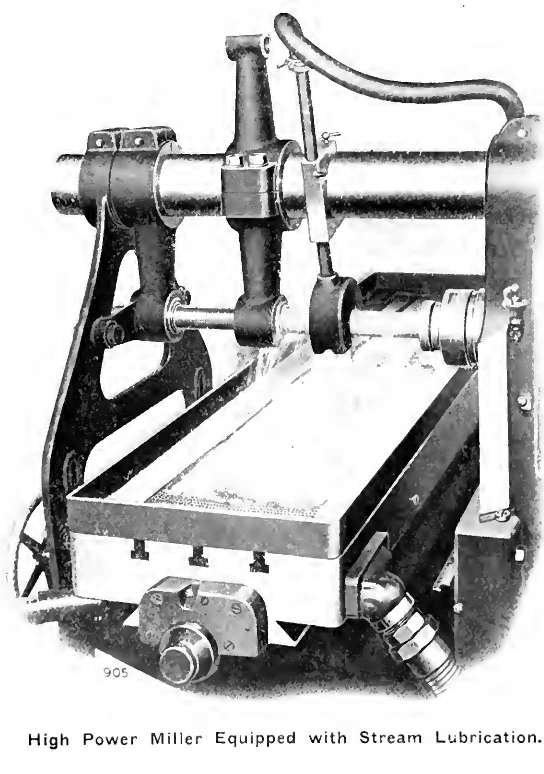
At this speed these chips came off as cold as the block from which they were milled. The cutter ran all day with no appreciable signs of distress.

The Cincinnati Stream Lubrication or Cutter Cooling System (patented) enables us to mill in actual practice THREE to FIVE times faster than has been possible in the best practice with high-speed steel cutters.

The fundamental principle of the system is the container—or CUTTER HOOD that retains the lubricant around the cutter, forcing it to run in an inverted bath, completely cooling it. This device is patented. The system has other essential features, described fully in our pamphlet.

Why don't you profit by this new discovery? Write us for details how to apply its advantages to your milling work.

A copy of "Cold Chips" is yours for the asking.



High Power Miller Equipped with Stream Lubrication.

The Cincinnati Milling Machine Company

CINCINNATI OHIO, U. S. A.

dies. This form of die is very convenient for use in close quarters in straightening bruised threads on studs and bolts.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 31-C describing and giving specifications for Chicago Classes "H-SO" and "N-SO" pneumatic gasoline and fuel oil engine driven compressors.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Pamphlet on Hess-Bright ball bearings for axle lighting generators, comprising a brief discussion of ball bearings and their application to axle generators.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 3002-A, Section 3049-A on electric arc welding processes, illustrated with examples of work done and describing Westinghouse electric arc welding outfits.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Sheets 99, Class IV and 100 Class V, dealing with ball bearing mountings for semi-floating rear hub and ball bearing mountings for jib crane columns, respectively.

Canedy-Otto Mfg. Co., Chicago Heights, Ill. Circular of wall or post radial drill No. 50, especially adapted for work in shops where a radial drill is necessary but too costly. It drills to center of circle 64 inches diameter, outside of column.

Standard Tool Co., Cleveland, Ohio. Folder descriptive of the "Standard" patent emery wheel dresser. The cutter is of hardened tool steel and of such construction that the cutting edges always retain the same sharp angle until worn to the hub.

Greenfield Machine Co., Greenfield, Mass. Circular of the Greenfield No. 4 plain grinding machine with hydraulic table feed. The advantages claimed for this feed are very smooth and even movement and unlimited number of speed changes from zero to the maximum.

Walsh Press & Die Co., 4709-4711 W. Kinzie St., Chicago, Ill. Circular of the Walsh safety device for power presses which makes it necessary for both of the operator's hands to be placed on finger buttons before the treadle can be tripped and the clutch of the machine released.

Gisholt Machine Co., Madison, Wis. Folder B. M. F.-1, descriptive of the Gisholt 42-inch boring mill, especially adapted for machining locomotive driving boxes. A special type of chuck is employed which allows this work to be done much more rapidly than by former methods.

Hannifin Mfg. Co., Chicago, Ill. Catalogue on "Aero" chucks, 38 pages, 4¾ by 7 inches, showing air-operated chucks of the universal, collet, alligator, releasing, and milling machine types. Air-operated countershafts, clamping fixtures, vises and special tools are also illustrated.

Dazie Mfg. & Supply Co., Inc., Lawrence & Clearfield Sts., Philadelphia, Pa. Circular of "Drive-Em-All" drill sockets, consisting of a rifled ferrule forced onto the shank of the drill which interlocks with the end of the regular Morse collet or socket, the same having been milled to fit.

Westmacott Gas Furnace Co., Providence, R. I. Sectional catalogue of Westmacott gas blast furnaces, showing bench furnaces, oven furnaces, muffle furnaces, melting furnaces, tinning and galvanizing furnaces, blast soldering iron heaters, brazing blow-pipes and positive pressure blowers.

Automatic Drill Chuck Corporation, Majestic Bldg., Detroit, Mich. Catalogue of "Quictite" automatic drill chuck operated by hand without keys or wrenches while spindle is running. The chuck grips straight shank drills, reamers or counterbores and holds more tightly as the load increases.

Lutz-Webster Engineering Co., Inc., Philadelphia, Pa. Circular of the Lutz compressed pipe and stud wrenches, lathe dogs and drill ratchets. The compression wrenches grip the smooth surfaces of pipe or studs without marring and drive positively, releasing on the back stroke and gripping again on the reverse.

Fort Wayne Electric Works of the General Electric Co., 1616 Broadway, Fort Wayne, Ind. Bulletin 46203 for March, 1914, illustrating and describing type K5 single-phase watthour meters. The advantages claimed for this meter are simplicity in mechanical construction, compactness, and a high degree of accuracy.

Ingersoll-Rand Co., 11 Broadway, New York City, is issuing a limited number of books containing a reprint of an article from "Scribner's" magazine on the Panama Canal. The book is handsomely illustrated with plates showing the dams and locks in natural color. The last two pages show Ingersoll-Rand drills used in excavating the canal.

Link-Belt Co., Chicago, Ill. New book No. 190, 31 pages, 6 by 9 inches, illustrating and describing the Link-Belt portable wagon and truck loader. This machine will load coal, coke, gravel, stone, sand and similar loose materials from ground storage at the rate of sixty tons an hour. It will load a five-ton auto truck in less than five minutes.

Sanitation Corporation, 50 Church St., New York City. Bulletin, Series G, No. 2 containing an article by Dr. Endris on the mechanical treatment of sewage in Germany and the application of the Reinsch-Wurl screen thereto. Managers of isolated manufacturing plants having to render their sewage innoxious will find this bulletin of interest.

Bonney Vise & Tool Works, Inc., Allentown, Pa. Catalogue 18, comprising 68 pages, 6 by 9 inches. This book was compiled with the idea of presenting not only a catalogue of Bonney products but a reference book on vises and wrenches as well. All the types of wrenches and vises (with the exception of pipe vises) in common use are illustrated.

Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio. Circular R-3-A, descriptive of 4-, 5- and 6-foot regular plain radial drills equipped with variable speed motor drive and motor and speed box drive. The machines may, at extra cost, be fitted with a special base, cooling equipment, tapping hood, tapping lead mechanism and other special attachments.

Prince-Groff Co., 50 Church St., New York City. Circular of the "Kwik-grip" positive lock vanadium steel pipe wrench. This wrench of the "alligator" type is made with the serrated jaw in line with the axis of the handle. This construction is claimed to effect an improvement in the gripping power and efficiency of the wrench as compared with the ordinary alligator type.

Jaeger Rotary Valve Motor Co., Inc., Mount Vernon, N. Y. Catalogue of the Jaeger rotary valve, six-cylinder 60-horsepower motor. The design of the motor eliminates poppet valves and camshafts, one valve serving for all cylinders, being located longitudinally in the tops of the cylinders. This valve is cooled internally and externally and it is driven by gearing from the crankshaft.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Catalogue on the application of Hess-Bright ball bearings in flour and feed milling machinery. It is claimed that these bearings when properly mounted and not overloaded, have practically no wear and should last as long as the machine. They require no refitting or other attention of any sort, save to supply lubricant once in two or three months.

Newton Machine Tool Works, Inc., Philadelphia, Pa. Catalogue 48 of horizontal milling machines of the planer type. Examples of the company's slotting machines; special grinding machines, including locomotive link grinding machines; cylinder and valve chamber boring machines; vertical milling machines; crank planing machines; locomotive rod boring machines; cold metal sawing machines are also shown.

Lufkin Rule Co., Saginaw, Mich. Catalogue 9, containing 110 pages, 6 by 9 inches. This catalogue is devoted exclusively to measuring tapes and rules. Attention is called to the fact that in addition to this line which the company has manufactured for the last twenty-five years, it now has ready for the market a complete line of folding boxwood, and flexible spring joint wood rules. Requests for copies of this catalogue will receive prompt attention.

Electric Controller & Mfg. Co., Cleveland, Ohio, is distributing a booklet which is a reprint of an article entitled "Lifting the One Hundred and Thirty Million Pound Quebec Bridge," by H. F. Stratton, that appeared in the December, 1913, issue of the "Engineering Magazine." With the exception of the motors, all the electrical apparatus used in erecting the Quebec Bridge is being designed and supplied by the Electric Controller & Mfg. Co.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue P, 35 pages, 6 by 9 inches, treating of "Brownhoist" overhead hand-traveling cranes. These cranes consist of a single I-beam supported at each end on a patented truck-frame of cast steel. The construction is such as to permit them to be used where there is very limited head-room. The tables of dimensions, prices, etc., will be found useful by those desiring to purchase this equipment.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. New catalogue on steel. 40 pages, 4¼ by 6½ inches. This book contains a complete description of high-speed tool steels, alloy tool steels, carbon tool steels, die-sinking steels, special tool steels, construction steels, spring steels, etc., made by this company. Some valuable tables on machining allowances, hardening colors and temperature equivalents, weights of bar steel per foot, etc., are included.

American Roller Bearing Co., Pittsburg, Pa. Catalogue entitled "Roller Bearings for All Purposes," 16 pages, 6 by 9¼ inches, dealing with the advantages, construction and application of the "American" roller bearing. These bearings are especially designed for conditions where the load is unusually severe. They are adapted for motor car construction, lineshaft hangers, loose pulleys, railroad service, trolley wheel equipment, and many other classes of service.

National Tube Co., Frick Bldg., Pittsburg, Pa. Proceedings at the annual meeting of the stock holders of the United States Steel Corporation, April 20, 1914, and statement as to wages, hours and other conditions of labor among employes of the United States Steel Corporation and subsidiary companies. Those interested in profit sharing plans and the relation of employes to one of the largest corporations in the world will find these reports of extraordinary interest.

Mesta Machine Co., Pittsburg, Pa. Bulletin on air compressors and vacuum pumps. The air compressors manufactured by this company have been equipped with an automatic plate valve (Iversen patent) which makes possible the economic use of much higher piston or rotative speed. The higher speed permissible means a smaller cost of installation, inasmuch as the compressor equipped with plate valves takes only about two-thirds of the floor space required by other compressors.

Pratt & Whitney Co., Hartford, Conn. Catalogue on the Pratt & Whitney side head boring mill, 34 pages, 9 by 12 inches. This catalogue is handsomely illustrated with a number of halftones showing the machine in its various working positions. The side head of the machine is operative on work up to 38 inches in diameter and the vertical head is operative on work 44 inches in diameter. The independent side head which may be lowered below the work table permits of increased swing.

Lumen Bearing Co., Buffalo, N. Y. Booklet on "Lesoyl," a semi-fluid concentrate containing graphite in suspension. "Lesoyl" is mixed with lubricating oil and grease to improve its lubricating quality; its virtue does not lie in the graphite alone, but in a large measure is due to the ingredients composing the menstruum in which the graphite was ground. While "Lesoyl" is used to improve lubrication on all bearing surfaces, it is especially valuable where the pressure on the bearings is severe and intermittent.

R. D. Nuttall Co., Pittsburg, Pa. "Heat-treatment of Gears and Pinions," a treatise prepared by W. L. Allen, commercial engineer, which is intended to give builders and users of machinery a better idea of the great improvement in the physical characteristics of steel to be obtained by heat treatment. The company makes a specialty of heat treating gears and pinions and the booklet is written with the view of informing the average man on some of the technical features of modern heat-treatment methods.

Vulcan Process Co., Inc., 25th and University Aves., S. E., Minneapolis, Minn. New book entitled "Vulcan Process Instructions on Oxyacetylene Welding and Cutting," 86 pages, 6¼ by 8¾ inches. Although pertaining especially to Vulcan apparatus, this book contains much general information on welding. It takes up the formation and composition of the oxyacetylene flame, its use and application, as well as the various equipment with which it is used. A number of interesting repairs made by the oxyacetylene process are shown.

Schuchardt & Schutte, Cedar and West Sts., New York City. Circular of gage standards adaptable in combinations of 0.00001 inch, the individual block units being of such precision that a combination of four or five of them will have a total error of not more than 0.00004 inch. These gage standards are made of high-carbon steel rectangular prism shapes with highly polished parallel surfaces, each block being stamped with its dimension. The standard gages are sold in various combinations and numbers. The circular also illustrates and describes a precision measuring and screw testing microscope which gives means of measuring the pitch, depth of thread and angle of screw threads.

Builders Iron Foundry, 9 Codding St., Providence, R. I. Bulletins Nos. 1 to 7 inclusive in "Builders Construction Series," entitled "The Better Grinder," illustrating methods of construction employed in manufacturing "Builders" grinding machines, as follows: 1, Machine-molding "Builders" Heads; 2, Grinding Grinders; 3, Grinding Spindles; 4, Milling Heads; 5, Inspecting Spindles; 6, Shrinking on Pulleys; 7, Assembling Smaller Sizes of Heads. These bulletins, 9 by 12 inches, are issued each month and each is illustrated. Mechanical men generally will find the series of interest and value as they illustrate and describe the methods followed in the manufacture of a well-known floor grinder.

National Machinery Co., Tiffin, Ohio. "National Forging Machine Talk No. 3" discusses the value of large "gather" in the forging machine. By "gather" is meant the distance of travel of the heading ram after the gripping dies close. Realizing the importance of this point in design, the National Machinery Co. makes its heavy-pattern forging machines with three different "gathers" as follows: 246 heavy-pattern forging machine, 2 inches rated capacity, 4 inches die opening, 6 inches gather; 357 heavy-pattern forging machine, 3 inches rated capacity, 5 inches die opening, 7 inches gather; 469 heavy-pattern forging machine, 4 inches rated capacity, 6 inches die opening, 9 inches gather.

Bristol Co., Waterbury, Conn. Bulletins 188 and 189 on two types of Bristol recording differential pressure gages. Bulletin 188 describes the patented spring type of Bristol recording differential pressure gage equipped with diaphragm or helical type pressure tubes and a patent frictionless sleeve. Bulletin 189 treats of the patent float type of Bristol recording differential pressure gage in which no springs are employed. This type is especially recommended, although there are certain applications for which the spring type is adapted. These gages are particularly valuable for use in connection with pitot tubes and venturi tubes for measuring and recording the rate of flow of air, gas, steam, water and other liquids.

General Electric Co., Schenectady, N. Y. Bulletin 41302 covers the complete line of G-E standard polyphase induction motors. The repair parts for this line are also illustrated. Bulletins 43400, 43401 and 43402 deal with the subject of modern lighting in woodworking plants, the clothing industry and machine shops and metal working plants, respectively. The various lamps adapted for this service are described and suggestions are given as to the size and style of the units best suited to secure the greatest efficiency. Bulletin 46201 takes up the construction of the single-phase watthour meter, type I-14. Bulletin 48010 is devoted to the use of electricity in the shoe and leather industry. Illustrations show numerous installations in various factories of prominence in the East.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin Form 8011 describing the construction and operation of "Little David" riveting hammers. Illustrations show the application of these tools. All "Little David" riveting hammers can be furnished with a rivet set retainer as illustrated in Form 8011-I. This retainer is simple in design and meets the requirements of the safety laws being drafted by the various states. All those interested in "Safety First" as applied to the operation of pneumatic riveting hammers should have this booklet. Copies sent free on request. Form 4020 treats of Leynor-Ingersoll water drills. Among the unique features of construction may be mentioned the hand hammer blow, the water feature, the oiling system, the butterfly valve, etc. A descriptive table giving sizes and capacities of these drills is included.

MACHINERY

AUGUST, 1914

MANUFACTURE OF SAVAGE 0.22 CALIBER HIGH-POWER RIFLE—2

INTERESTING MACHINING OPERATIONS ON VARIOUS RIFLE PARTS—SPECIAL MACHINES AND FIXTURES USED AT FACTORY OF SAVAGE ARMS CO.

BY FRANKLIN D. JONES*

IN the manufacture of a Savage rifle such as the 0.22 caliber high-power type, 815 operations are necessary. To handle this amount of work and at the same time produce a high-grade rifle which can be sold at current prices is a striking illustration of what can be accomplished with modern tools backed by efficient and systematic manufacturing methods. In the preceding installment of this article (published in the July number) the action for the 0.22 caliber high-power rifle was described, and the manufacturing and inspection systems employed at the factory of the Savage Arms Co. were referred to in a general way. In the present article reference will be made to some of the more important operations on various rifle parts.

Machining a Rifle Barrel

The barrel for a Savage high-power rifle is made of alloy steel of special composition to withstand the enormous pressure to which it is subjected. This pressure, in the case of the 0.22 caliber high-power rifle, is approximately 48,000 pounds per square inch at the instant of discharge. The barrel, after being centered, is rough-turned tapering in an ordinary lathe equipped with a follow-rest. This roughing operation is for removing most of the outer stock, thus relieving the barrel of any strains which might exist in or near the outer surfaces. The barrel is then drilled in a Pratt & Whitney drilling machine, as will be described later. There are two additional turning operations on the barrel after the hole is drilled, one being a second roughing cut and the other a finishing cut.

One of the special lathes used for these turning operations is shown in Fig. 2. The barrel is supported by a three-roller back-rest *A* carried by the large bracket *B* extending along the bed at the rear. This roller-rest remains in a central position with relation to the barrel being turned, and the tool is guided by an attachment which operates on the principle of an ordinary taper attachment; that is, the cross-slide carries a bar and roller which bears against a former at the rear, curved to correspond with the shape required for the barrel. (The octagonal barrels used on the smaller rifles are gang milled, several being held at a time in multiple index centers set to give the required taper.) When taking the finishing cut over the barrel, the mark which is sometimes left by a roller-rest is prevented in the following manner: The central bearing for the roller-rest is turned down a few thousandths larger than the required size, and the tool, when taking the finishing cut is automatically stopped when it reaches this roller-rest spot. The cut is then started on the opposite side and the turning continued. The spot is finally removed in the polishing department on a leather-faced polishing wheel.

Drilling a Rifle Barrel

One of the most delicate operations in rifle manufacture is that of machining the hole through the barrel. To drill a straight hole 0.22 inch in diameter through twenty inches of tough alloy steel is a job that requires the right tool and the right machine. The drilling machines used are of a duplex type, two barrels being operated on at the same time. A detail view of one of the barrel drilling machines used at the Savage factory is shown in Fig. 3. The barrels *A* revolve and the drills *B* remain stationary, except for the feeding movement. This is in accordance with the well-known principle of deep-hole drilling. When the drill revolves, a slight deviation from the true course tends to increase, but when a rotary motion is given to the work instead of to the drill, if the drill point varies from its central position, it will be carried around in a small circle and, consequently, the drill shank will be bent in various directions. The result of this bending action tends to force the drill point back to the course of least resistance, which is along the axis about which the work revolves; therefore, because of this tendency, the drill follows a true course if all conditions are favorable.

First, the drill must be properly ground; moreover it must be guided by a close-fitting bushing when starting the hole and the hole must be kept clear of chips. The drills are supported in brackets *C* attached to the base of the machine, and they are started true by passing them through bushings which fit over the turned ends of the barrels. The drill used

Fig. 1. An Example of Artistic Carving and Engraving on a Savage Rifle

* Associate Editor of MACHINERY.

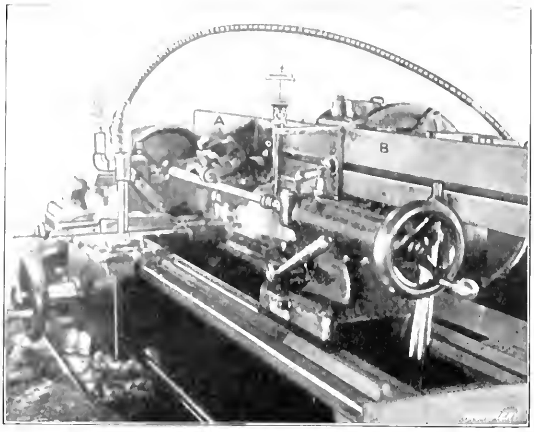


Fig. 2. Special Lathe used for turning Rifle Barrels

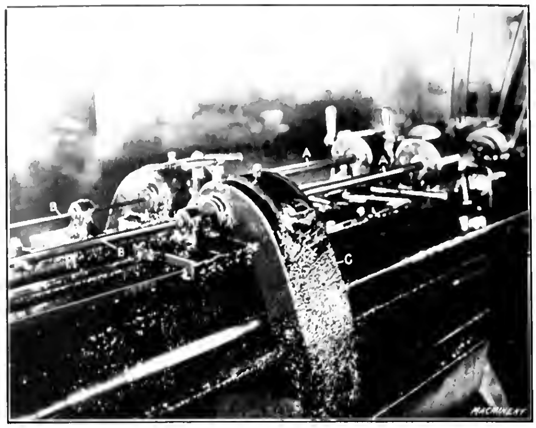


Fig. 3. Detailed View of Pratt & Whitney Rifle Barrel Drilling Machine

for this work has one straight flute and one cutting edge. Back of the cutting edge there is a section that is practically straight, which supports the cutting end so that the hole itself form a bushing as the drill feeds through the barrel. The drill tip is from four to eight inches long and is held at the end of a tube or shank. The lubricant is forced through this shank and also through a duct passing through to the drill point. As the pressure of the lubricant is about 200 pounds per square inch, the chips are forced back along the straight flute with the lubricant.

The feed of the drill per revolution of the barrel, for drilling a 0.22 caliber rifle, is about 0.0025 inch per revolution of the work. The speed at which the barrel rotates depends upon the material and the size of the bore, varying from 1500 to 2400 revolutions per minute. When the hole is drilled, a trip automatically shifts the driving belt and stops the machine. The hole is drilled to within 0.005 inch of the finished diameter.

Reaming the Barrel Hole

The next operation on the bore is that of reaming, in order to finish the hole to the exact diameter required. The reaming is done in a machine which is duplex but differs from the drilling machine in that the reamers are revolved slowly by the machine spindles while the barrels feed over them and remain stationary except for the feeding movement. Two kinds of reamers are used: The first is a cutting reamer and its cross-sectional shape is shown by the enlarged view at *A*, Fig. 5. This type of reamer removes about 0.003 inch; the remaining 0.002 inch is then removed by a scraping reamer, the shape of which is shown at *B*. The tops of the teeth of this scraping reamer are ground and stoned to form sharp ridges which take very light scraping cuts and leave a "mirror finish" in the bore of the rifle.

The number of times these cutting and scraping reamers have to be passed through the bore depends upon the caliber. After the first reaming operation, the accuracy of the bore is tested by dropping through it a close-fitting plug eight inches long. If this passes through without being forced, it shows that the barrel is straight within very close limits. The accuracy of the bore is also tested by holding the barrel in line with a narrow strip placed across a ground glass in one of the windows. By sighting through the bore on this strip and then turning the barrel, any inaccuracy will be shown by the movement of the shadows of the strip reflected along the sides of the bore. (This method was described and illustrated in an article entitled "The Ross Rifle and its Manufacture," published in the November, 1911, number of MACHINERY.)

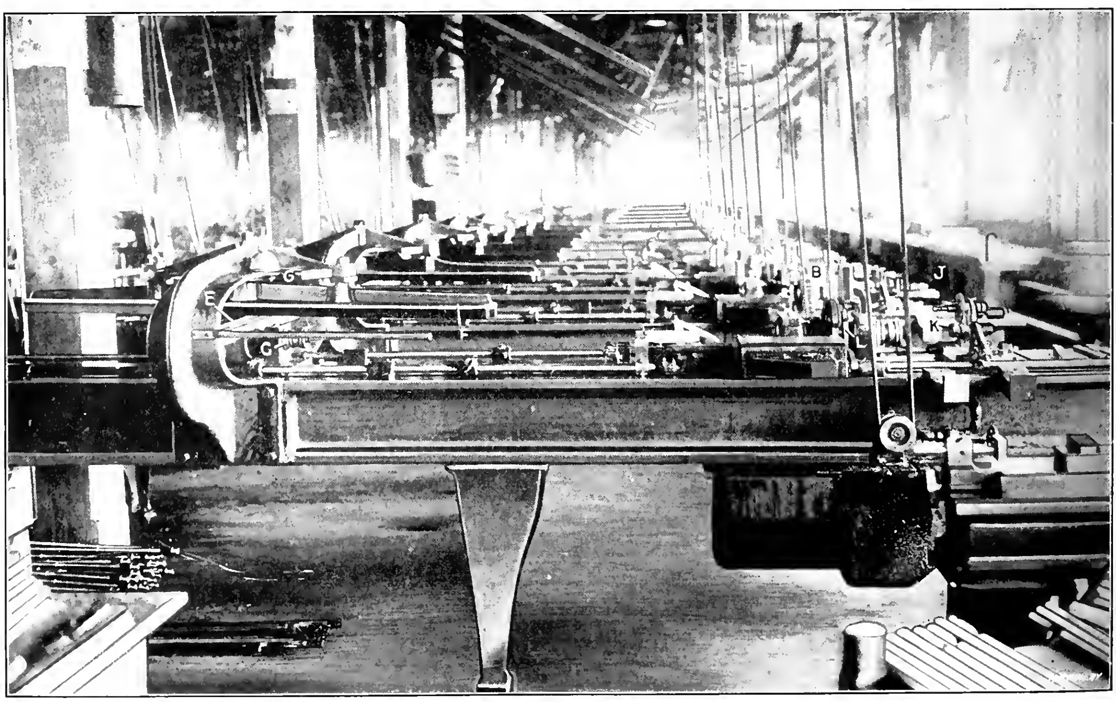


Fig. 4. Group of Pratt & Whitney Rifling Machines at Factory of Savage Arms Co.

Rifling the Barrel

Helical or spiral grooves are cut in the barrels of all modern firearms to impart a rotary motion to the bullet, as is generally known. This rotary motion causes the axis of an accurately made bullet to keep in a line with its flight or trajectory, which increases the range, accuracy, and penetration. Experiments have demonstrated that the mean deviation of the shots fired from a rifled gun at medium ranges is only one-third that from a smooth bore, when all known and controllable causes of deviation have been eliminated.

In the Savage 0.22 caliber high-power rifle, there are six of these rifling grooves which have a pitch or lead of twelve inches, this being the distance that the grooves advance in one turn. The cutting of these grooves, which are only 0.003 inch deep and 0.065 inch wide, is a very interesting operation. Pratt & Whitney rifling machines are used. A group of these machines is shown in Fig. 4. The operation, briefly described, is as follows: The rifle barrel is held in an indexing head *B* and remains stationary except when indexing from one groove to the next. The grooves are cut by a small tool, the cutting edge of which corresponds to the shape of the groove required. This tool is carried in a tool-head screwed to a long shank which is gripped by chuck *C*. This chuck, in turn, is carried by the draw-head of the machine which is moved back and forth by a horizontal screw that is rotated in first one direction and then the other, by open and cross belts. The rifling cut is taken on the draw stroke and after the tool has passed through one groove and has returned to the starting point at the breech end of the barrel, the latter is indexed so that the tool on the next stroke passes through another groove. When a cut has been taken through the six grooves, the tool is automatically fed outward a slight amount and another series of cuts is taken through the groove, and so on until all the grooves are machined to the required depth.

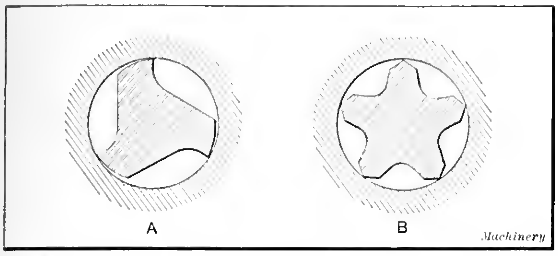


Fig. 5. Sectional Views showing Shape of Reamers used for finishing the Bores of Rifle Barrels

The tool is turned as it passes through the barrel, to produce helical or spiral grooves, by the arrangement seen at the left-hand end of the machine. On the spindle which carries the chuck *C*, there is a gear which meshes with a rack on cross-slide *E*. This cross-slide has a roller on the top which engages with a groove or channel extending along the under side of arm *F*. When the draw-head is traversed along the machine bed by the screw, the cross-slide *E* is caused to move laterally (provided arm *F* is set at an angle with the travel of the draw-head), and this lateral movement turns chuck *C* and the cutter. The amount of this cross movement depends, of course, upon the angular position of arm *F*; graduations on the quadrant *G* show what the position of the arm should be for generating grooves of different leads.

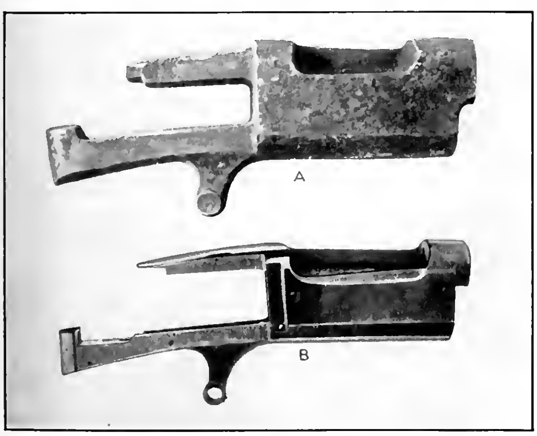


Fig. 6. (A) Drop-forging for Receiver; (B) Finished Receiver

The cutter, which is small and delicate, is relieved on the return stroke to prevent dulling the edge. This is done by a small finger which pushes the cutter back into the head at the end of each stroke. At the opposite end of the stroke a pin in the end of the cutter-head strikes a stop on the feeding head *J* and forces the cutter out (by means of a wedge in the head) to the cutting position. The feeding of the cutter outward at the completion of each revolution of the barrel is effected by a feed-screw at the end of the cutter-head. This screw has a square head, which at the extreme end of each stroke enters a square hole in stop *K*. When the barrel has made one turn, a lug on the indexing disk *L* comes around and through suitable mechanism turns stop *K* slightly. The result is that on the next stroke the feed-screw of the cutter-head, as it enters the square hole, is turned a corresponding amount, the end of the square hole being rounded so that the feed-screw can enter readily. (A sectional view of the cutter-head and a more detailed description of the feeding mechanism was given in the November, 1911, number of MACHINERY.) Lubricant for the cutter is forced through the hollow shank of the tool, connection being made with the draw-head by telescoping pipes which permit the necessary reciprocating movement.

The cartridge chamber in the barrel is reamed to conform to the shape of the "bottle-necked" cartridge used in the 0.22 caliber high-power rifle, and the end of the barrel is finished in the turret lathe by using a combined reamer and face mill. The chamber is then finished by hand reaming to obtain as smooth a surface as possible, because if this chamber were at all rough, the shell when exploded would be forced out into the minute depressions and could not be extracted easily.

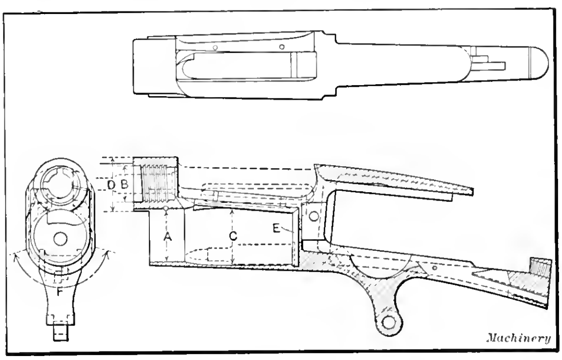


Fig. 7. Plan View and Section of Receiver

Machining the Receiver

The receiver of a rifle is that part between the barrel and breech which contains the "action" or loading and firing mechanism. The receiver of a Savage rifle of the '99 model, which is the style used on the 0.22 caliber high-power type, is illustrated in Fig. 6. The rough drop-forging *A*, from which the receiver is made, weighs 6½ pounds, which is one-quarter pound heavier than the entire weight of the finished rifle, whereas, the finished receiver *B* weighs only one pound thirteen ounces. The total number of operations required on this receiver is 128. A few of the more interesting operations will be referred to in detail.

In order to machine the various interior and exterior surfaces and have them properly located with reference to each other, it is important first to provide surfaces which can be used for locating the receiver in the various jigs and fixtures. The top and left side are machined first on an ordinary Lincoln type milling machine, and practically all subsequent operations are located with reference to these surfaces.

Fig. 8 shows a detail view of a very interesting special machine used for roughing out the magazine chambers A and C (Fig. 7) and the hole B for the barrel, as well as the end surfaces. The magazine chamber is cylindrical at the forward end A, but part C is enlarged and shaped to conform somewhat to the tapering cartridges. This enlarged part is milled out in an ingenious way by the semi-automatic machine shown in Fig. 8. This machine has a spindle for each separate operation to be performed, and the receivers are held in a circular fixture which forms the machine table. The spindles are all fed downward simultaneously by a large cam drum in the center, to which suitable cams are attached. After all the spindles have been fed to depth, the machine is automatically tripped; the spindles are then raised and the work-table is indexed by hand, so that each receiver moves around to the next spindle where the succeeding operation is performed. As all the spindles perform their operations simultaneously, a finished part comes around to the front each time the table is indexed and the operator removes it and inserts a rough forging.

The order of the operations is as follows: First the cartridge chamber hole is drilled with an ordinary twist drill. The bottom of the hole is then squared out by another drill held in the next spindle. The milling of the enlarged part C (Fig. 7) of the chamber then follows. First, a milling cutter enters the hole and for a time simply revolves in a central position while the other tools are at work. When it has reached the proper depth, a gear which is cam-operated and independent of the driving gear turns part of a revolution,

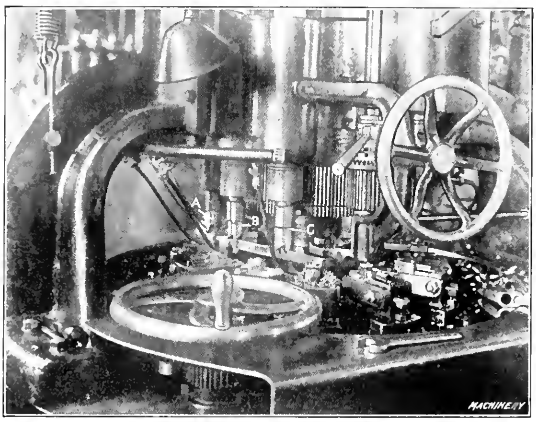


Fig. 8. Special Multiple-spindle Machine for drilling, reaming and milling Rifle Receivers

which locates the spindle and milling cutter in an eccentric position. Then the cutter not only revolves about its own axis but, at the same time, has a circular or planetary motion around the hole, thus enlarging it. When the cutter has finished one revolution, the cam-operated gear again turns slightly in the same direction, thus placing the cutter more off center for taking another cut. At the end of the second cut the gear is automatically returned to the starting point, thus bringing the cutter spindle back to its central position before it is raised for indexing the work-table.

After the chamber is milled as described, the work is indexed to a second milling cutter which operates in the same way and takes a lighter cut around the cartridge chamber. The receiver is now indexed to another drilling spindle where the barrel hole is drilled. This hole is then reamed out by the spindles A and B, Fig. 8, and the top surfaces faced. Finally the outside diameter D (Fig. 7) is machined by the hollow mill C. There are two of these machines, both of which were built by the Adriance Machine Works of Brooklyn.

The surfaces roughed out on the Adriance machine are finished by separate operations on other machines. The cylindrical part A (Fig. 7) and the bottom of the cartridge chamber, as well as hole B and the outside of the circular boss D, are finished in a four-spindle drilling machine equipped with reamers and a hollow mill.

Fig. 9 shows a special fixture used for finishing the enlarged part C (Fig. 7) of a cartridge chamber and for milling a narrow annular recess E at the bottom for receiving the projecting rims of the cartridges. This fixture A is revolved by worm gearing B and the receiver R feeds around the rotating cutter, which removes just enough stock to finish the cartridge chamber.

Another revolving fixture used for milling the outside surface F (Fig. 7) on the bottom of the receiver is shown in Fig. 10. The fixture in which the work is held is also revolved by

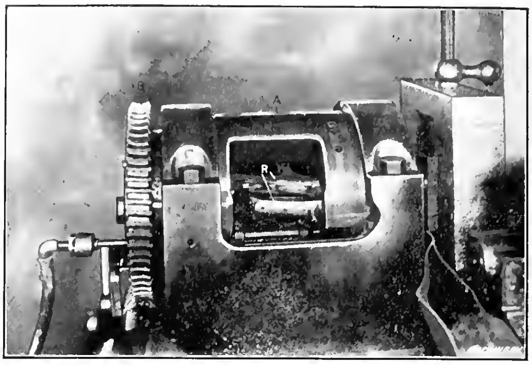


Fig. 9. Special Attachment on Lincoln Milling Machines used for finishing Cartridge Chamber of Receiver

worm gearing. The receiver R is located by the top and side locating surfaces and it is held by a clamp across the tang and plugs which enter the barrel and chamber holes. The milling cutter C, which is supported at the outer end by a bracket A, simply revolves in a fixed position and the work feeds around it. When the cut is completed, the rotation of the fixture is stopped automatically by the disengagement of the driving worm.

Fig. 11 illustrates how the thread for the rifle barrel is cut in the receiver. This thread is milled by cutter A and the receiver R is held on a rotating fixture B. The spindle of this fixture passes through a bronze nut in the main bearing of the machine, and when milling the thread the revolving spindle and fixture feed forward at a rate proportional to the pitch of the thread. The spindle is rotated through worm and spur gearing. When the thread is completed, the forward feeding movement of the fixture is automatically stopped by a trip which releases a catch and allows the feed-worm to be quickly drawn out of mesh by a spring. The continuous thread which is milled with this machine is partly cut away at the top and bottom of the threaded hole so that the barrel, the thread of which is also milled and then cut away to match the receiver, can be removed by simply turning it one-fourth of a revolution. When the barrel has been

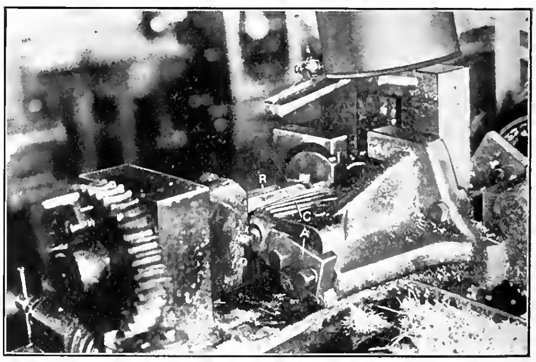


Fig. 10. Rotating Fixture used for milling Round Bottoms of Receivers

turned this amount, the threads on it are aligned with the unthreaded part of the receiver. The threads in the latter are cut away in a profiling machine.

Stock Turning Machine—Wood Profiler

A detail view of one of the lathes used for turning the rifle stocks is illustrated in Fig. 12. This lathe is similar to

the type used for turning shoe lasts and other irregular shapes. There is a former A which corresponds to the shape of the finished stock. This former is mounted on one side of an oscillating frame B which carries on the opposite side the walnut stock C that is to be turned. The former and stock are rotated simultaneously by gears connecting shafts D and E. The cutter-head H, which is equipped with six U-shaped cutters, is mounted on a carriage F and traverses along the bed as the stock is turned. The wheel G, which bears against the former, also moves along with the carriage.

Fig. 11. Detailed View of Special Machine used for milling Barrel Thread in End of Receiver

The contact of the former with this wheel causes frame B and its shafts D and E to oscillate in such a way that the stock is turned to the same shape as the former. The cutter-head rotates very rapidly and when the cut is completed the carriage feed stops automatically.

The walnut which is used for rifle stocks must be carefully seasoned and dried before it is suitable for use. There are four classes of stocks, *viz.*, the plain walnut, the semi-fancy, the fancy, and the circassian. The "fancy" stocks are so classified because of the beauty of the grain and are used for the more expensive rifles.

The forward ends of the stocks are cut out to fit the upper and lower receiver tangs in a machine similar to that shown in Fig. 13, which operates on the same principle as a metal profiling machine. The cutters revolve very rapidly and are guided by a former plate as at A, which is engaged by a guide-pin, thus controlling the movement of the cutter. This machine has four spindles into which cutters of different shapes and sizes can be inserted. In this case only three of the four spindles are being used. The vertical position of each cutter is regulated by the adjustable stop-screws seen at the right of each spindle slide. Such accurate work is done by this machine that practically all hand fitting is eliminated. The stocks are next finished smooth by the use of garnet

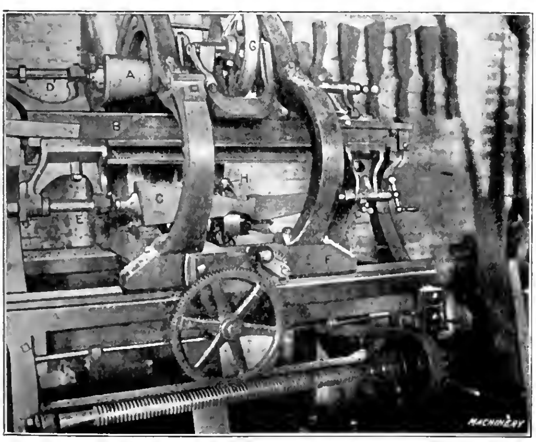


Fig. 12. Machine used for turning Walnut Rifle Stocks

paper and then they are ready for finishing. The grain of the wood is filled to secure a smooth surface and after the application of shellac and varnish, the stocks are given a polish by rubbing with a mixture of pumice stone and paraffine.

Checking and Ornamental Engraving

The checking on the stocks as well as the carving on the fancy stocks is done entirely by hand and, obviously, requires a great deal of skill and artistic ability. The engraving on the sides of the receiver, etc., is also done by hand. In many cases special designs have to be engraved to order. A drawing of the design is first made on paper. When this has been approved, another drawing is made directly on the polished steel surfaces to be engraved. A very light coating of grease is first applied to the polished surface, and part of the design, in case there is considerable detail and the design is large, is then drawn with a sharp-pointed lead pencil; these lines are then traced with a sharp steel pencil. The engraver now has a light outline to serve as a guide and the design is then cut out by small hand tools. This work must be done by the aid of a magnifying glass, and great care is required to prevent the tool from slipping and cutting farther than was intended or in the wrong direction. An example of artistic carving and engraving is shown in Fig. 1. To engrave a fancy design such as this one requires considerable time and a degree of skill which few men possess.

In a succeeding article some interesting profiling operations on rifle and automatic pistol parts will be described.

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Some years ago, it was shown by a series of experiments conducted by A. E. Outerbridge (*Journal of the Franklin Institute*, February and April, 1904) that cast iron subjected to alternate heating and cooling increased in dimensions with-

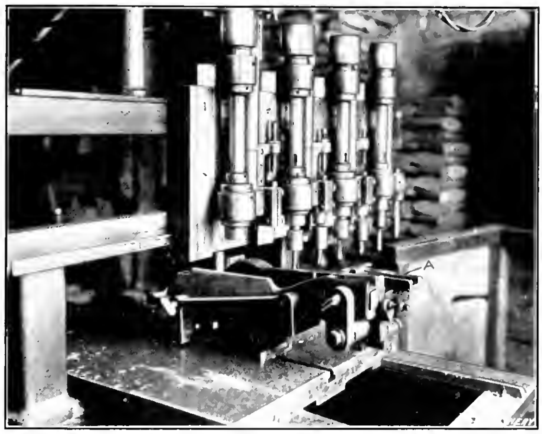

Fig. 13. Profiling Machine for cutting out Forward End of Stock to fit Receiver Tangs

out increasing in weight, whereas wrought iron under the same treatment contracted slightly in all dimensions. The cast-iron test bars used in these experiments increased in dimensions from 14 13/16 by 1 inch by 1 inch to 16 1/2 inches by 1 1/8 inch by 1 1/8 inch. The wrought iron bars decreased 1/8 inch per foot in dimensions and the cast-iron bars increased in volume about 40 per cent. The opinion was expressed in connection with these experiments that the strength of cast iron decreases in proportion to the increase in volume. These facts indicate that cast iron is not the best material to use where castings have to be subjected to comparatively high temperatures. Wrought iron castings now available have been demonstrated by comparative tests and observations to be far superior, outlasting ordinary cast iron from four to six times.

* * *

A German chemical publication states that coatings composed of rubber mixtures, raw or semi-vulcanized, prepared from low-grade rubbers rich in resin, and preferably containing large proportions of factis (a rubber substitute) and inorganic fillers, when pierced by a projectile, will close over the hole and so prevent the inrush of water. The coating may be made more resistant to water by adding tar. It is laid on or cemented to the hull of a ship and painted to protect it from attack by marine life.

METHODS OF HOLDING AND MACHINING THIN WORK*

SHOWING WAYS OF SUPPORTING SLENDER PARTS AND EQUALIZING THRUST OF CUTS TO AVOID DISTORTION

BY ALBERT A. DOWL†

IN nearly every kind of manufacturing it becomes necessary to machine certain pieces of work which are of a fragile nature, and which can neither be held nor machined by ordinary methods without considerable distortion. Sometimes the work is a casting of very thin section, while in other instances a forging is to be cut down until the walls are not over 1/8 inch in thickness. The work may be of comparatively small diameter or it may of large size, and it may also be either long or short. It may be cylindrical in form or of irregular shape, and may occasionally require the addition of holding lugs in order to hold it properly. In the machining of this class of work we shall consider two types of machines only—the horizontal and the vertical turret lathes. The horizontal type of machine would naturally be used for the smaller work, while the larger pieces can be more profitably handled on the vertical machine. While work of this character must be very carefully held in order to avoid distortion, the problem of machining is also of great importance. It is quite possible to hold a piece of work so that it will not spring out of shape, and yet the machining operations may be very unsatisfactory due to vibration in the work itself. This causes chatter which nearly always ruins both the work and the tools used in machining. Vibration is more apt to be troublesome on long work than on the shorter pieces, because the torsion or twisting action induced by the pressure of the tools in removing stock is more apparent when this action takes place at a considerable distance from the points at which the work is supported and held. On short work the support is nearer the point at which the work is being done, and there is consequently less chance for the metal to twist under the pressure of the cut.

In connection with the machining it is well to note that the speed and feed have a great influence on the vibration, but it is difficult to give a definite rule which will apply to all conditions. Methods of holding have a great influence on this matter, for it is obvious that the more securely the work is held, the greater may be the feed and speed, other things being equal. Speaking generally, less vibration results when slow speeds are used with fairly coarse feeds, but this is not always the case. Sometimes it is possible to run the work at a fairly good speed using a fine feed, while at other times a procedure of this kind will cause chatter which can be heard all over the factory. An increase of one step in the feed or a decrease of one step in the speed will frequently stop the trouble, but there are occasional instances which require considerable experimenting before the desired result is obtained. When outside and inside cutting are going on at the same time, it is a good plan to arrange the boring and turning tools so that they are working opposite each other; that is, the tools should be working one against the other with nothing but the wall of the casting between them. If used in this way there is less chance of springing the work, and also less chance of vibration. In handling thin work, special care must be taken to see that all bearings, gibs, etc., are set up snugly, so that no chatter will be caused in the machine itself. The tool-holders and the tools themselves must also be as solid as possible. A few points in connection with the handling of work of this character may be of interest and are given herewith.

Important Points relating to the Handling of Thin Work

1. The method of holding should be very carefully thought out with a view to rigidity and freedom from distortion of the work itself. It may be advisable in some cases to have supplementary lugs or pads added to the pattern in order to facilitate chucking. When this is necessary it is well to consult with the pattern-maker, so that unnecessary expense in the pattern will be avoided.

* For articles on work holding devices and kindred subjects, see "External Holding Devices for Second-operation Work," in MACHINERY, June, 1914.
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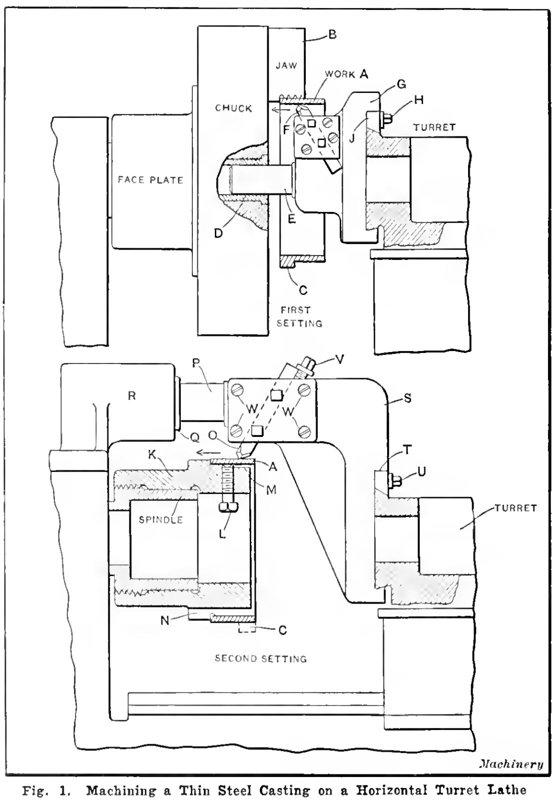

Fig. 1. Machining a Thin Steel Casting on a Horizontal Turret Lathe

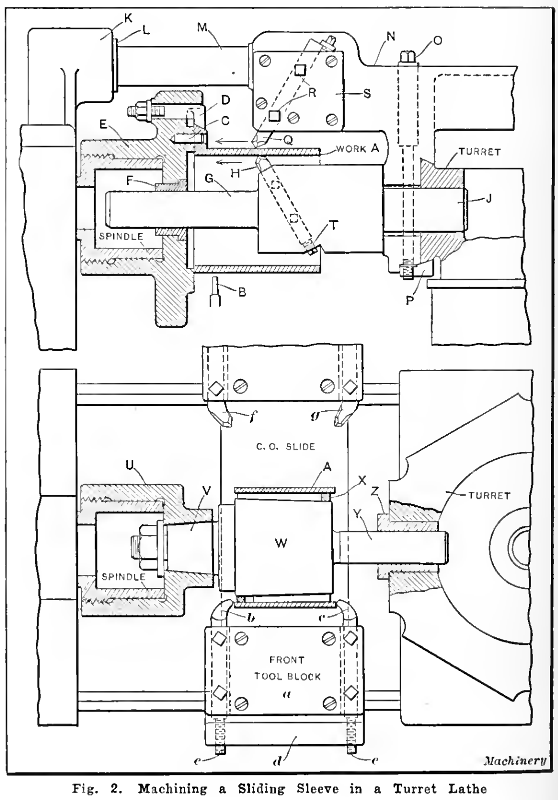

Fig. 2. Machining a Sliding Sleeve in a Turret Lathe

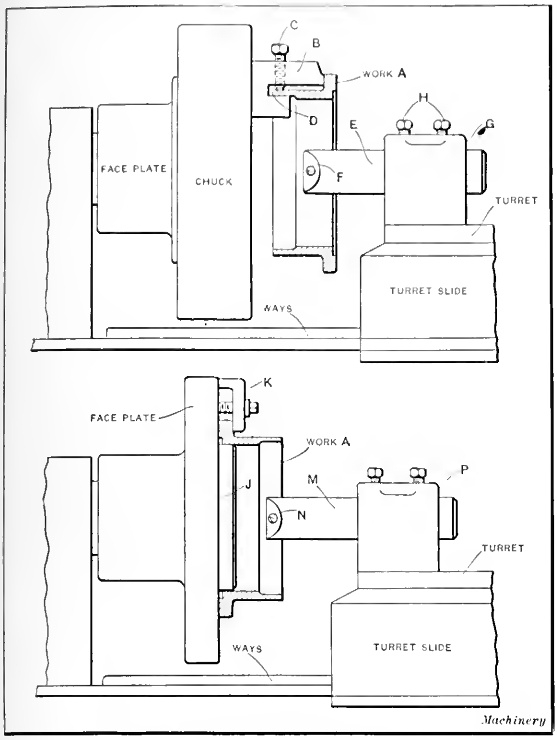

Fig. 3. Thin Flanged Collar machined on a Pratt & Whitney Turntable Lathe

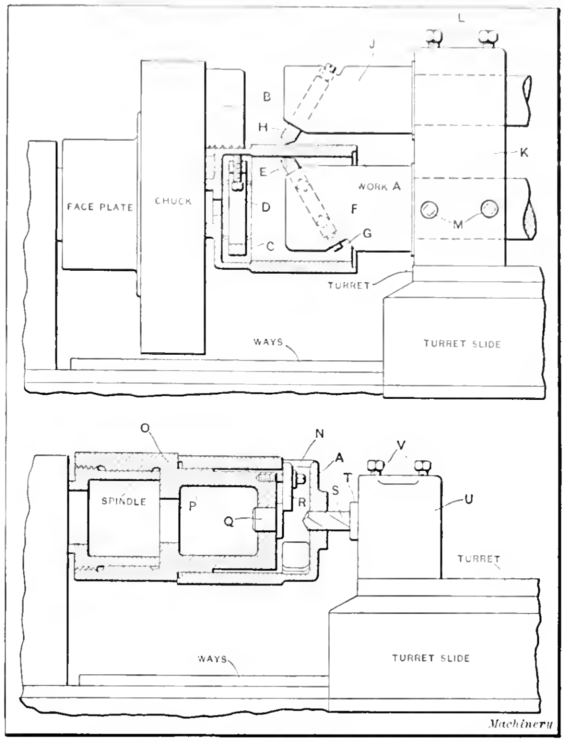

Fig. 4. Steel Casting of Fragile Construction machined on Turntable Lathe

2. The overhang from the spindle should be as short as possible, so that vibration will not be caused by an excessive weight revolving without support at its outer end.

3. The rapidity of operation is an important point if a great many pieces are to be machined. Clamps should be easily accessible and conveniently operated. It is advisable to make all nuts of the same size so that one wrench can be used for all. It is also desirable to make them of such a size that a standard machine wrench can be used.

4. The locating surfaces, if the work is irregular, should be carefully selected, so that inequalities of the casting will be equalized as far as possible. Care should be taken so that no locating points come where the casting is gated or where letters or numbers appear. Neither should they come where the pattern is parted.

5. The tooling should be very carefully studied both from the viewpoint of upkeep and of rigidity, so that every possible precaution may be taken to prevent chatter.

6. The cost of equipment should be considered on the basis of the number of pieces to be machined. Obviously, it does not pay to design very elaborate equipment for work which will not be machined in large quantities.

7. The selection of a machine best adapted to the work is an important point, and should be decided upon before anything is done in the line of equipment.

Machining a Thin Steel Casting on a Horizontal Turret Lathe

The work shown at *A* in Fig. 1 is a steel collar which is to be finished all over on a horizontal turret lathe. When in the rough, the thickness of the wall of the casting is 5/16 inch, and it is to be finished to 3/16 inch. As the work is so thin that the action of the chuck jaws would tend to crush it out of shape, if they were used in the ordinary manner, the driving lug *C* was added to the casting. In this way much less pressure is required on the jaws than would be the case if friction only were used for driving. It will be noted that the jaws *B* have a narrow shoulder against which the work rests. The body *G* of the boring tool is of cast iron and is fastened to the turret by the angular gib *J* and the screws *H*. A pilot *E* of tool steel is hardened and ground to fit the bushing *D*, which is forced into the chuck body. The tool *F* is set in a vertical plane in the holder in order to minimize errors in indexing the turret. Two holders of this kind are used for the work, and the cut-off slide tools face the end of the collar. While the piece is being rough-bored, the jaws are set up firmly on the work, but care is used so that too much pressure is not applied. Before the finish-boring takes place the jaws are loosened up to take care of the spring of the casting.

In the second setting (shown in the lower part of the illustration), the work *A* is pushed onto the arbor *K* which is screwed onto the end of the spindle; the cup-pointed driving screw *L* is set up against the finished inside surface. A shallow groove *M* is provided so that the burr thrown up by this screw will not cause trouble when removing the work. A moment's work with a scraper takes out the slight roughness after the work has been removed from the arbor. The grooves *N* on the periphery of the arbor facilitate the removal when the casting has been machined. The body of the turning tool *S* is fastened to the turret by gib *T* and screws *U*, and it has a pilot of steel at its forward end *P*. This pilot enters a bushing *Q* in the spindle cap bracket *R*, thus greatly assisting in the prevention of chatter. A steel plate is fastened to the body by four screws *W*, and supports cutting tool *O*. A refinement will be noted in the backing-up screw *V* which permits fine adjustments to be made. It was found advisable to cut off the lug *C* with a hacksaw previous to this setting, as the interrupted cut produced when attempting to machine it off with the turning tool tended to twist the work on the arbor.

Machining a Sliding Sleeve

The sliding sleeve shown at *A* in Fig. 2 is of cast iron, 1/4 inch thick when finished. Its outside diameter is important and its overall length also. It is likewise essential that the two ends should be parallel, and square with the outside. The casting is made up in the form of a pot with three beveled lugs spaced 120 degrees apart. The end of the pot is rough-ground on a surface grinder, and three holes *C* are jig-drilled to act as drivers and locaters. This work was done previous to the machining of the piece on the turret lathe. The fixture body *E* is then screwed to the spindle of the machine and is furnished with driving and locating pins which enter the drilled holes. The hook-bolts *D* are beveled

to the same angle as the lugs and extend back through the body so that they may be tightened from the rear, thus leaving the front of the fixture free from projections and permitting the turning tool to work without interference. Attention is called to the manner in which the hook-bolts are backed up by the boss, which is cut away at one side so that the bolt can be turned out of the way when assembling or disassembling the work. The body of the fixture is provided with a bushing *F* which acts as a guide for the pilot of the boring-bar *G*. This bar is firmly secured in the turret at *J*, the regular turret binder being used to hold it. The tool *H* is adjustable for diameters through the backing-up screw *T*. The outside turning is accomplished by means of double-end turning tool *N* which is fastened to the turret faces by the gibs *P* on the lower dovetailed faces, these being secured by the long special screws *O* which pass down through the body of the tool. A steel pilot *M* enters the bushing *L* in the spindle cap bracket *K*. A steel plate *S* is mounted on the body, and tool *Q* is secured in place by two screws *R* which pass through the plate. A collar-head screw is provided by means of which fine adjustments can be readily made. Attention is called to the manner in which the turning and boring tools are arranged so that they are working opposite each other, thus tending to keep the work nearer to size than would be the case if they were set to cut on different portions of the casting. After the work has been finished, the parting tool *B* cuts off the end of the sleeve slightly longer than required, so that a finish allowance is made for the second setting.

The second setting is shown in the lower part of the illustration and consists of roughing and finish-facing both ends of the sleeve to the prescribed size. For this setting the work *A* is held on the arbor *W*, the expanding sleeve *X* being forced up on the taper in the usual manner. A nose-piece *U* is screwed to the spindle and receives the tapered end of arbor *V*, while the other end *Y* is hardened and ground to a nice running fit in bushing *Z*, located in the turret. A special tool-block *a* is mounted on the front of the cut-off slide and holds the two rough-facing tools *b* and *c*. The tools enter slots in the block and are held in place by the set-screws shown. A ledge is cast at *d* on the rear of the block to allow the use of adjusting screws *e*. The finishing tools *f* and *g* are mounted in a special block on the rear of the cut-off slide in the same manner as those in front.

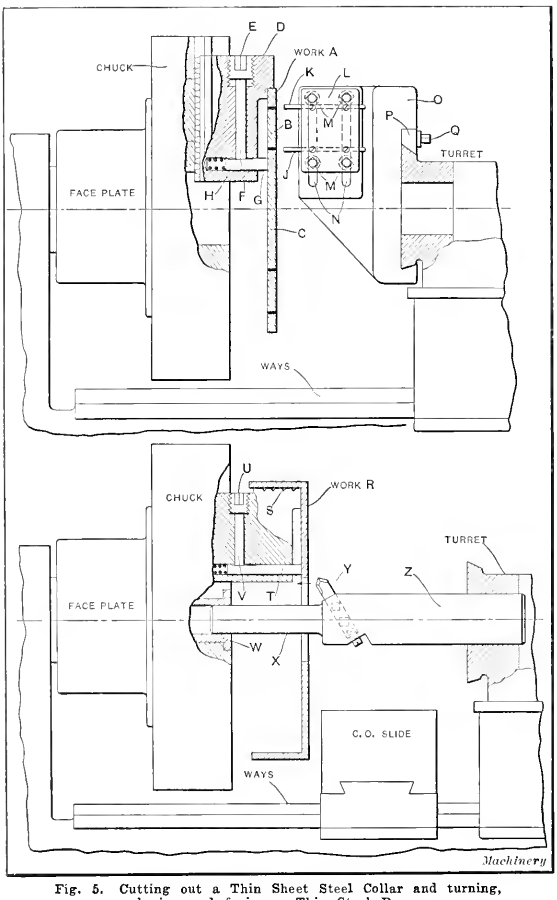

Fig. 5. Cutting out a Thin Sheet Steel Collar and turning, boring and facing a Thin Steel Drum

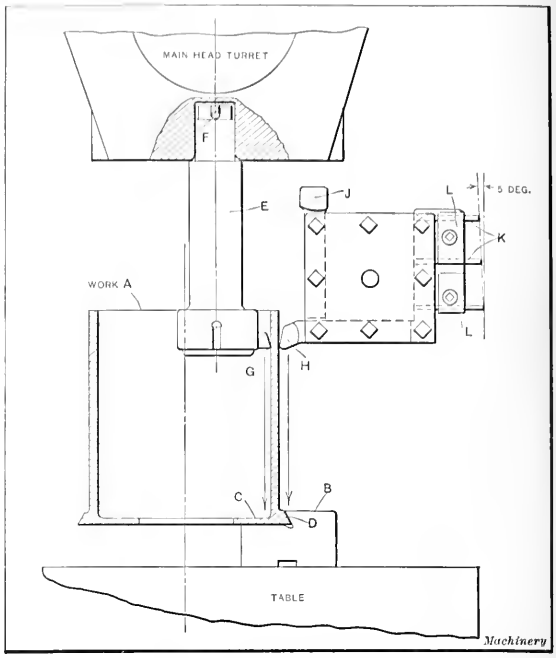

Fig. 6. Machining a Thin Casting to be cut up into Rings on the Vertical Turret Lathe

Machining a Thin Flanged Collar on the Turntable Lathe

A turntable lathe made by the Pratt & Whitney Co. is used to machine the collar shown in Fig. 3, the cross-sliding turret of this machine being used to perform the facing operation on the flange and the cutting of the recess. The work *A* is held in the special jaws *B* of the three-jawed chuck, that portion of the jaw marked *D* being brought up lightly against the inside of the thin end of the work and the set-screw *C* tightened. The forward end of the jaw is used as a support for the flange and also serves to locate the work longitudinally. The boring-bar *E* holds the tool *F* which does the boring, the turret being set off center a sufficient amount to bore the required diameter. The tool-holder *G* is one of the regular type commonly purchased with the machine. The two set-screws *H* are used to force down a beveled shoe which, in turn, serves to contract a split bushing which grips the bar. In connection with this equipment attention is called to the fact that the jaws are used principally for centering the work, being brought up very lightly on the inside of the work so that they have no tendency to distort the casting. The set-screws are then set up tightly on the outside, and as the piece is backed up by the jaws on the inside, there is no danger of springing. A metal-to-metal contact is obtained in this way and any tendency toward vibration is avoided.

The second setting of the work is shown in the lower part of the illustration. For this setting a faceplate is used with a locating plug *J* which fits the previously bored interior, the flange face being brought up against the finished face of the plate. Three clamps *K* secure the work. The boring-bar *M* holds tool *N* for boring the thin portion of the work, the turret being set off center for this purpose as in the first setting. The bar is held in the same type of holder *P* as that shown above.

Machining a Steel Motor Casting

The work shown at *A* in Fig. 4 is a steel motor casting of somewhat fragile construction at its inner end. This is

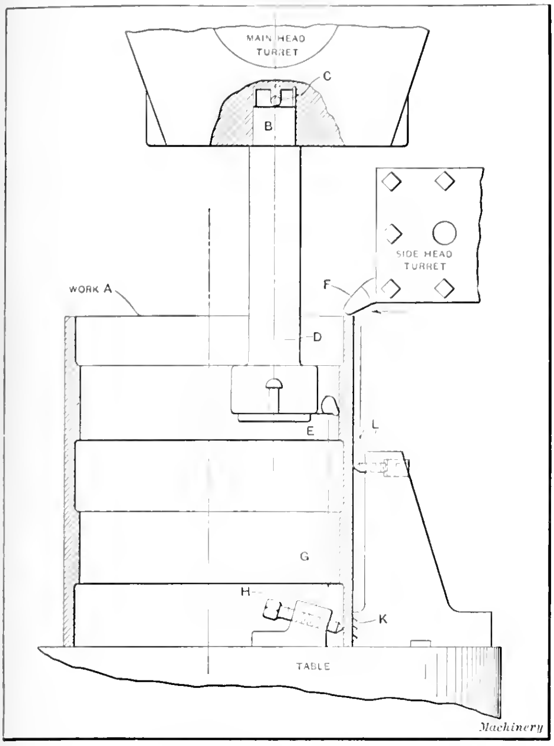

Fig. 7. Boring, facing and turning a Thin Casting in a Vertical Turret Lathe

another instance in which the turntable lathe is used. It will be noted that the casting is cored out at its inner end, so that there are three elongated openings at this point. In order to clamp the work without distortion, a steel ring *C* is provided with three set-screws *D*. This ring is placed in position in the casting before it is gripped by the jaws, the set-screws being set up with a moderate pressure against the inside of the walls. The casting is then placed in the chuck in such a way that these set-screws come opposite to the jaws. The jaws *B* may now be set up firmly without danger of crushing the work, the pressure being taken by the screws. The double tool-holder *K* is fastened to the turret face, and the set-screws *L* and *M* clamp the bars in position. These bars extend across the turret and the other ends are used for the finishing tools. The turning bar *J* is provided with a tool *H* which goes through the bar at an angle so that the tool is slightly in advance of the bar, thus permitting work to be done close up to a shoulder. A backing-up screw is provided for fine adjustments. The boring-bar *F* is arranged in the same manner, tool *E* being backed up by screw *G*.

The second setting is shown in the lower part of the same figure, the work *A* being held on a special arbor *O* which is screwed onto the end of the spindle. The finished end of the work is brought up against the shoulder on the arbor, the work being held on the portion *P* which fits the inside of the casting. The clamps *R* enter the cored holes in the casting *N*, and the steel stud *Q* forms a support for their inner ends. The tool-holder *U* is of the same type as previously described, the bushing *T* being compressed by two screws *V*, so that it holds the drill *S*. Other tools used in this setting are of a simple nature and need not be described. The facing is obviously done by the transverse movement of the turret.

Cutting Out a Thin Sheet Steel Collar

The illustration in the upper part of Fig. 5 shows a piece of hexagonal plate at *A* from which the thrust washer *B* is to be cut. In this work the center part of the blank *C* is saved and used for other work, but the outside portion is scrapped. The outside of the blank is held in the special jaws *D*, each of which is provided with a spring plunger *G*, a binding plug *F* and a hollow set-screw *E*. One side of the plunger is flatted off with a slight back taper as shown at *H*, so that any tendency to push back is offset by the wedging action of this taper. In operation, the plungers are first pushed down out of the way, and the jaws tightened, after which the plungers are released until they come in contact with the plate. The screws are now tightened and the work is ready for machining. A special tool-holder *O* is secured to the turret by angular gib *P* and screws *Q*. A steel tool-block *L* is mounted on a finished pad and is held in any desired position by the four screws *M*, which pass through the block and the body of the holder and are secured on the other side by nuts and washers. Vertical movement of the block is permitted by the elongated slots *N*, thereby allowing a number of different diameters of washers to be cut with the same tools. The tools *J* and *K* are ground on the sides to fit the slots in the block, and it should be noted that the lower of the tools is set forward slightly in advance of the other so that the center piece *C* will be cut out before the separation of the outer ring occurs.

Turning, Boring and Facing a Thin Steel Drum

The lower illustration in Fig. 5 shows another piece of work in which the same type of jaw with spring plungers is used to support the casting. In this case the jaws are so made that they grip the inside of the shell at *S*, while the plungers *T* come up against the web and assist in supporting it against the pressure of the cut. The same construction is used in the binding plug *V* and the hollow set-screw *U* as in the upper illustration. The facing of the web is performed by the cut-off slide tools while the boring-bar *Z* is cutting out the central portion with the tool *Y*. The forward end of this bar is hardened and ground at *X* to a running fit in the chuck bushing *W*. This piece of work was completed in another setting by holding it in soft jaws which extended in to form a support for the web.

Machining a Thin Ring Pot on the Vertical Turret Lathe

We now come to work of a larger size which can be handled to good advantage on the vertical turret lathe. On this type of machine the work stands vertically, so that there is no overhang of the spindle to contend with as on the horizontal type of machine. Aside from this, the conditions are similar

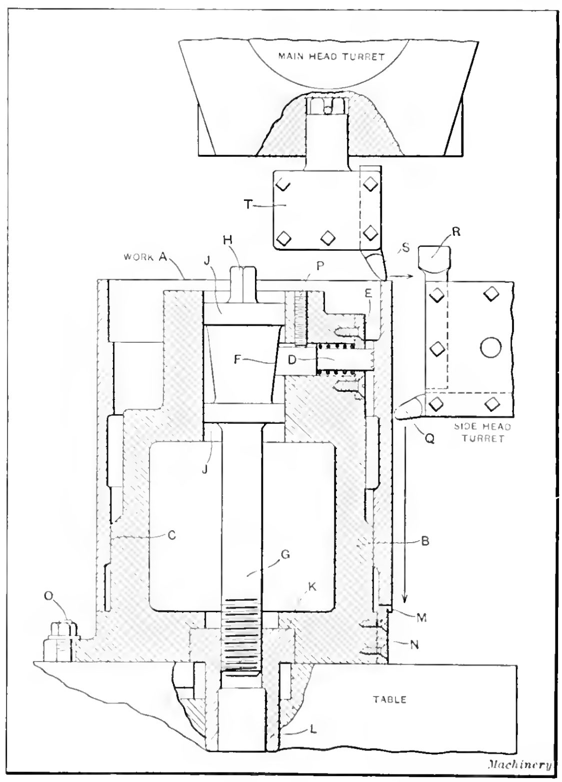

Fig. 8. Second Setting for machining Casting shown in Fig. 7

in both types. As the tools hang vertically, excessive overhang from the turret is not so apt to produce chatter as in the horizontal type of machine.

Fig. 6 shows a cast-iron ring pot from which four thin rings are to be machined. The pot casting A has a beveled flange around its lower end and is reinforced on the inside by web C. The jaws B are beveled to the same angle as the flange at D and, therefore, have a tendency to draw the

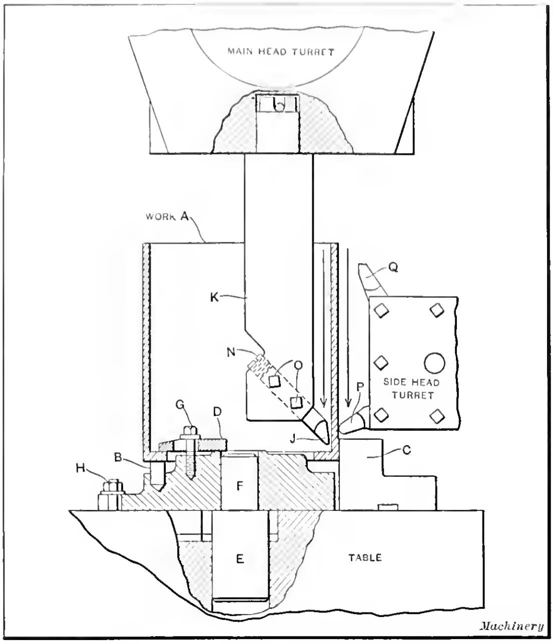

Fig. 9. A Thin Cast-iron Shell finished all over in a Vertical Turret Lathe

work down as well as to center it. The inner web tends to prevent crushing the pot when pressure is applied to the jaws. The bar E is a combination boring and reaming bar (as manufactured by the Bullard Machine Tool Co.), and is provided with slip-cutters and floating reaming cutters. (This type of bar was fully described in an article entitled "Design and Construction of Boring Tools," MACHINERY, March, 1914.) In this particular case the reaming cutters are not used, but roughing and finishing tools as shown at G are used in boring the casting. The shank of the bar fits the turret hole and is prevented from turning by pin F. The side-head turret holds roughing tool H and finishing tool J, these tools being used to turn the exterior of the pot. It should be noted that the boring and turning tools are working opposite each other, in the manner previously described. A special supplementary tool-block is fastened to the opposite side of the side-head turret and carries the three tools K which cut off the rings. These tools are ground on the sides so that they fit the slots in the tool-block, and are held in place by straps tightened by screws L. Attention is called to the fact that these tools are set so that a line passing through their cutting edges forms an angle of 5 degrees with the perpendicular. This is done so that the rings will be cut clean without ragged and broken edges, as only one ring is cut off at a time.

Machining a Piece of Electrical Work

The work A shown in Fig. 7 is a steel casting which is to be bored on the two internal annular pads, faced on the two ends, and turned on the outside. The casting is centered by the lower part of the special jaws K, these being brought up lightly against the casting so that they do not distort it. The screw dogs G on the inside of the work are then tightened until the pointed screws sink into the casting, thus holding the lower end firmly. The pointed set-screws L in the upper part of the jaws are now brought up against the work and tightened, after which the piece is ready for the machining operations. For boring the inside pads a special bar of the same type as that shown in Fig. 6 is used, the bar D being extra long. The shank B fits the turret and is driven by the pin C. A roughing and finishing slip-cutter E does the boring, while tool F in the side-head turret faces the end and turns part of the periphery.

The second setting is shown in Fig. 8, but between the first and second turret lathe operations a slot M is milled across the lower end of the casting to assist in driving. The work is held during the second setting on the special locating fixture B, which is made of cast iron and bolted to the table by the three bolts O, tee-shaped at their lower ends and fitting slots in the table. The centering plug K is a drive fit in the fixture body and is turned down at L to fit the center hole in the table. A steel strip N is fastened to one side of the body and its upper end acts as a driver in the slot M. The lower part of the outside of the body is turned at C to a nice fit in the casting.

The upper portion is firmly held by three expanding pins D which are flatted on one side where the screws P bear against them to prevent turning. The pins are shouldered for the coil springs and are beveled at their inner ends to fit the angle F on the operating rod. Three steel plates E are let into the casting to act as cover plates and hold the springs in place. The operating rod G is of tool steel with its lower end threaded with an Acme thread in bushing K. Two narrow rings on the upper end J are made cylindrical and a square portion is milled to receive a wrench by means of which the mechanism is operated. It will be seen that the purpose of the pins is to steady the upper portion of the casting and prevent torsion which might result under the pressure of the cut. Excessive pressure is not necessary on these pins, as a great amount of the driving is done by the block N at the lower end. The tool S is used for facing the

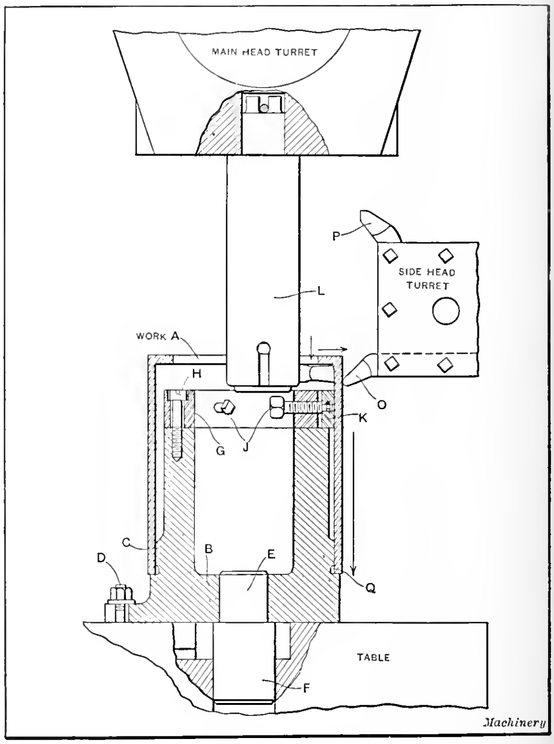

Fig. 10. Illustration showing Second Setting of Same Casting as shown in Fig. 9

end of the casting and is held in one of the regular toolholders T, the shank of which fits the turret hole and is driven by a pin. The side-head holds two tools Q and R which are used for roughing and finishing the periphery.

Machining a Thin Cast-iron Shell

The work shown at A in Fig. 9 is of cast iron and is finished all over, the side walls being only 3/16 inch thick when finished. A cast-iron base is held down on the table of the

machine by the three bolts *H*, which are tee-shaped at their lower ends and fit the table T-slots. A steel plug is forced into the base at *F* and fits the center hole in the table at *E*, thereby locating it centrally. Three hardened steel pins *B* are inserted in the base and act as supporting points for the casting. The three clamps *D* are operated by screws *G* and are slotted so that they can be pulled back, out of the way, when inserting or removing the work. In setting up, the jaws *C* are used to center the work, but they are not set up very tightly for fear of buckling the casting. Two special bars *K* are used for the roughing and finishing boring; tools

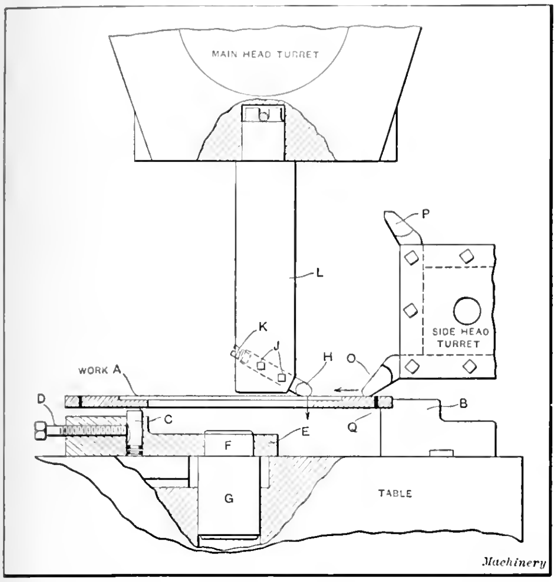

Fig. 11. Machining Steel Sprocket for Automobile Trucks

J are put in at an angle of 45 degrees so that there will be no interference with the clamps when near the bottom of the pot. Two screws *O* clamp the tools in place, and a backing-up screw *N* permits fine adjustments to be made. The tools *P* and *Q* in the side-head are used for roughing and finishing, and when in use are kept directly opposite the boring tools.

The second setting of the same casting is shown in Fig. 10, this operation consisting of boring the hole through the flange and undercutting it, and also approximately matching up the unfinished portion of the inside with that previously machined. The fixture body *B* is made of cast iron and is bolted to the table in the usual manner by the three bolts *D*. A locating stud *E* is forced into the body and fits the center hole in the table at *F*. The lower part of the body is turned at *C* to fit the inside of the bored shell. A shoulder is provided against which the finished end of the work is located, and a groove *Q* is cut so that trouble will not be caused by chips and dirt. A steel ring *G* is fastened to the upper end of the body by three screws *H* in such a way that there is clearance around the body of the screw; thus a floating or equalizing action is permitted. Three steel shoes *K* are let into slots in the ring and are controlled by screws *J* which pass through the ring. It will be seen that this arrangement permits the screws to be tightened sufficiently to perform their function without fear of forcing the work out of true, due to an unequal pressure on the screws, as the floating ring equalizes the strain. The boring-bar *L* used for the work is of the same general type as previously described, slip-cutters being provided for both boring and undercutting the flange. The facing of the flange is accomplished by tools carried in a regular tool-holder as shown in Fig. 8, while the outside turning is done by the roughing and finishing tools *O* and *P* in the side-head turret.

Machining a Steel Sprocket

The work shown in Fig. 11 is rather out of the ordinary. The piece when completed is a steel sprocket, such as used on automobile trucks. Two settings are required to complete the work, but the first one of these is the only one in which we are interested. The pieces from which the sprockets are machined are octagonal in shape and are of rolled steel with a large hole punched in the center. The work is roughly centered and gripped by the outside in the special jaws *B*. A cast-iron spider casting *E* is centered on the table by stud *G*, which fits the center hole in the table and the upper end *F* of which is a drive fit in the spider body. Three spring plungers *C* support the inner part of the plate and are locked in their positions by set-screws *D*. In operation, these plungers are pushed down, out of the way, until the jaws have been tightened, after which they are released and the set-screws tightened. The tooling for this piece of work is not out of the ordinary, bar *L* being similar to the one shown in Fig. 9, except that tool *H* is put in at an angle of 30 degrees instead of 45. The screws *J* hold the tool, and the backing-up screw *K* permits of fine adjustments. The tools *O* and *P* in the side-head are used for roughing and finish-facing. The recess is cut by a tool in the main head, while the final operation of cutting out the work at *Q* is accomplished by a parting tool in the main head.

Machining a Large Pot Casting

The work shown at *A* in Fig. 12 is of cast iron and is machined completely on the inside while the outside is turned as far as the finished pad extends. The work is held by the outside in the standard jaws *B*, supporting the bottom of the pot on the raising buttons *C*. A lug *D* on the outside of the pot acts as a driver against the side of the jaw. A long special tool-holder *J* holds the two tools *E* and *F*, these being held in place by set-screws *K*. These two tools turn the hub and bore the inside of the pot. At the same time that this

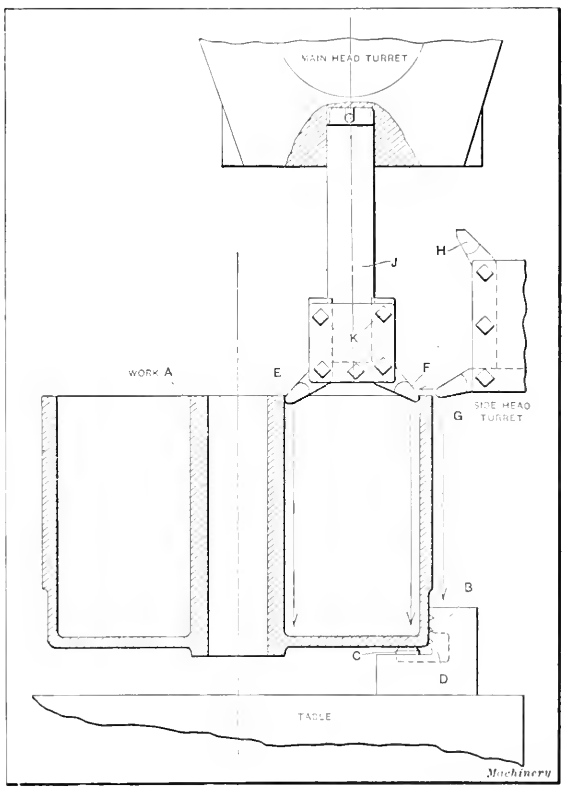

Fig. 12. Another Thin Casting machined in the Vertical Turret Lathe

operation takes place on the inside, tool *G* in the side-head turret is turning the outside diameter. The cutting points of all three tools are in a line. Another long tool-holder holds the tools for the inside finishing while tool *H* in the side-head completes the outside work.

* * *

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MACHINING DESK FAN PARTS

SPECIAL JIGS, FIXTURES AND TOOLS USED BY THE ROBBINS & MYERS CO., SPRINGFIELD, OHIO

SPECIAL jigs and fixtures that enable interchangeable manufacture to be handled economically and on a satisfactory basis are always of interest to the average mechanic, inasmuch as the majority of these methods can be applied directly to his own work. The manufacture of desk fan parts in large quantities, for instance, requires a special tool equipment that compares favorably with that used in any other line. A number of interesting devices and methods for this work have been devised by the Robbins & Myers Co., Springfield, Ohio, and a description of these will be given in the following.

Fig. 1. Jones & Lamson Double-spindle Flat Turret Lathes at work on Fan Motor Bodies

Machining Fan Motor Bodies on a Jones & Lamson Double-spindle Flat Turret Lathe

Fan motor bodies are made from cast iron and have a particularly thin wall, which makes them extremely difficult to machine, because of the tendency of the castings to spring out of shape when being clamped. Another difficulty is that of making the hole for the motor shaft absolutely true with the counterbore in which the field of the motor rotates. To machine one of these motor bodies satisfactorily, therefore, requires not only a first-class tool equipment for holding and machining, but also calls for great care on the part of the operator. Fig. 1 shows two Jones & Lamson double-spindle flat turret lathes set up and in operation on this class of work. The machine to the left is working on fan motor bodies, while that to the right is at work on the cover or end of the body. The machining operations on the body are the most interesting and therefore will be given here.

Fig. 2 shows a close view of the turret tools, etc., and also the chuck, and Fig. 3 gives a clearer idea of the construction of the chuck and the method used in holding the work. The chucks used are of the ordinary three-jaw type, carrying special cup-shaped housings G fastened to their faces as shown. Around the periphery of these housings are located six knurled headed thumb-screws H. The points of these screws bear lightly against the body of the castings after they have been tightly gripped on the bearing hub by the three jaws of the chucks. The holding and driving is done by the chuck jaws, the housings and knurled screws being used merely to steady the castings. The screws bear against the castings and are tightened just sufficiently to hold them from being shifted out of place by the thrust of the cutting tools. The order (see Fig. 2) in which the operations on this fan motor body are handled is as follows:

First, remove scale from large bore with two tools held in the turret.

Second, index turret; rough-bore and counterbore small holes and rough-bore large holes with tools held at A in the turret.

Third, index turret; rebore small holes with boring tool B.

Fourth, index turret; finish-ream small holes and counterbore with tools C floating; finish-bore large holes with inserted-tooth cutters D and finish-face end of casting with tools F.

While the double-spindle type of machine takes a little longer to set up for various operations, it has the advantage of turning out two pieces in the same time that one could be turned out on a single-spindle machine. As far as accuracy is concerned, the work produced comes up to requirements and, in fact, the Robbins & Myers Co. has found that the double-spindle machine is especially adapted for this class of work, as a product of sixty-eight completed bodies in ten hours should bear evidence.

Two-speed Milling Device

A two-speed milling device for operating two milling cutters of different diameters at their correct peripheral speeds is shown in Fig. 4. The part being machined is a one-horsepower alternating-current motor body which is face-milled and has a slot cut in its base at the same time. Two of these castings A are clamped to the milling machine table at one time and the bases are machined by a large inserted-tooth milling cutter B, driven in the usual manner. The slots are cut with an end-mill C driven by a special arrangement passing through the spindle of the machine and the large cutter.

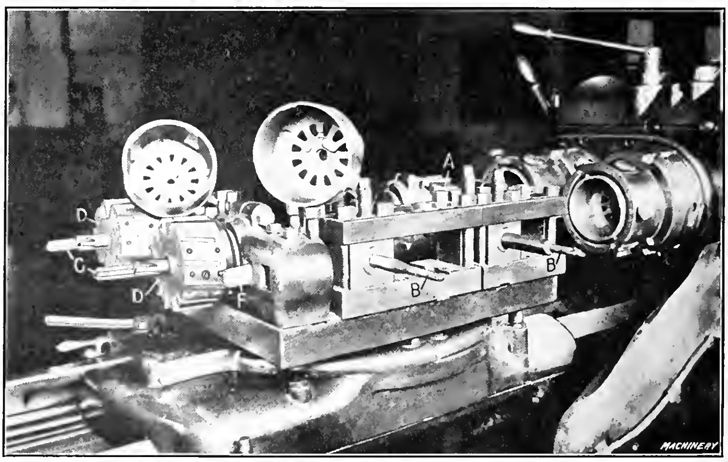

Fig. 2. Close View of Jones & Lamson Double-spindle Flat Turret Lathe showing the Turret Tools, Chucks and Work

A special spindle which passes through the spindle of the milling machine is supported at the outer end by the arm D, generally used for supporting the milling arbor, which, with the milling machine, as can be seen, has been reversed for this purpose. On this spindle a pulley E is located which is driven from the overhead works by a belt as shown.

The end-mill is screwed into the forward end of the spindle

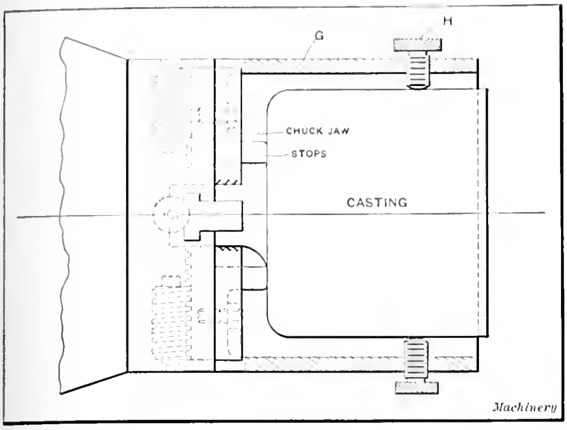

Fig. 3. Detail of the Chuck and Method of holding Fan Motor Bodies in the Two-spindle Jones & Lamson Flat Turret Lathe

and works in a hardened and ground bushing in the end. In the illustration, one of these bushings has been loosened and turned around so that the character of the operations accomplished can be seen and a better view of the cutters obtained. It is evident that it would be impossible to operate the end-mill at the same rate of feed as the large cutter, if the small cutter were rotated at the same peripheral speed. By giving the end-mill a proper peripheral speed, it can be operated at its proper cutting speed and the table of the machine given a rate of feed suitable for the large inserted-

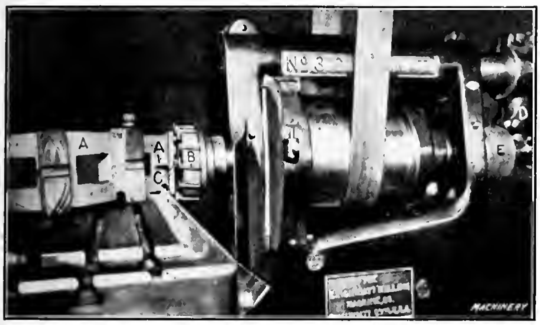

Fig. 4. Two-speed Milling Attachment for machining Alternating-current Motor Body Castings

tooth milling cutter, so that both cuts can be completed at the same time. This method of machining these motor bodies and the use of this special two-speed milling device may appear impractical to some mechanics, but, not having a milling machine of sufficient capacity to take care of the large variety of bodies and sizes, this company has used this method with very satisfactory results. Another method would be to mount the bodies vertically on fixtures on the table of the milling machine, and to use three spiral milling cutters of sufficient width, placing a milling cutter of the proper width for the slot between the two wider cutters. The entire operation could thus be accomplished in one cut.

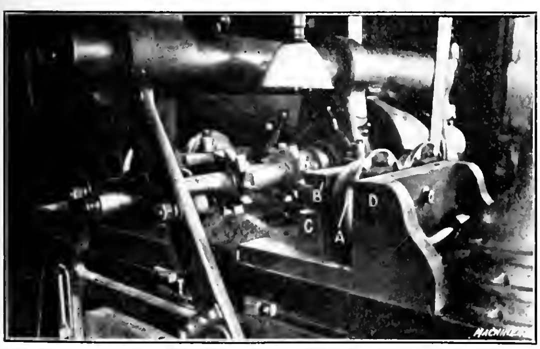

Fig. 5. Reciprocal Milling Attachment for machining the Slot in Desk Fan Bases

A Reciprocal Milling Fixture

Another interesting milling fixture is shown in Fig. 5. This is of the reciprocal type and is used for milling a 1 1/16 inch wide by 1 3/4 inch deep slot in desk fan bases. The spindle of the machine carries two side-relieved milling cutters 7 inches in diameter operated reciprocally on the four castings held in the two fixtures at each end of the milling machine table. While the cutters are at work on the two castings held in the fixture to the left, the operator is loading the fixture to the right and *vice versa*. The circular tapered bodies of the castings *A* are held by clamps *B* in V-grooves in blocks *C*. As the grooves are tapered to correspond with the taper on the work, the action of the clamps forces the base of the castings tightly against the face of the angle-plate *D*, holding them square and rigidly in position. This type of fixture gives very satisfactory results for this work and enables a

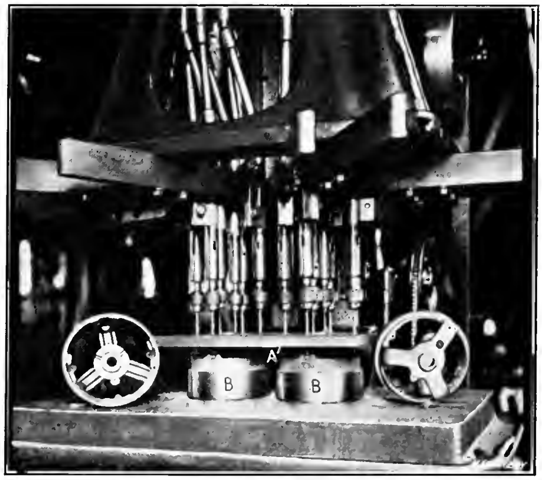

Fig. 6. Drilling Two Alternating-current Motor Bodies in a Pratt & Whitney Multiple Drilling Machine at the Same Setting

production of six hundred castings to be turned out in ten hours.

Gang Drilling on a Multiple Spindle Drilling Machine

An interesting fixture applied to a Pratt & Whitney multiple spindle drilling machine is shown in Fig. 6. This is used for drilling six holes in alternating-current motor bodies *B*, two castings being machined at the same time. The fixture, as Fig. 7 clearly shows, is of simple construction. It consists of a plate *A* which carries the drill bushings for guiding the drills, the motor bodies being located on central

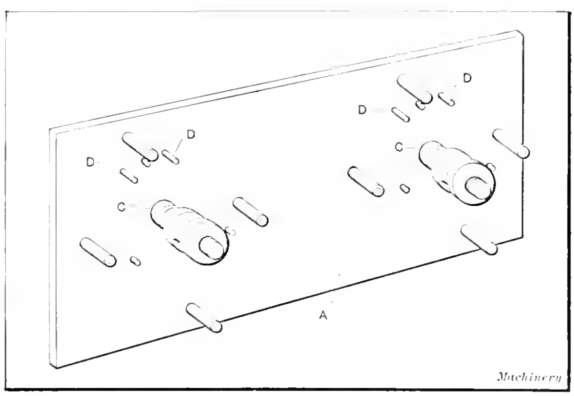

Fig. 7. Detail View of the Fixture shown in Fig. 6

guide studs *C* by two guide pins *D* in the proper positions from one of the arms. This type of jig is of open construction, easily cleaned, and enables the work to be removed and replaced very quickly.

Doubling Production on the Cleveland Automatic

Fig. 8 shows an improvement in tool arrangement on the Cleveland automatic for making the commutator shells shown

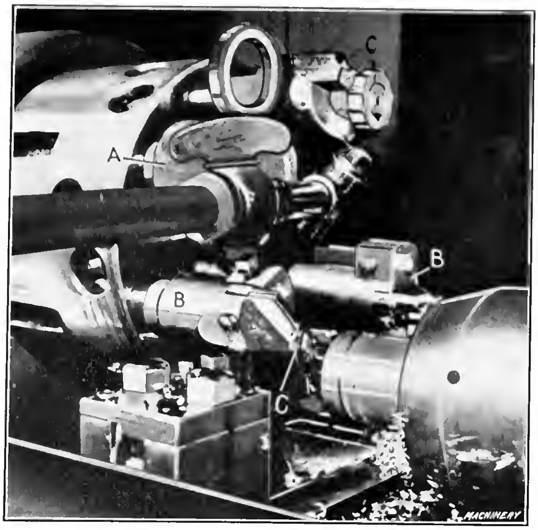

Fig. 8. Doubling Production on a Cleveland Automatic Screw Machine by having two Sets of Tools in the Turret

in Fig. 9, which are used on an automobile electric starter. These parts are made from a 3¼-inch bar of cold-rolled steel, and by the tooling arrangement shown in Fig. 8 the production was increased from 14 to 28 pieces per hour. The tooling equipment consists of two sets of tools carried in the turret and a form tool for producing or shaping two pieces instead of one at each stroke of the cross-slide. The order of operations is as follows: After feeding the stock out to the stop *A*, the hole is drilled and the bar turned by a combination tool *B* held in the turret; then by means of the combination reamer and counterbore *C*, the hole is reamed and counterbored in the front end to the beveled shape shown in Fig. 9. The cross-slide then advances and cuts the first formed piece off, after which the other set of tools comes into operation and forms another piece, two pieces dropping from the machine at every complete index of the turret. This method of doubling up the tools in the turret can be used to advantage on thin work of this type where only a few operations are performed from the turret.

D. T. H.

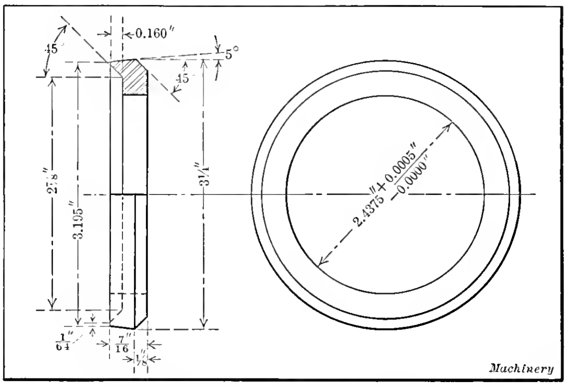

Fig. 9. Commutator Shell on which Production has been doubled on the Cleveland Automatic Screw Machine

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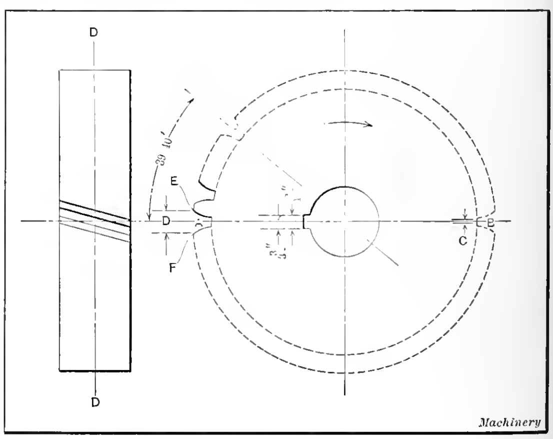
ACCURATE METHOD OF LAYING OUT KEYWAYS IN TIMING GEARS

BY ERNEST A. RUNGE*

Between the crankshaft and camshaft or the magneto driving shaft in an automobile motor, there are many places where errors may occur, the aggregate of which may seriously affect the timing. This makes it necessary—especially when building a model requiring the work to be done without special fixtures—for each keyway in the shaft or timing gear to be located very accurately. We have had quite a lot of this to do on model and special work, and have noticed that otherwise good mechanics have difficulty on this work through the lack of a good method. Believing that there are many others who do not get this kind of a job often enough to have worked up a simple and direct system of their own, I herewith describe the method we have followed with excellent results.

Let us suppose we have a timing as shown in the accompanying illustration, and for the sake of simplicity, let us for the present assume it to be a spur gear, the specifications calling for a 3/16-inch keyway located on the center line of the tooth space. The number of teeth is immaterial. Our first move will be to mount the gear, with the mandrel properly dogged, etc., on the index centers. If we have a true running expanding mandrel that fits in the index spindle, it will be somewhat handier than the solid mandrel. See that the index head is equipped with an index plate, one having a circle with the largest number of holes that will permit division in degrees being preferable for this purpose. With a surface gage having a very sharp pointed scriber, find the center of the gear; this is accomplished by approximating as nearly as possible and then, with the backlash in the index head taken up, scribe a short line near the edge of the gear, say at *A*. Then index the gear through one-half turn, which brings this line at *B*, and scribe another short line at this position with the same setting of the surface gage. If the setting is correct, the two lines will coincide; but should there be a difference *C* as shown, it will indicate that the surface gage scriber is either too high or too low. If this is found to be the case, adjust the scriber to bring the point exactly midway between these lines and repeat the test; when the line drawn on one side of the center coincides with another line drawn on the opposite side—the gear being indexed one-half turn as previously explained—we have found the center. Next we must find the tooth space represented by the distance *D*. With the surface gage scriber at position *A*, set the scriber point so it just touches the periphery of the gear, and index the gear around in the direction of the arrow so that the edge *E* of the gear tooth comes exactly to the scriber point. Mark the position of the index crank with the index sector. Now move the gear around until the edge *F* of the next tooth comes exactly to the scriber point. Count the number of holes passed over in the index plate. Let us suppose we count twelve holes; then the distance *D* requires twelve holes, and one-half of this or six holes will give us the point midway. Now return to *E* and index that number, and we have brought the gear to the position shown in the illustration.

We can now lay out the position of the keyway by adjusting our scriber point 3/32 inch above or below the center, and scribing a fine line from the hole to the left as shown; then indexing the gear around one-half turn, bringing *A* to position *B*; and then with the same setting of the surface gage, scribing another fine line from the hole to the right.



Method of laying out a Keyway in Relation to a Tooth Space

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The two parallel lines thus obtained mark the location of the keyway. If the keyway is to be cut in the shaper, an additional center line at right angles to *A—B* will be of service in setting the gear in the shaper vise, as by our method we set the gear with this vertical center line parallel to the vise jaw and carefully guide the tool between the lines scribed for that purpose, until we arrive at the proper depth. If care has been exercised in the previous operations, you will have the keyway located as accurately as is possible without an elaborate special fixture. It is assumed that unless you are blessed with unusually good eyesight, you will use a magnifying glass to assist in making these settings. Had the drawing called for a keyway to be located in a position 39 degrees 40 minutes measured counter-clockwise from the center of the tooth space, after we had found the center of the tooth space, we would have indexed the gear that amount in the direction of the arrow, which would bring the tooth space center to position marked *G*. The keyway would then be laid out as before.

In the previous examples we have assumed the gear to be a spur gear. Had it been a helical gear, if the layout for the keyway is shown on the side, our method would be the same as for a spur gear, except that in finding the center of the tooth space we would be obliged to work entirely on the side of the gear. A moment's consideration will show why this must be. The layout may be shown on a plane at the center of the gear width as indicated by the line *D—D*; only one helical cut is represented to avoid confusion. In a case like this, before mounting the gear on the mandrel, we would scribe a line *D—D* on the ends of the gear teeth. Then after the gear is in position, to find the center of the tooth space as in the previous examples, we set our surface gage scriber point exactly on this line *D—D* and find the center of the tooth space as before. Having found the center, scribe the line across the side of the gear and proceed the same as for the spur gear. Had it been necessary to work from the center of a tooth instead of a tooth space, the procedure, except for this difference, would have been the same.

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FIXTURE FOR MILLING CLUTCHES

BY I. W. SPRINK*

The accompanying illustrations show the design and construction of a special form of dividing head used for cutting the clutches on transmission drive pinions and sliding gears.

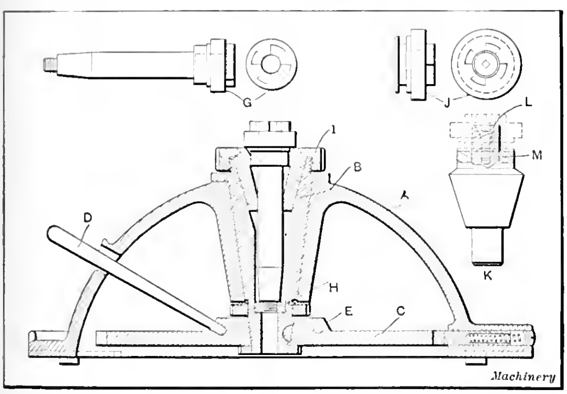

Fig. 1. Cross-sectional View of Fixture for milling Clutches and Details of Work-holding Mandrels

This fixture consists of a frame *A* into which the spindle *B* is fitted. The spindle is designed to serve as a collet chuck on the upper end and is arranged to carry the large index plate *C* at its lower end. The method of operating this dividing head is very simple, the spindle being rotated by means of the handle *D*. The index plate has a series of holes *E* drilled in it at a convenient angle to receive the handle *D*. To turn the spindle, it is merely necessary to withdraw the locking bolt *F* by means of the small lever provided for that purpose, and move the index plate around by means of the handle *D*.

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The method of chucking the pinion shaft *G* is clearly shown in the cross-sectional view, Fig. 1, and will need little description to make it clear to any mechanic. It will be seen that a small collar *H* rests in a hole at the bottom of the spindle; this collar receives the downward thrust of the work and also serves the purpose of locating the lower end of the work to bring it exactly perpendicular. In using this fixture it is customary to put a sheet-metal washer between the lower face of the pinion and the top surface of the chuck ring *I* in order to keep chips and oil from running down into the dividing head. The collet chuck is cut into three parts and provided with springs between its faces to expand the collet.

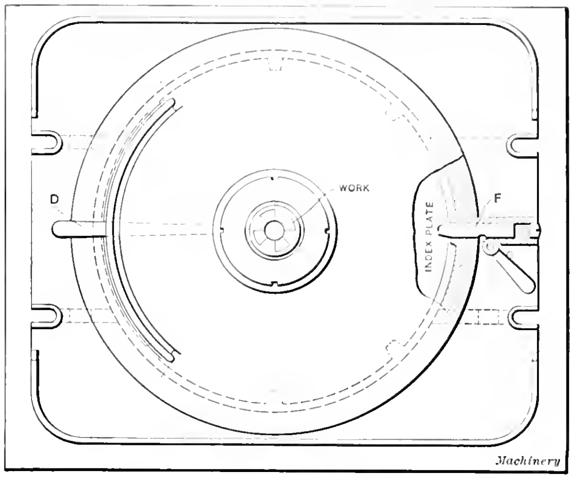

Fig. 2. Plan View of Fixture for milling Clutches

When milling the clutch gear *J* the split collet is replaced by the expansion chuck *K*. The body of this chuck fits into the spindle and is locked in position by the chucking ring *I*. The work is held on this chuck by expanding it by means of the taper headed screw *L*, which is turned by a square key. The hardened steel collar *M* is fitted onto the chuck to provide a good bearing surface and resist wear. The clutch gear is shown in position on the chuck by dotted lines.

It will be evident that eight cuts are required to complete the milling operations on one of these clutch gears, and consequently it is necessary to use an eight-point index plate. A cutter ½ inch wide is used. After setting to bring the cutter to the required depth, the milling machine saddle is moved in until one edge of the cutter registers with a point 0.010 inch to the left of the center; four cuts are then made, completing one side of the clutch teeth. To mill the other side of the teeth, the milling machine saddle is moved out until the other side of the cutter registers with a point 0.010 inch to the right of the center. The head is then indexed ⅛ revolution to mill the side of the first tooth, and then ¼ revolution for taking each of the three remaining cuts. The clutch teeth are cut a little off center in order to give the clutches the required amount of clearance.

All steel parts of this dividing head are carbonized, hardened and ground to make a good serviceable tool. The ideas embodied in the design of this special dividing head may suggest other uses for a tool of this kind where it is required to perform milling, drilling and other operations on work for which the regular milling machine dividing head is not suitable.

* * *

What is claimed to be the largest wind motor in the world has lately been erected at Harlingen, in Holland, for draining a tract of lowland redeemed from the sea by high embankments, the area being nearly 2000 acres. This wind motor is provided with steel sails and is mounted on a steel tower. It has a diameter of 50 feet. It is an interesting fact that while some years ago the wooden windmills of Holland began to be replaced by internal combustion engines, during the last five years the steel windmill has begun to be more and more employed, especially for pumping purposes.

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THE PROBLEM OF DISTRIBUTION

The greatest problem confronting society is that of distributing the products of factory, mine, farm, and every industry more efficiently, which means at less cost. Scientific management has done wonders in reducing the cost of manufacture, but it is of little avail to cut the cost of manufacturing products when the great cost of distribution remains practically unchanged. The disparity in the price of farm products in the city and country is notorious. What is needed is some better means of bringing producer and consumer together.

Manufacturers spend money liberally to bring their products to the attention of possible customers, and it must be counted a great achievement of advertising that some great businesses have been developed very largely by its aid. But while it is true, and of course perfectly natural, that a man will read advertisements which describe the tools and materials of his own trade or business, and about anything in particular which appeals especially to him in a personal way, it is true also that the advertising of general products is not habitually read by the general reader as the editorial pages are read. This is one of the great problems of distribution, but we believe it is in course of solution. The old suspicion of advertising claims and statements is wearing away. Advertising has gained greatly, not only in good taste and in the ability to impart information, but also in the reputation for reliability.

The columns of the foremost newspapers, the leading magazines and technical journals are open only to the advertising of reputable people whose claims are scrutinized, and no reader of important journals can now afford to neglect the advertising. Speaking of technical journals in particular, the reader who regularly consults the advertising acquires a great deal of valuable technical information, a knowledge of new developments and considerable trade information which can be acquired in no other way. The day is not far distant, we believe, when the advertising pages of MACHINERY, for example, will rival the reading pages in presenting news of improved practice, materials, machines and designs. Stilted catalogue advertisements devoid of life and drawing power will be entirely displaced, as many of them are now, by masterly argument and convincing claims that will make the silent salesman—the technical journal—an even more potent factor in the great problem of distribution.

HERRINGBONE GEARS FOR HEAVY DUTY

In the beginning of mill construction the gearing was made with wooden teeth, and this form was slowly displaced by cast-iron gears with integral teeth, molded from a full pattern. These cast gears, however, were inaccurate and noisy. The patternmaker might make the pattern with thoroughness and skill, but it was soon warped by rough usage in the foundry and the influences of the weather. A great improvement in cast gears was effected by the molding machine which eliminated the tooth inaccuracies inherent in the full pattern. A pattern of one tooth only, indexed step by step, formed a mold in the sand with precision, and thus eliminated the troubles and expenses incident to the use of the old full patterns. But the requirements of modern machinery construction were not always met satisfactorily in cast teeth, and so the final step in spur gear making was effected when machines were built for forming the teeth from the solid metal by formed cutters or generating tools. Today spur gears twenty-five feet in diameter and larger are machine cut, but this stage, too, is but another step in the evolutionary process.

The spur gear drives its mate evenly or unevenly, depending on whether or not its tooth forms are true shapes. If the shapes are true, if the gears are correctly mounted and if they are not overloaded the angular motion transmitted will be regular, but ideal conditions are difficult to realize in the beginning and almost impossible to maintain.

The inherent defects of spur gearing are being more and more realized as the requirements of machine users become more and more rigid, and designers are specifying herringbone or double-helical gears for positions in which spur gears have proved unsatisfactory. The smooth running characteristic of the double-helical gear is no new discovery. On the contrary, it has been known a long time, and this type of gear has been much used, but only when its higher cost was warranted by the conditions to be overcome. Now, however, the difference in the cost of spur and herringbone gears is becoming less and less as improved processes are being applied to the production of the latter. As some one has aptly remarked, the herringbone gear is to the spur gear what the cut gear was to the cast gear. That, in a nutshell, tells the story of evolution.

* * *

ALLOY STEEL GEARS IN MACHINE TOOL CONSTRUCTION

Considerable experimenting has been done by machine tool builders in an endeavor to follow automobile manufacturers in the use of alloy steel gears in gear-boxes and other power transmitting units of machine tools in order to prevent breakage and stripping of gear teeth. Alloy steel, such as chrome-vanadium and chrome-nickel, has been used with more or less success. Where it is impossible to make a complete analysis of the steel before working it up, it has been found that alloy steel gives far more trouble than ordinary carbon steel. The limits of fluctuation in heat-treatment are much narrower than in ordinary carbon steel, and the material must be handled much more carefully if good results are to be expected. One machine tool builder in the Middle West has tried both chrome-vanadium and chrome-nickel steel for gears which are used in a gear-box transmitting considerable power. Very unsatisfactory results had been obtained, and this manufacturer has gone back to the use of ordinary carbon steel having a carbon content of 0.20 per cent, heat-treating the gears in the most scientific manner known. Since using carbon steel this company has found that its troubles in the way of breakage and stripping of gear teeth are practically eliminated. A more uniform carbon content, in ordinary carbon steel, is obtained; and hence the same heat-treatment on different classes of gears can be employed with very little loss. This seems interesting, since the development, of late, has pointed rather to the use of chrome-nickel and chrome-vanadium for gears that are required to work under severe conditions of load, speed and shock.

FORCED FITS

Periodically, in the transactions of engineering societies and in the technical press, discussions appear with regard to the proper allowances for making forced or pressed fits with full holding power and maximum economy of metal. There seems to be no such uncertainty with respect to shrinkage fits—a confidence which is justified fully by their extensive use in all built-up ordnance. The integrity and safety of every high-powered gun, in all armies and navies, depends upon shrinkage allowances, and the total absence of accidents in recent years through the bursting of the breech in such guns proves that these allowances are adequately proportioned for the stresses which the compound cylinder forming the breech must meet when the charge is exploded. The thickness of these cylinders and their relative "allowances"—that is, the difference before shrinkage between the external diameter of the inner cylinder and the internal diameter of the outer—are always based fundamentally on Lamé's formula for the determination of the stresses in thick cylinders. The derivation and application of this formula have been fully discussed in previous numbers of MACHINERY.

If the allowances for the forced fit are so proportioned that, in pressing home the inner member—axle, shaft or crank-pin—into the outer member—wheel-hub or crank—there occur only expansion of the latter and compression of the former, both within the elastic limits of the metals, then Lamé's formula is fully applicable to forced fits also. Let us consider the effects which, by this formula, are shown to be caused by shrinkage and on the assumption as above by forcing also.

The radial pressure on the contact surfaces of the fit produces a radial, compressive stress in both the inner and outer members. As a result of this stress there are induced in the outer member a circumferential tensile stress or "hoop tension" and also, through lateral contraction, a longitudinal compressive stress which, in wheel or crank-pin hubs, is negligible. The hoop tension diminishes in intensity very rapidly from the inner to the outer circumference of the hub, and hence the critical and dangerous part of the fit lies at the inner layer, that is, at the bore. So long as the tensile stress in this layer does not exceed the ultimate tensile strength of the metal, the hub will not burst, and, conversely, no hub thickness whatever will prevent rupture if the ultimate tensile stress of the metal at the bore be exceeded. Further, as the radial stress decreases so rapidly toward the outer circumference, the influence of wheel-arms and crank-webs on the resultant hoop tension is relatively slight. The allowance per inch of diameter of the inner member depends upon its coefficient of elasticity, the allowable tensile stress at the bore and the quotient of the true compressive stress at the outer surface of the inner member, divided by the hoop tension at the bore. The holding power of the fit is the sum of the total radial pressures on the contact surface, and this pressure is, in turn, affected by the size of the allowances and the compressibility and expansibility of the inner and outer members, respectively, the expansibility depending to some extent on the thickness of the hub. As increased diameter gives augmented contact surface, the allowance per inch of diameter may be decreased if the holding power required does not increase proportionately with this surface.

While the basic principles governing shrinkage and forced fits are the same, the methods of making them differ, and hence there is some doubt, especially with large allowances, as to whether the formulas for a shrinkage fit apply fully to the forced fit. With the latter, in driving the inner member home, the effective allowances and holding power may be reduced either by abrasion or, with unduly large allowances and ductile metal in the hub, by an axial flow of that metal in advance of the entering inner member. There seems no question, however, that with metals of average stiffness, the allowances in forcing should not exceed those for shrinkage, as otherwise there will be at the bore either excessive stress, permanent set or rupture, with ultimate failure of the fit.

OPPORTUNITIES FOR THE MACHINIST

BY F. B. JACOBS*

Anyone who has associated with machinists to any extent cannot help but realize that they are sometimes discontented with their prospects in life. When the machinist compares his wages and outlook with those of his fellowmen who are employed at other vocations, he naturally draws conclusions, which may, or may not be logical. In interviewing a number of machinists, we find some that are satisfied and contented. On the other hand, many claim that their wages are insufficient when compared to the rates paid in other skilled trades, and that life offers no better prospects than uninteresting daily toil for years to come. It cannot be justly claimed that all forms of discontent are harmful, for ambition and discontent often go hand in hand, the one being the direct cause of the other. The dissatisfied machinist has a vague idea that he would like to work at some other calling, but for some unknown reason the majority, when discussing the subject, seem to have a leaning toward vocations for which they have had no training. However, an examination of the ideas advanced shows the same desires: *viz.*, greater compensation for energy expended, less manual labor and more leisure time. We cannot claim that these desires are unreasonable, for they have been, and always will be, entertained by useful citizens in all walks of life. How about the machinist? What chance has he in the competitive struggle? Twenty-five years of close association with machinists and machine shops has convinced the writer that the machinist has a better chance than the average worker and the conclusions drawn are taken from actual experience. The word "worker" is used in this case to designate anyone who is not possessed of an independent income.

In considering the wages paid machinists, we must not lose sight of the fact that they are regulated by the inflexible law of supply and demand. As an illustration, if there are ten open positions at $3.50 per day, and fifteen idle machinists to fill these positions, it is evident that not one of the fifteen could reasonably expect more than the current rate. On the other hand, if there were only five available men, it is evident that some of this number would succeed in getting a higher rate, depending, of course, on their ability to sell what they have to offer—their labor.

When considering the wage question there is another fact that is often overlooked by the mechanic; that is, the close competition that exists between manufacturers whose products are identical. Let it be assumed that two concerns are engaged in the manufacture of machine tools—lathes, for instance. They both buy material in the open market at practically the same prices, the shop management is as efficient as possible, the selling methods are the same, and the combined output goes to the same market. In both cases the selling prices must be practically alike for tools of like design and purpose. It is a well known fact that labor is the most expensive factor in any industry; therefore one concern cannot pay more than the current rates for skilled mechanics and dividends to the stockholders at the same time.

In comparing machinists' wages with those paid other skilled workers, we must take equal conditions, considering carefully the amount of skill involved, the number of available working days per year, the personal risk encountered, and in some cases the physical strength required. A die-sinker receives high wages because his work calls for a combination of mechanical skill and artistic ability. A toolmaker is well paid, as it calls for more than ordinary skill, together with long practice, to work to close limits. An experimental hand, that is one who constructs initial machines from drawings without the aid of jigs, is well paid, as it takes more than ordinary ability to become proficient at this class of work. It is not logical to compare machinists' wages with the rates paid to those employed in the building trades, carpenters, masons, tile setters, structural steel workers, etc., because these trades do not give steady employment owing to inclement weather and off seasons. While the building trades are well paid, their members are seldom better off,

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year for year, than the machinist. Their only gain is too much leisure time. This is a serious setback from a financial point of view, as one always spends more than usual while unemployed, that is if one has it to spend. Structural steel workers are well paid because their work involves the daily risk of life and limb. Perhaps the highest paid skilled workers are the rollers employed in steel mills. They receive from $8 to $15 per day, depending on the material rolled. This work calls for unusual strength, great skill and a sure eye and hand—hence the high wages. In all the callings mentioned it would be comparatively easy to obtain workers at low rates if more than enough men possessing the necessary qualifications were constantly in the ranks of the unemployed. That high priced men find ready employment at the above-mentioned trades is due to the fact that they possess certain qualifications not found in the average person.

On the other hand, the machinist receives better compensation for the time and effort spent than many other skilled workers. As an illustration we can consider the furniture workers of Grand Rapids, Mich., or Evansville, Ind. These are two of the largest furniture manufacturing centers in the country. While the component parts of any piece of furniture have to be accurately machined, the work is of a semi-automatic nature. As it is routine work any man can become skilled in a short time, provided he possesses a certain amount of mechanical ability. For this reason the wages paid are comparatively low, as men who could become qualified and who would be willing to work for moderate wages can easily be obtained.

Coming back to the direct subject: How is the machinist to better his condition to the extent of increasing his compensation? There are many ways. For example, instead of being an ordinary hand on uninteresting routine work, why not be an expert all-around man? The work is interesting and the wages good. While the way to success is somewhat rocky, it has been traveled by many and the skill attained is sure to be recognized sooner or later. When a machinist has once earned the reputation of being a skilled and reliable workman, the fat pay envelope becomes a reality instead of a dream. There are three primary qualifications, good health, mechanical intuition and the love of adventure. It is an acknowledged fact that shop practice varies greatly, not only locally, but all over the country. For this reason, it is necessary for the man who desires to become an expert to follow the wanderlust for a period of years. This involves working on all sorts of machine work in many localities. The scene of activities often includes every large city in the country. The life is hard in many ways, calling for a cast-iron constitution. Days of misery are sure to be encountered; there will be times of sickness among total strangers, or what is worse, no money. It is well to mention these facts in passing; otherwise one might form the opinion that the life of the roving machinist is a bed of roses. It is worth while, however, as the experience gained by travel and association is invaluable. After a machinist has worked in thirty or forty shops he should be a good mechanic if it is in him to be one.

No system of training is without its drawbacks, and the schooling received by the wandering machinist is no exception. Often times the wanderlust is irresistible to one who has once answered it. This is especially true during the first balmy days of spring. The stay-at-home hears the same call, but he lacks the courage or initiative to answer it. The result of answering the call is that many mechanics never settle down. This is true of the minority only, for the roaming machinist is very like his stay-at-home brother in one respect; he cannot, or at least does not, resist the feminine charms. Thus he generally marries, and home ties eventually compel him to settle. He is careful where he settles, however, as experience has taught him to compare conditions and to form accurate decisions as to what constitutes fair treatment, wages, etc. His varied training has developed initiative. Therefore he knows how to proceed in selling his labor to the best advantage. Those who have been trained in the school of experience seldom try to stir up trouble when unfair shop conditions, real or fancied, are encountered. If dissatisfied they remedy the situation very simply by following the line of least resistance—they seek employment elsewhere.

It is sometimes argued that under present conditions a varied training is not necessary, that we are in an age of specialization, etc. Perhaps we are. Nevertheless the fact remains that men who have had the varied training on actual work invariably succeed in obtaining responsible positions at good wages. There are several kinds of varied training. The college trained mechanical engineer is one example. That he is college trained is due to the fact that his parents were financially able to not only support him, but pay expensive tuition fees during a period of his life when his earning power was absolutely nil. We respect the college man because he has had a varied training along theoretical lines. Thousands of dollars have been spent on his education. Why was this done? To fit him for his life work and to make him a useful member of society. The practically trained man is respected because he has shown ability to fight his own way, thus making possible a varied training. He has asked no favors of anyone. Not only has he made his success possible, but he has also been a producer the meanwhile. Who deserves the greater credit, the one who had the way paved for him, or the other who fought his own way?

It is sometimes claimed that the machinist's opportunities for betterment would be greater if his labor organization were stronger. If the test of time is of any value, it would appear that this theory is not well grounded. To be sure, card men are conspicuous in the Western and Southern states; indeed a non-union man finds it almost impossible to obtain employment in these sections. The South and West, however, contain comparatively few manufacturing centers. Taking the country as a whole, the majority of the employers of machinists run strictly open shops. If one happens to be a card man he is not molested. On the other hand, card men are not permitted to intimidate or cajole their fellow workers who are not organized. As a matter of fact non-union men often receive higher wages than those paid under the rates set by the union scale. Organized labor automatically adjusts itself to conditions; we do not have to consider it theoretically, as known results give us the base on which to frame our arguments and draw our conclusions. The wandering machinist is always a card man; necessity compels him to be. However, at the same time, he generally favors the open shop, whether he acknowledges it or not, as it is there that he receives the highest compensation.

Is the machinist better off, financially and otherwise, in the city or country? This question must be viewed from many points. That the city offers greater opportunities for employment cannot be denied. The cost of living in cities is, of course, greater, but to offset this wages are higher. Many live in the suburbs, traveling back and forth daily. This consumes time and incurs an extra expense, but it is argued that the advantages gained by living away from crowded districts outweigh the extra time and expense. If one is employed in a comparatively small town, the cost of living is much less than it is in the city. On the other hand, one is practically tied down, especially if he happens to be a property owner. Under these conditions the shop management is in a position to exercise a dictatorship even to the extent of controlling the political rights of the workman. In the small town the union does not set the rate—the shop management does. Thus one might be ever so skilled or efficient and yet find it impossible to obtain more than the fixed rate.

One reason for this, and a logical one, too, is that in a comparatively small town everybody is acquainted with their neighbors' affairs. Let it be assumed that Bill succeeded in getting an increase of twenty-five cents per day. Naturally he tells Mrs. Bill, for ten chances to one she would find it out anyway, and if he had not enlightened her at first there would be domestic warfare for the time being. Now Mrs. Bill is very much pleased. An extra $1.50 per week that was not looked for will go a long way. She may get a new hat, who knows? She cannot resist the feminine tendency for gossip to the extent of keeping Bill's good fortune to herself.

She tells Mrs. Jim and what is the result? Mrs. Jim, of course, tells Jim when he comes home to dinner. He gets peeved and thinks that he, too, deserves a raise. He may get it, and again he may not. However, it soon gets noised around that Bill has had his pay raised, and the first thing the management knows they are confronted with a general demand for more money. This could not happen in a city, for city people are master hands at attending to their own affairs; indeed they seldom know their next-door neighbors. In a small town, the shop management is shrewd enough to realize that the workman cannot, or at least does not, care to incur the expense of moving to another locality. Another reason why many hesitate to locate in country towns is that there is very little to offer in the way of recreation, aside from a moving picture show or two. All work and no play makes Jack a dull boy; therefore the machinist cannot be blamed for working in places that have at least the appearance of being lively.

After all is said, the machinist has as many opportunities as any other worker, if he will take steps to turn chances into success. No one can reasonably expect to succeed by waiting for fortunate chances—these have to be sought.

* * *

COOPERATION OF THE FACTORY MACHINE SHOP WITH THE TRADE SCHOOL*

BY JAMES F. JOHNSON†

In the present move toward supplying the demand for trained mechanics through trade education departments, it is timely to note the important part that can be played, and really should be played, by factories having trade apprentices. The apprenticeship system has about passed out of existence. Because of the general trend of manufacturing competition, every effort is brought to bear upon production and the idea of taking the time of a valuable producer to instruct young apprentices who are not producers of any great worth does not usually appeal to the manufacturer. Because of this state of affairs, the apprentice is obliged to learn his trade as well as he can. The result is inevitable, and surely cannot be considered valuable in building up the trade.

The opportunities offered by the trade school at Bridgeport, Conn., have brought about cooperation with the manufacturers that has proved an excellent way of dealing with this important problem. What has been done there should encourage other industrial centers to make an effort in this direction. In order that those young men who are at work daily might enjoy the benefits of a trade education, there was opened up in the trade school a department for those apprentices who are employed in the shops outside. These young men attend the school five hours per week, fifty weeks in the year, during the length of their apprenticeship in the factory, and are paid by the factory while they are at school.

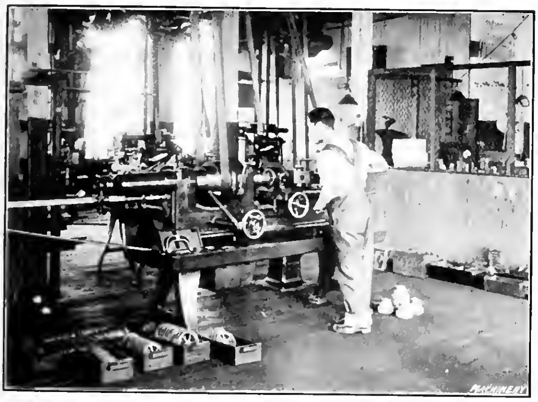

Fig. 1. An Apprentice learning to set up and operate a Hand Screw Machine

Instruction is given in those branches directly related to their trade but which cannot be given in the factory. The scheme is a praiseworthy one and those manufacturers cooperating in such a cause are to be complimented. The work as it is carried on for the machine apprentices is of most interest to the readers of MACHINERY and is here described. Fig. 1 shows an apprentice being instructed in screw machine operating, and Fig. 2 shows one of the ten divisions of machine apprentices coming from different shops. These are instructed in blueprint reading (the blueprints of the respective shops being used), shop drawing and shop mathematics. Besides this, a portion of each session is set aside for the reading of trade literature, or for shop talks. Little if any instruction is given in actual machine work, as their respective shops will furnish enough of that—but what is needed most and what the factories do not give is what is taught in the school. The work is in charge of a thorough tradesman who appreciates the needs of the machinist.

Fig. 2. A Class of Apprentices employed in Factories, who attend School One-half Day a Week

Each week this instructor visits the shops where these boys are employed and secures such information as may be of value to him in his work. The great value of this instruction to the coming tradesman is daily illustrated in the places where the boys are employed. It is not an unusual thing to see one of them and the assistant foreman or the foreman with their heads together talking over features of a design shown on a blueprint. When there is doubt about a calculation in the shop, the student-apprentice is consulted, or rather he is given the work to do.

The spirit of cooperation between the tradesman and the apprentice is growing. The old hand at the trade smiles at the youth and slaps him encouragingly on the back, and he is given his place among the workers, for he is becoming an intelligent mechanic. This training carried on for the length of his trade apprenticeship is sure to have a very desirable effect. Besides being a machinist, he knows the whys and wherefores of things and is a more valuable man to himself and to his employer. As a result there will be among the coming machinists a group of young intelligent workers who thoroughly understand their trade and its relation with allied trades, and realize their position in the manufacturing world. The effect of this is undeniably good. It means a better workman, a better product, increased production, and better working conditions.

* * *

A New Zealand correspondent writes that he considers it a serious mistake on the part of advertisers of American machine tools not to quote prices when advertising, and that the names of foreign agents or dealers handling their goods are seldom given. As a result the larger part of New Zealand business goes to English agents in New Zealand, much of which might be secured by American concerns if they displayed a little more enterprise in advertising, giving prices, the names of foreign representatives, and other specific information.

* For additional information on the subject of industrial education published in MACHINERY see also "Rational Methods in Engineering Education," March, 1914; "The Advantages of Manual Training Schools," March, 1914; "A Trade School Product," January, 1914, "Wood's Apprentice Industrial School," December, 1913; "A New Zealand School Workshop," November, 1913; "A Modern Apprenticeship System," June, 1913; "Development of Skilled Mechanics," June, 1913; "A School that Trains Boys for Shop Work," June, 1913, and other articles referred to in connection with the last mentioned article.

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MAKING CON-ECCENTRIC TAPS*

METHOD USED IN CUTTING RELIEF ON TAPS LEAVING PART OF THREAD CONCENTRIC

BY SERVER

I HAVE been particularly interested in reading the articles which have appeared in MACHINERY on machine relieved taps, and feeling that a brief discussion of the method of machining this relief would be of interest to others, I have prepared the following article. In conducting this operation, certain difficulties are met with in connection with "picking up the thread" preparatory to relieving the lands of the taps, and in connection with a description of the method of conducting this operation I propose to explain a few short-cuts which greatly simplify the work. A number of tap-makers seem to have recognized the con-eccentric relief for taps as most satisfactory, and apparently each of these manufacturers has been using this method secretly in the belief that his product was the only one embodying this valuable feature. Under the pressure of business competition, this fallacy has been exploded, thus meeting the fate of the majority of such business and trade secrets. The information given in this article applies particularly in cases where special or small lots of standard taps are put through. The methods described are in no sense representative of standard practice in the manufacture of taps on a commercial scale, as plants engaged in this line are equipped with more or less special machinery for cutting the threads. Machines used for this purpose are semi-automatic in operation, the operator being merely required to set the work up in the machine and to see that it operates properly.

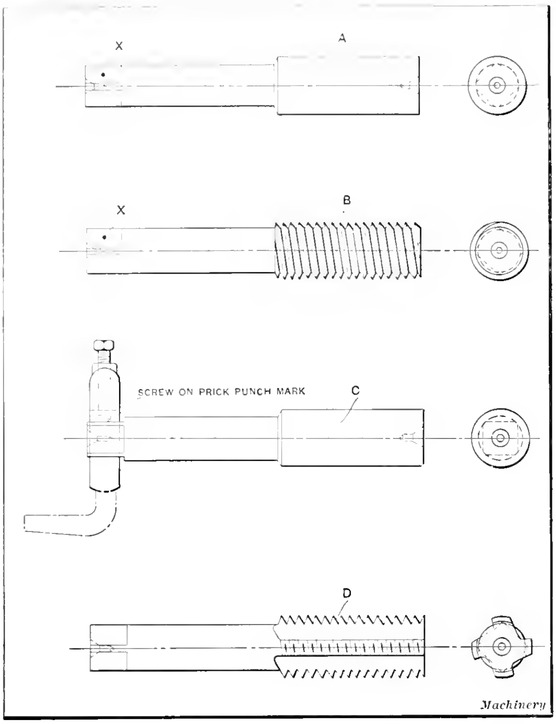
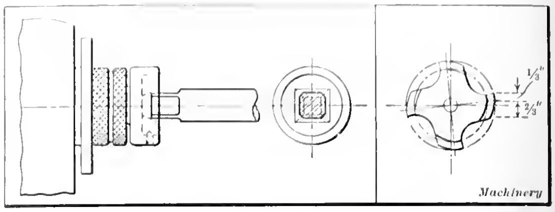


Fig. 1. Operations in Tap Making which precede cutting the Relief

Fig. 1 shows the preliminary operations involved in making a tap according to the methods which are outlined in the following. Previous to cutting the thread and relief, the taps are first machined to the form shown at *A*, with the square cut on the end of the shank. Before starting to cut the thread it is a wise precaution to place a prick-punch mark or other point of reference on one side of the square, as indicated at *X*. This mark comes under the screw of the dog, as shown at *C* in Fig. 1; and the reason for observing this precaution will be explained in a subsequent paragraph. Each tap is next placed in the lathe to have the thread cut in the usual way, no attention being paid to the matter of relief. After the threading operation has been performed on each of the taps, they are set up on the milling machine to have the flutes cut, which brings the work to the condition shown at *D*. In performing this operation care is taken to have the prick-punch mark previously referred to, in line with a suitable mark on the spindle of the indexing head, if a center similar to the one shown in Fig. 2 is used. In case the work is mounted on centers and driven by a dog, the screw of the dog is brought down on the side of the square having the index mark. The reason for always placing the dog on the square is the necessity of having the flutes on each tap in the same relation to the thread. If there are either four or eight flutes on the tap, however, it is unnecessary to follow this method as the relation of the flutes to the helix will be the same on each tap regardless of the position of the prick-punch mark. In any case, the reference mark would be placed on one side of the square, as it is used again in a subsequent operation.



Figs. 2 and 3. Centers used for the Fluting Operation and End View of Finished Tap showing Con-eccentric Relief

So far as their appearance goes, the taps are now finished. In order to make them cut more freely, however, it is the practice to make them with one-third of the land concentric and two-thirds eccentrically relieved. Fig. 3 shows an end view of one of these con-eccentric taps, from which the method of relief will be readily understood. To machine this relief, the taps are returned to a lathe fitted with a special relieving attachment connected to the cross-slide. The drive is obtained by gears and a shaft which actuates a cam that causes the cross-slide and threading tool to move in on each land to produce the eccentric relief, and then come out again ready to engage the next land. The general arrangement of the relieving attachment is shown in Fig. 5. In machining the relief, the cross-slide moves in the direction of the arrow, this movement being controlled by the cam on the driving shaft; the cross-slide is held in contact with

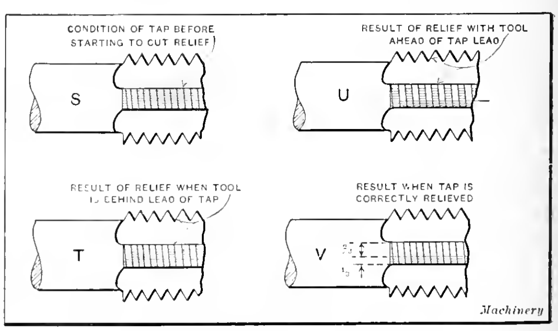


Fig. 4. Illustrations showing Various Conditions of Relief

* For additional information on the relief of taps, tap making and allied subjects published in MACHINERY, see also "Relief of Taps," January, 1914; "Relief of Taps," December, 1913; "Tap Fluting Cutters," March, 1913; "Special Shanks for Taps," February, 1913; "New Standard Dimensions for Taps," January, 1913; "Notes on the Early History of Tap Making," December, 1912; "Manufacture of Taps," January and February, 1909; "Testing the Lead of Taps and Screws," January, 1908; "Remarks on the Making of Hand Taps," June and July, 1907; "Formulas for Determining the Proportion of Taps," January, 1907; and "Proportions of Hand Taps in Sets," December, 1905.

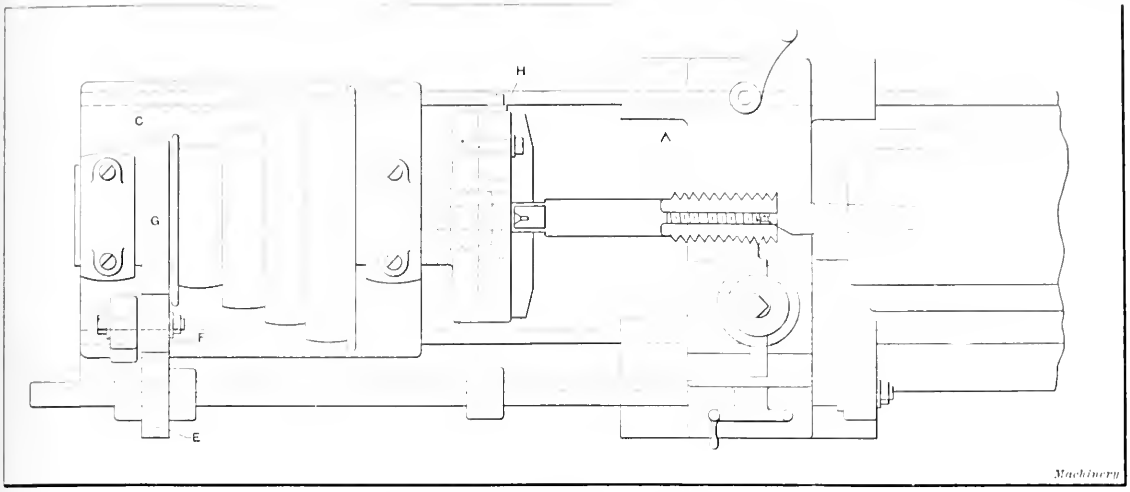


Fig. 5. Design of the Relieving Attachment for cutting Con-eccentric Relief

the cam and pulled back through the action of a counterweight. In some cases it is found advisable to substitute a spring in place of the counterweight. Power is transmitted to the driving shaft through the gears *E* and *F*, which, in turn, are driven from the gear *G* carried on the lathe spindle. The gear *E* is a change gear, different gears being substituted according to the number of lands on the tap. The relieving attachment is operated at a speed four times that of the lathe spindle in the case of taps with four lands to be machined, six times as fast if there are six lands, etc.

Before proceeding to machine the relief on the taps, they are taken to the hardening department and heated in a lead bath, after which they are allowed to cool gradually in the air. This leaves the surface a dark blue in color, as indicated by the shade lines in Fig. 4. When one of these colored taps is set up on the relieving lathe, the first thing to do is to have the reference mark on the square come under the screw of the two-jawed chuck *H* in Fig. 5. After screwing the tailstock center up to hold the work in place, tighten the chuck on the square end of the tap. This chuck is used in place of a driving dog in order to avoid lost motion which would cause the tap to "thump" when each land of the tap came in contact with the relieving tool. This would be disastrous to the tool and ruin the finish of the work. A detailed illustration of the special chuck used for holding the taps in the relieving lathe is shown in Fig. 6, where it will be seen that the jaws are operated by a single screw *J*. The jaws float in the slot *K* in order to eliminate any tendency to throw the tap off center, which might otherwise exist. It will be seen that the chuck is made in two parts *L* and *M* which are held together by two screws *N* which fit in elongated slots. The purpose of this construction will be explained in a subsequent paragraph.

With the tap set up on the lathe in the usual manner for threading, we proceed to pick up the thread. Particular care must be observed at this point, and the following outlines a little kink which facilitates the performance of this part of the work. A piece of white paper is placed on the cross-slide so that the space between the tap thread and the point of the threading tool can be clearly seen. In this way the operator knows just how far and in what direction the tool is out of lead with the tap. This will be better understood by referring to Fig. 7, where the amount that the tool is out of lead with the tap is shown by the space *O*, this space being clearly shown by the sheet of white paper *P* placed under the work. In order to get the tool into lead with the tap, the lever *Q* in Fig. 8 is thrown over to disengage the gears *R* that drive the screw-cutting attachment. The spindle is next turned and the gears re-engaged at another point which, in the operator's judgment, will give the correct lead. After allowing the lathe to turn through a few revolutions, the tool is once more tried with the thread to see if it engages properly with the lead of the tap, this procedure being repeated until the tap thread and tool match up as nearly as the eye can judge. A trial cut is then taken along the thread, and the manner in which the relief is being cut can be determined from the amount of colored surface that is removed. The result of this trial cut may produce either of the conditions illustrated in Fig. 4. In this illustration *S* shows the tap before starting to cut the relief, in which all of the color produced by treatment in the lead bath is still on the surface of the tap, this color being indicated by the shading. At *T* a tap is shown where the relief was cut with the travel of the tool behind the lead of the tap, this condition being indicated by one side of the thread having more of the coloring removed than the other. At *U* the tool is a little ahead of the lead of the tap, this being the reverse of the condition shown at *T*. Where the difference in lead is so slight that it can only be noticed by this method, it would not be possible to correct the error by throwing the gears out of mesh and re-engaging them at another point, as this is too coarse an adjustment. By tightening or loosening the tailstock center, however, the lead can be corrected very accurately, with the result that the tap is relieved correctly, as shown at *V* in Fig. 4. Referring to this illustration, it will be seen that the amount of coloring left on the surface of the tap and the amount removed are in the ratio of one-third to two-thirds, as they should be.

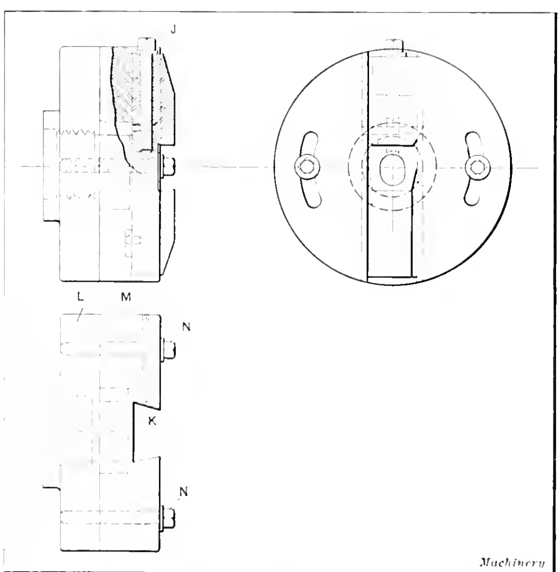
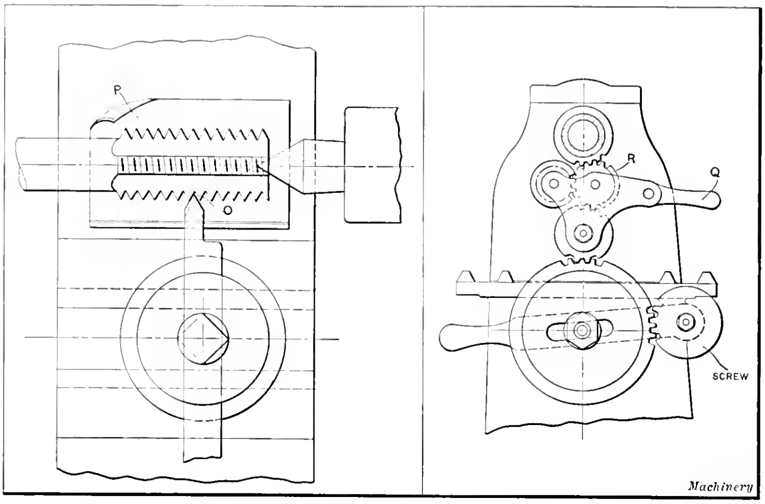


Fig. 6. Design of the Special Form of Chuck used

After the first tap of a given size has been set up and properly relieved, the remaining taps will come so near to being in lead with the tool that there is no need to bother with the method of throwing the gears out of mesh to obtain the proper position. Slight variations can be taken care of by manipulating the tailstock center as previously mentioned, and provided the prick-punch mark on the square was placed under the jaw with the screw in it, satisfactory results will be obtained. Should the lands or the helix of the thread vary greatly in their relation to the square with the prick-punch mark on it, this is evidence that the operator on one of the previous operations failed in properly locating the tap in the machine. This can sometimes be corrected by chucking on one of the other squares, if the error is in the fluting, or possibly the operator will have to disengage the gears in picking up the thread, in order to bring the tool into lead with the tap. It is necessary to start up the machine in order to take up any back-lash; then stop it and try the tool in the thread to see if everything is as it should be.

While this method holds good for V-threads, in machining taps with other types of threads, the tool will also be required to machine the top of the thread. Tools of this class for machining Acme and Whitworth threads are illustrated in Fig. 9. In connection with Fig. 6, it was mentioned that the chuck is made in two parts which are held together by screws fitting in elongated slots. The purpose of this construction is to enable the operator to move one part of the chuck independently of the spindle in order to bring the lands of the tap into correct relation with the cam of the relieving attachment. Although this may appear to be a somewhat complicated process, the operator will soon become proficient in following it. In fact, the method is much quicker than filing the relief, and as the equipment used is simple and does not interfere with the use of the lathe for other operations, there is a great advantage as compared with machines which can only be used for a single purpose. It must not be forgotten, however, that for making standard taps where it may be required to machine hundreds at a time, a special machine with cams of the required form, automatic feed for the cross-slide, and an automatic trip for operating the cross-slide —thus enabling the threading and relieving to be finished at the same time—will be far more economical. In using such machines, the flutes are milled last, so that care must be taken that they are milled in exactly the required place. This is provided for by using the reference mark placed on one of the squares on the tap shank.



Figs. 7 and 8. Method of "Picking up the Thread" and Arrangement of the Screw-cutting Gears

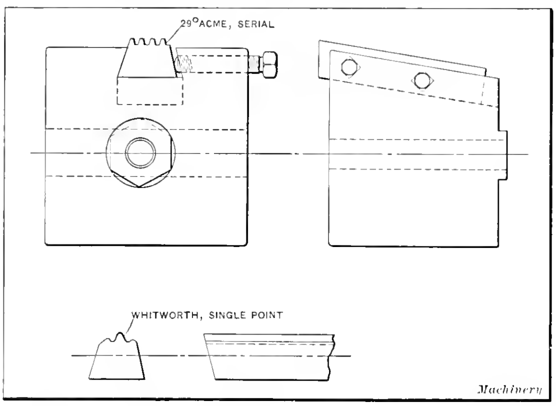


Fig. 9. Tools for relieving 29-degree Acme and Whitworth Threads

* * *

Remember there is always work for skilled hands.

STANDARDIZATION OF PIPE THREADS*

Pipe was first generally used in the latter part of the eighteenth century, when the invention of illuminating gas required some means to convey it from place to place. At about this time the long-continued war which had been in progress between France and England came to a close and a large quantity of gun barrel stock remained on the market. The first gas pipe was, therefore, made from gun barrels, and as these were made tapering, it was a simple matter to screw the small end of one into the large end of the next, thereby making a threaded socket joint. Thus, threads were used to connect pipe from the earliest time of its employment. There is no information as to what kinds of threads were used in the early days of gas pipe lines. The present standard for pipe threads in general use in the United States is named after Robert Briggs, who was active in gathering information regarding thread systems both in this country and in England. He had considerable engineering and manufacturing experience, and was for several years superintendent of the Pascal Iron Works, and later engineering editor of the *Journal of the Franklin Institute*. He did not originate the thread which bears his name, but standard gages for pipe threads were made under his supervision while he was with the Pascal Iron Works. These gages were used as master gages and were the standard employed by Messrs. Morris & Tasker, owners of the Pascal Iron Works, since they started the making of pipe about 1830. This firm was the first large manufacturer of pipe in the United States.

The cutting of taper threads on pipe or bolts was first accomplished in the lathe. The first record we have of a taper thread that could be cut by dies is in the invention of P. W. Gates, Jr., who, in 1847, patented a taper die. The adoption of taper dies soon became general, and the Crane Co., of Chicago, then known as the Northwestern Mfg. Co., as early as in 1866 listed taper taps and dies in sizes up to three inches.

However, few manufacturers adhered closely to the Briggs standard until 1885. At that time a committee was appointed by the American Society of Mechanical Engineers to confer with the manufacturers of pipe dies and fittings, with a view of bringing about and maintaining a uniformity in pipe threads by the use of gages which should definitely represent whatever standard was adopted. This committee issued circular letters to various manufacturers of pipe, boiler tubes and fittings, and in due time each manufacturer of pipe fittings or dies sent to the Pratt & Whitney Co., Hartford, Conn., a sample piece of pipe of each size, 6 inches and

* Abstract from an article by A. M. Houser and C. A. Olson of the Crane Co., Chicago, in the "Valve World."

smaller, threaded on one end according to their own standard. These samples were tested by the Pratt & Whitney Co. with Briggs standard gages, and a report was made to each manufacturer as to the state of his gages compared with the Briggs standard. In examining these samples certain variations from the Briggs standard were found to exist, but they were not great enough to warrant any departure from the Briggs gages, and it was, therefore, decided that the Briggs gages should be recognized as standard. This gave a standard for male threads for pipes or fittings, but no standard was adopted for female threads, and it has been the practice of manufacturers to tap female fittings so as to allow a certain number of turns of the male standard plug gage before binding. The number of threads "turn" adopted by various manufacturers varied somewhat. Because of this difference, therefore, a definite standard for ring pipe gages has now also been adopted. (Details of this standard were given in the May number of MACHINERY.)

* * *

BLANKING DIES FOR PUNCHING SAW-TOOTH SECTIONS

It is a recognized fact among diemakers that punchings with extremely sharp corners or points of a very acute angle are hard to produce, the difficulty being in the upkeep of the punch and die. The Nelson Tool Co. of New York City was recently called upon to make a punch and die for the piece of work illustrated in Fig. 2. This is a saw tooth section that is riveted on the edge of a cotton gin wheel. It was formerly the practice to make these cotton gin saws solid,

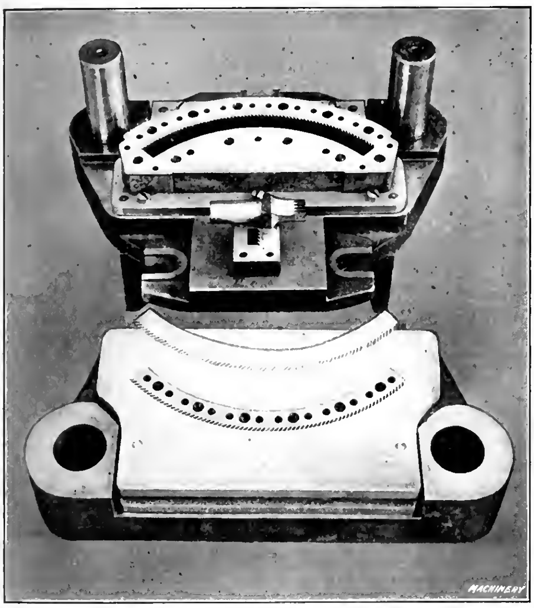


Fig. 1. Punch and Die and Trial Tools for making Blank in Fig. 2

indexing and cutting the teeth on a machine similar to a gear cutter. But as the teeth wore out rapidly it was found very expensive to keep replacing the saws, and so it was decided to make a punched segment that could be placed around the rim of a saw blank. The sheet steel, 0.017 inch thick, is a high carbon steel, capable of being hardened.

Before attempting to make the punch and die proper, a punch and die covering a small section was first made; this may be seen between the large punch and die in Fig. 1. The object of making this trial die was to punch enough of the steel to see how the points would stand up and thus determine whether it was practical to make the die or not. After 15,000 blanks had been run off on the small trial punch and die, and the corners of both punch and die had stood up in good shape, it was decided to make the die. Referring now to the punch and die shown in Fig. 1, the most difficult part is, of course, the making of the sections of the punch and die in which the teeth appear. It will be seen that these parts are composed of six sections, each of which is located by means of two dowel-pins and a screw. The sections may be followed by observing the groups of three holes, of which there are six on each of the curved tooth sections.

Observing carefully the shape of the teeth in Fig. 2, it will be seen that they are not straight but curved. This, of course, would render the shaping of the teeth by filing a very difficult job; therefore, the teeth in both punch and die were formed by milling. The teeth are spaced at a pitch

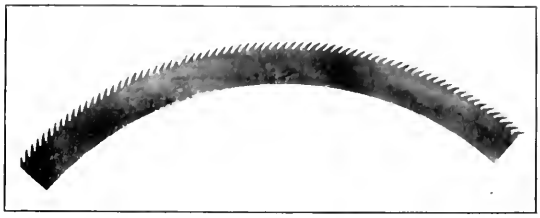


Fig. 2. Toothed Blank made in Punch and Die shown in Fig. 1

that would give 288 teeth in a complete revolution; therefore, the first thing to be done was to provide a means for indexing 1/288 of a revolution for each tooth. Fig. 3 shows how the blocks were mounted by dowel-pins on a master block, which, in turn, was clamped to the circular attachment of a Brown & Sharpe milling machine. The blocks were positioned with reference to a central arbor which may be seen in the foreground of this illustration, and the tooth section was therefore located at the proper radius from the arbor. Next, the collar on the rotating screw of the circular table was graduated with twenty-four divisions. As each revolution of the rotating screw turns the table one degree, it was necessary to move the rotating handle through thirty of the graduated lines or one and one-quarter revolution to get 1/288 part of the circumference.

A special cutter-base was made in which inserted teeth were placed, and while in place they were turned to the proper shape to cut the tooth shape in the punch or die section, as the case may be. Each of these sections was slightly relieved on the cutting edge for a distance of about $\frac{1}{2}$ inch; this left the remaining $\frac{5}{8}$ inch for the wearing life of the die. The sections were not mounted directly on the subpress parts, but on separate plates that were removable to facilitate grinding. The main reason for making the die in sections was, of course, to obviate the shrinkage and distortion that might occur in hardening. Fitting the punch and die was particularly difficult because of the delicacy of the tooth outline. When the die was completed it fitted so well that thin paper was cut without leaving any burr. C. L. L.

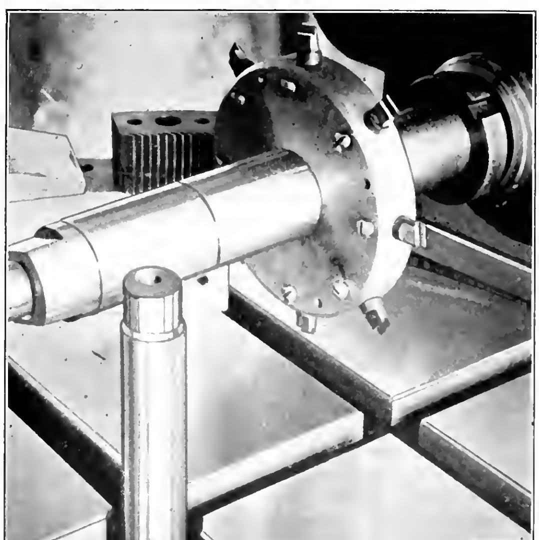


Fig. 3. How the Toothed Sections were formed

STATE LAWS ON ACCIDENT PREVENTION

SAFETY DEVICES AND CONDITIONS OF OPERATION REQUIRED BY LAW

BY MANCIUS S. HUTTON*

It has only been within the last five years that a factory owner or company about to purchase a machine has taken the time and trouble to look at the danger points and see whether or not they are properly safeguarded before deciding upon what make to buy. This change of attitude upon the part of the purchaser has been brought about through the passage of the workmen's compensation laws and the state factory investigations, resulting in the passage of more exacting laws in regard to the requirements of safety devices that must be provided in factories, work shops and mercantile establishments in the different states. If the manufacturer should not furnish an adequate guard which will meet the requirements of either the state or insurance company's inspectors, he may be asked to make the necessary changes in his shop before shipping, or the purchaser may have to provide the guards after receiving the machine. In either case there will be a delay before the machine can become productive. The cost in placing the guards on the machine after it has been assembled will in all probability be more than if they were put on while being built. At the present time, a machine will be given greater preference from the purchaser if it can be shown that it amply protects the workman against injury and will meet every requirement of the state labor-law enforcing body and the insurance companies.

The American Bridge Co. has the following words stamped on every letter sent out by their purchasing agent in pursuit of material or machines: "Provisions for safeguarding workmen should be brought to our attention, as we will consider them in selecting new machinery and equipment." Another company having its factory in New York State has the following note made a part of each order and contract: "This order for machinery is accepted with the understanding that it will in all requirements absolutely comply in every particular with the New York state laws as laid down for the preservation of life and limb, and of machine operators, or any persons whose duties may call them around the machine, as such laws may be interpreted by the New York state inspector. Unless the machine is received in this condition, we reserve the right to return it at once without notification, charging the transportation charges to the maker, or to make such changes as may be necessary to make it satisfactory to the New York state inspector, and take the same from the price formerly agreed upon." Other companies have given notice to the manufacturers that safety is one of the most important things that will be considered when purchasing new machines.

One of the crying needs of today is uniformity of practice in the matter of safeguards, *i. e.*, what is to be guarded and how. On account of the varying conditions to be met in the different shops throughout the country, those who are in the factory inspection departments say that it is impossible to draw up a definite set of rules which can be applied to all conditions. Some of the large companies and railroads which have a large number of plants situated in the different states have, however, decided upon a certain standard of safety which is used in all their factories.

Out of the forty-eight states in the union the following eighteen have no laws concerning safeguarding machinery: Alabama, Arizona, North and South Carolina, North and South Dakota, Delaware, Florida, Georgia, Idaho, Kentucky, Mississippi, Montana, Nevada, New Mexico, Texas, Utah and Wyoming. In Louisiana, Maine and Maryland there are only laws regarding sanitation in factories. Again in Arkansas, Missouri, and New Hampshire the laws are not of the kind that either the manufacturer or the purchaser is interested in. This leaves the following twenty-four states which have laws of interest to the readers of this journal: California, Colorado, Connecticut, Illinois, Indiana, Iowa, Kansas, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Vermont, Virginia, West Virginia, Washington and Wisconsin. Undoubtedly before very long the twenty-four states which have been backward in protecting their industrial workers will step to the front and become the leaders in the safety movement.

A glance at this list of twenty-four states reveals the fact that practically all of them are either agricultural or mining states and that with the exception of four these states do not have more than 100,000 industrial workers. In nearly all of the large mining states such as Arizona, Pennsylvania and West Virginia there are laws for the protection of miners which are not included in this article. These laws are enforced by a different set of inspectors who are usually expert miners.

When the states labor laws were first framed the question of whether a guard was to be placed over a certain machine or a part of a machine was left entirely to the judgment of the commissioner of labor or his assistants. The wordings of the laws have changed in this respect in a number of states latterly by making it mandatory upon the owner or person in charge of a factory to provide safeguards upon the machines or machinery mentioned in the laws. Machines may sometimes be so placed in the shop that no known guard could be used, in which case the law says that a guard must be used "if practicable." A list of the states which still leave to the discretion of the inspectors the question of safeguarding a machine or machinery are the following: Indiana, Michigan, Rhode Island, Tennessee and Vermont.

In an examination of these laws it will be found that a large number of them were written before the advent of the safety movement and have not been changed since that time. They merely mention the names of some of the machines and machinery or part of it that must be guarded, giving very little information as to how or how much of it must be guarded, this being left to the owner and inspector to decide.

The laws in the twenty-four states which are of interest to both the manufacturer and the purchaser can be divided into three groups which, again, can be subdivided. The groups are: 1. transmission machinery; 2. productive machines; and 3. hygiene and sanitation.

TRANSMISSION MACHINERY

Mechanical

1. *Belt Shifters.*—"Belt shifters or other mechanical contrivance for the purpose of throwing on or off belts or pulleys while running." This expression is found at present in the laws of the following fifteen states: Colorado, Indiana, Iowa, Kansas, Michigan, Minnesota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Washington, and Virginia. In Wisconsin the industrial commission has made the following rulings: All loose pulleys must be furnished with a permanent belt shifter, so located as to be within easy reach of the operator. All belt shifters must be so constructed as to make it impossible for the belt to creep and must be equipped with a lock or some other efficient device which will prevent the shifter from being accidentally shifted. Illinois also mentions the fact that the belt shifter must be placed within easy reach of the operator.

2. *Loose Pulleys.*—"Wherever practical all machinery shall be provided with loose pulleys." In Illinois it is only on machines which are required to be started and stopped frequently that loose pulleys must be used. In place of the loose pulley a clutch or other disengaging device can be provided. In Wisconsin the loose pulley or clutch is required on all machines that are not individually motor driven. The number of states requiring loose pulleys is eleven. They are the same as those that require belt shifters, with the exception of Colorado, Iowa, Nebraska, Ohio, Oklahoma, Oregon and Washington.

Drums.—"Drums,—etc., shall be guarded." The word drum appears in the text of the laws of nine states, namely:

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Connecticut, Illinois, Massachusetts, Minnesota, New Jersey, Rhode Island, Tennessee, Vermont and West Virginia.

3. *Belting, Shafting and Gearing.*—"All cogs, gearing, belting, shafting and machinery of every description shall be properly guarded." This is practically the wording in the text of the laws of twenty-one states with the exception of New York and Wisconsin which are given below. The names of these states are the same as those given under belt shifters with the addition of Connecticut, Massachusetts, Rhode Island, Tennessee and Vermont. According to the New York law all belting and revolving shafting within seven feet of the floors must be protected on its exposed surface by being encased so as to effectively prevent any part of the body, hair or clothing of all persons from coming in contact with such belting or shafting. The wording of the rules in Wisconsin are as follows: "All belts, ropes or chain driving machinery or shafting exposed to contact, except those which are so small or those which move so slowly that there is no possibility of danger, must be guarded. In all cases the point where the belt, rope or chain runs onto the pulley, sheave or sprocket must be guarded. All horizontal belts, ropes or chains driving machinery or shafting seven feet or less from the floor, where exposed to contact, must be guarded. Note:—In guarding overhead belts or rope drives, unless so guarded that persons cannot pass under them, the width of the guard should not be less than the width of the belt or rope drive and the length should not be less than the distance between the outer faces of the two pulleys. It should cover the outer faces of the two pulleys or sheaves and extend upward to such a point and be attached in such a way that in case the belt breaks it will withstand the whipping force of the belt." "All gears where exposed to contact must be entirely enclosed or equipped with a flange guard which must enclose the teeth of the gears. All arm or spoke gears and all web gears with holes in the web, which are over eighteen inches in diameter, where exposed to contact, must be entirely enclosed." "All transmission shafting in work-rooms or in passageways leading to work-rooms and located less than six and one-half feet from the floor, where exposed to contact, must be guarded." Besides Wisconsin, Minnesota mentions rope and chain drives as requiring to be protected in the state.

4. *Pulleys, Clutches, Friction Drives and Sprockets.*—These are only mentioned in Wisconsin, where the rules say that pulleys near the shaft hanger must be provided with a guard placed adjacent to the pulley to prevent the belt from leaving the pulley and also that all pulleys over eighteen inches in diameter, which are exposed to contact, must be guarded. Again, all clutches and sprockets must be guarded especially when exposed to contact. The contact faces of all arm or spoke friction drives and all web friction drives with holes in the web, when over eighteen inches in diameter and exposed to contact must be entirely enclosed.

5. *Flywheels.*—"All vats, pans, saws, gearing, shafting, flywheels, etc., and machinery of every description shall be guarded." This is the wording in the states of Illinois, Minnesota, Ohio and Pennsylvania. In Wisconsin the rules state that all sections of flywheels, with spokes, which are six feet or less from the floor and which are exposed to contact must be guarded. Flywheels which run in pits must be provided with toe boards around the pit. The guard around the flywheel of an engine located in the engine room may be in the form of a railing. This railing must not be less than thirty inches in height and must be constructed of two rails, the bottom one being not less than eighteen inches from the floor.

6. *Conveyors.*—These are merely mentioned as requiring to be safeguarded in the states of Colorado and Washington.

7. *Mechanical Stop for Machines.*—A loose pulley, clutch or other adequate device must be placed within easy reach of the machine operator in the states of Nebraska and Wisconsin so that any machine can be stopped instantly. In New Jersey the law calls for friction clutches to be provided in order to stop machinery. In Illinois where the machines are direct-connected to the prime mover, where arranged in groups and power supplied by the prime mover located in the confines of such group, or where arranged in groups with prime mover located without the group, the power being received through a main shaft or lineshaft; a switch, throttle or other power controlling device shall be furnished and placed within easy reach of the operators affected, so that all shafting, transmission machinery and machines of such group can be simultaneously shut down in case of need or accident.

Electrical

The guarding of the electrical transmission wires in a factory or work-shop is mentioned in the laws of Illinois and Minnesota.

PRODUCTIVE MACHINES OR MACHINERY

Before taking up the individual machines as a whole it will be advisable to refer to certain parts which need to be protected.

1. *Set-screws, Keys and Bolts.*—These are mentioned as in need of protection in seventeen states, of which fourteen casually mention them in the same class as belting. These states are the same as those given under belt shifters with the exception of Minnesota, Oregon and West Virginia. In New York and Ohio the law states that all set-screws, keys, bolts and all parts projecting beyond the surface of the revolving shaft shall be countersunk or provided with a suitable covering. In Wisconsin the meaning is the same as regards set-screws as in the New York law but the wording is different. As regards keys and keyseats, the latter state says that all projecting keys or keyseats, where exposed to contact, must be guarded. An exception is made with keyseats on machines which are impossible to guard or fill without interfering with the operation, or where they are in shafts that are so small or run so slowly that there is no danger.

2. *The Shuttle of a Loom.*—In Illinois and Massachusetts a guard must be placed to prevent the shuttle from flying out at each end of its travel. Massachusetts also forbids the use of a shuttle which requires the operator to use his mouth or lip to thread it. This is a hygienic precaution rather than a safety regulation.

3. *Counterweights and Balance Gears.*—The covering or fencing in of these is required in Minnesota.

4. *Line Rollers.*—The need of some kind of protection for the employes working around line rollers is mentioned in the laws of Colorado, Illinois, Nebraska, Oregon and Washington.

5. *Ovens, Furnaces, Forges and Tables.*—Why Illinois should mention these as especially requiring a guard is not very clear, but such is the case.

6. *Woodworking Machinery.* In Illinois saws, planers, shapers and sandpapering machines, in Ohio saws, planers and shapers, while in Wisconsin saws, planers, shapers and stickers must be guarded. The other states which require saw and planer guards are Colorado, Indiana, Iowa, Kansas, Michigan, Nebraska, New Jersey, New York, Oklahoma, Oregon, Pennsylvania, Vermont, Virginia, and Washington. Trimmers are required to be guarded in Colorado and Washington. In practically all the states, with the exception of Wisconsin, these machines are mentioned in the same sentence as belting, gearing, vats and pans. In Wisconsin the rules of the industrial commission are that all hand jointers or planers must be equipped with a safety cylinder head and have a guard placed over the knives. Also that all band saws, both the upper and lower wheels and the saw itself, except that part below the saw guide, must be covered. Circular saws, besides being guarded, must be provided with a splitter. In general, all knife heads, wood shapers, stickers, planers, when exposed to contact, must be guarded. West Virginia alludes to a corner machine as one on which a safety device must be placed.

7. *Laundry Machinery.*—All laundry machines in Illinois are considered dangerous and therefore will be required to be safeguarded. Besides Illinois, mangles are required to be protected in Colorado and Washington.

8. *Hydro-extractors.*—A screen must be placed over hydro-extractors in Illinois, Nebraska and New York.

9. *Power and Foot Presses.*—This class of machines causes, next to the saws and planers, the greatest number of accidents, yet it is only given in the law of one state—New Jersey.

10. *Paper Machines.*—An inspector knows from experience that certain machines to be found in paper mills should be fully protected, yet it is a fact that Illinois is the only state to mention this class of machines.

11. *Corn Shredders.* Corn shredders or husking machines are not allowed to be sold or offered for sale in Minnesota and Wisconsin unless provided with reasonable safety devices to protect the operator from accidents from the snapping and husking rollers, and these guards must be so designed as to compel the operator to stand a safe distance from the rollers while feeding the machine.

12. *Electrical Apparatus and Appliances.*—All dynamos, motors, switches, fuses, etc., must be guarded in Illinois and Minnesota.

13. "*Machinery of Every Description.*"—This phrase is to be found in sixteen of the state laws. It simply means that dangerous machines or machinery which are not definitely stated in the law can be required to be guarded if the inspector considers it desirable to do so in order to prevent accidents. In certain states such as Minnesota, the following sentence is to be found: "All dangerous parts of machinery ———— shall be fenced, boxed or otherwise protected." While the wording is different, the meaning is exactly the same as the above.

HYGIENE AND SANITATION

Dust-Creating Machinery

1. *Grinding and Buffing Machines.*—"Exhaust fans of sufficient power shall be provided for the purpose of carrying off dust from emery wheels and grindstones and dust-creating machinery from establishments where used." This is the wording in the states of Indiana and Minnesota. The meaning of the law in Iowa is the same as that expressed above with the addition that the exhaust system must be carried outside the building or to some receptacle placed so as to receive the dust. In Connecticut an exhaust system must be installed in any process which generates an excessive amount of dust. In this state tripoli, rouge and corundum wheels are mentioned besides emery. The Colorado and Washington law is very similar to that of Connecticut. In Wisconsin the dust-creating machinery must be equipped with either an exhaust or water system which will remove all particles of dust that are light enough to float in the air. In New York the exhaust fan which operates the exhaust system must be of sufficient capacity and power and must be kept running constantly while the machines are in use. In Massachusetts, Michigan, New Jersey, Ohio and Pennsylvania emery belts of either leather, leather covered, felt, canvas, paper, cotton, or wheels or belts rolled or coated with emery or corundum, or cotton wheels used as buffs besides the solid emery wheels, shall be provided with an exhaust or blowers placed over, beside or under the wheels or belts, arranged in such a manner as to carry off the dust arising from or thrown off the same while in operation. Massachusetts also has a law requiring an exhaust system on this class of machines. The laws of Connecticut, Indiana, Iowa, New York, Minnesota, Washington and Wisconsin require exhaust systems or other efficient dust-removing means on all dust-creating machinery. There are a number of cases in which grinding wheels are exempt from these requirements in certain of the states. These exemptions are as follows:

a. Grinding machinery upon which water is used at the point of grinding contact.

b. Small emery wheels which are used temporarily for tool grinding.

c. Solid emery wheels used in woodworking establishments.

d. Wheels or belts which are not used continuously more than three hours in the twenty-four.

e. Small shops employing not more than one man at work upon an emery wheel.

f. Emery wheels which are in general use by all employes, in common, for touching up tools or castings or for sharpening saws.

g. Emery wheels six inches or less in diameter used in establishments where the principal business is not emery wheel grinding. The exemption under *a* is found in the states of Iowa, Massachusetts, New Jersey, New York, Ohio and Pennsylvania; *b* in Iowa, Massachusetts, New Jersey; *c* in New York; *d* in Pennsylvania; *e* in Ohio; *f* in Wisconsin; and *g* in Massachusetts. In the laws of Michigan, New Jersey, Ohio and Washington, the material of which the hood or hopper of the wheel is made, the size of the exhaust pipe and the capacity and power of the exhaust fan are laid down definitely; while in New York the same data has been collected and published by the State Department of Labor in book form. In Massachusetts, New York and New Jersey the plans of an exhaust installation must be submitted to the proper state department for approval before commencing work.

2. *Tumbling Barrels or Rattlers.*—These are mentioned specifically in Iowa and Wisconsin.

3. *Flint Grinding.*—The flint grinding mills of Maryland are required to be equipped with an exhaust system to carry the flint dust away from the place where the men have to work.

4. *Hair Picking Machines.*—In the upholstering or mattress establishments or other factories in Michigan where hair, moss, tow or cotton is used for filling, the hair picking machines shall be placed in such a position as to carry away the dust thrown off by the machines while in operation directly to the outside of the building or to some other receptacle established to receive and confine the dust.

5. *Industries or Processes in which Lead is used.*—In order to prevent lead poisoning the laws of Ohio and Pennsylvania require that the crushing, mixing, shifting, grinding and packing of all the lead salts or other compounds shall be so conducted as to keep the air in the work-room in which the process is carried on free from the dry lead dust. This is done by requiring all hoppers, chutes, conveyors, elevators, vents from separators, dumps, pulverizers, chasers, dry pans or other apparatus for drying pulp lead, dry pan dumps and all barrel packers and cars or other receptacles into which corrosives are emptied to be connected with a dust collecting system. Also all vessels or containers in which dry lead in any chemical form is being conveyed from one place to another within the factory shall be equipped at the places where the same are filled or discharged with hoods having connection with an air-exhaust. Such exhaust system should be regulated by the discharge of air from a fan, either through a cloth dust-collector having an area of not less than one-half square foot of cloth to every cubic foot of air passing through it per minute, the dust collector to be placed in a separate room which no employe shall be required or allowed to enter except for essential repairs while the works are in operation, or by any other apparatus which will efficiently remove the lead dust from the air before it is discharged into the outer air.

Machines and Processes Giving Off Fumes

1. *Vats and Pans.*—"Shall provide and maintain in use reasonable safeguards for all vats, pans, etc." This is practically the wording in Colorado, Indiana, Kansas, Michigan, Minnesota, New Jersey, Oklahoma, Pennsylvania, Vermont, Virginia, Washington and Wisconsin. The words "giving off fumes or vapors which are irritating, obnoxious or injurious to the health" are added in the Wisconsin rules, while the words "containing molten metal or hot or corrosive fluids" have been added to the Colorado law in Illinois, Maine, Rhode Island and Tennessee. In New York every vat or pan which is so located that the top is on a lower level than the operator's elbow shall be protected with a cover which shall be maintained over the same while in use in such a manner as to prevent the operator or other persons falling in or coming in contact with their contents. Should it be necessary to remove the cover from the vat or pan while it is in use it shall be protected by a railing placed around the same.

2. *Linotype and Type Casting Machines.*—In Louisiana every newspaper or printing concern using three or more linotypes or other type casting machines is required to install an exhaust fan or other device sufficient to keep pure air circulating and to expel the fumes. They must also install a vent pipe on each machine running from the metal pot to a flue or other aperture. Iowa has the same provision.

3. *Industries or Processes in which Lead is used.* The two states that require exhaust systems to carry off the lead dust also require that the lead fumes be carried out of the room in which the employes work.

General Ventilation and Sanitation

In several of the states such as Connecticut, Colorado, Massachusetts, Maine, Oregon, Rhode Island, Tennessee and Vermont the state inspector can order changes to be made in a factory should he consider either the heating, lighting, ventilation or sanitary conditions to be injurious to the health of the workmen. Under this general clause a commissioner of labor or his inspectors in these states can order an employer to install a vacuum system on all dust-creating machinery and a vent for receptacles containing molten metal or hot liquids which give off obnoxious fumes.

In what has preceded no mention has been made concerning what was required in the way of safeguarding the employes in the state of California. The reason for this is that on the first of this year the inspection of factories and the issuing of rules in regard to protection became a part of the duties of the industrial accident commission which was created in 1911 to handle the operation of the workmen's compensation law. The commission has not, as yet, made rules for the guidance of the employers of the state and its own inspectors. There is no doubt but that this state will place itself in the very forefront of the safety movement. The commission is given very liberal powers and the new law expressly states in Section 52 that "every employer shall furnish employment which shall be safe for the employes therein and shall furnish a place of employment which shall be safe for employes therein and shall furnish and use such safety devices and safeguards and shall adopt and use such practices, means, methods, to render such employment and place of employment safe and shall do every other thing reasonably necessary to protect the life and safety of such employes."

According to the secretary of state of North Carolina there is a common law in that state which requires that employers shall furnish reasonably safe appliances for their employes. But it can be seen that this law would become a dead letter in this state, as the commissioner and his deputy are not required to examine industrial plants except those against which a complaint has been lodged. The only qualifications that the commissioner has to have is that he be a practical printer.

Section 5 of the safety law of the state of Minnesota requires that "whenever practicable the point of danger in any machine or mechanism shall be securely guarded by the maker and the manufacture or sale of any machine or mechanism not so guarded is hereby prohibited." At the present time this is the only state which is prohibiting the manufacture and sale of unguarded machinery.

The industrial commission of Wisconsin has determined upon the following standards regarding safeguards:

1. No safeguard required which cannot be proved to be practical.
2. No safeguard required which the commission cannot show how to install.
3. Homemade safeguards which as far as possible can be constructed and installed cheaply in the shop.

As a part of the safety laws in Colorado, Indiana, Minnesota, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Virginia, West Virginia and Wisconsin, it is stipulated that should a machine or any part of it be found in a dangerous condition or not properly guarded the commissioner of labor or one of his inspectors may prohibit the use of the machine until the same has been made safe. He is required to attach a notice to the machine while it is in the unsafe condition calling attention to the same.

In Illinois, Indiana, Minnesota, New Jersey, New York, Pennsylvania and Virginia no person is allowed to remove or make ineffective any safeguard while working at the guarded machine except for making immediate repair, and after being repaired it should be promptly replaced.

The interpretating and enforcing of the labor laws is done through a state department or commission consisting of a chief inspector and a number of assistants. The inspectors have the right of entry into a factory of the state during regular working hours as often as they may consider it necessary for the purpose of inspection. The salary paid the state factory inspector in most of the states is never higher than $2000 and in most cases is in the neighborhood of $1200 to $1500 a year. The chief inspector or commissioner of labor receives a salary varying from $1800 to $8000

In twenty-eight states the inspectors are not required to pass a civil service examination nor is any practical experience or technical training required of them, while in five states that have no civil service requirement the inspectors are required to have some practical experience. In nine states the inspectors must pass a civil service examination before being appointed.

In three states—California, Ohio and Wisconsin—the state factory inspection department has been absorbed by the industrial commission which now has charge of the inspection of factories as well as the administration of the workmen's compensation law.

In New York and Pennsylvania there has been created an industrial board consisting of the commissioner of labor and four associates. In Massachusetts the state board of labor and industries and the industrial accident board, sitting jointly, act in the same capacity as an industrial board. They have the power to obtain the services of experts upon their committees. These persons serve without pay. The board in each of these states has the power to draw up rules and regulations regarding the installation, position, operation and use of machines and machinery, the furnishing and use of safety devices and appliances for machines and of guards to be worn upon the person and other cognate matters, whenever it finds such regulations necessary in order to provide for the prevention of accidents in factories. These rules and regulations after a public hearing become the same as law. All meetings of the board are open to the public. The industrial commissions spoken of above have also the same power as regards the making of rules which eventually become laws. Besides the making of laws, they have the right to make exceptions to existing laws where they see that the letting down of the bars will not increase the number of accidents.

* * *

INCREASING THE EFFICIENCY OF THE CUTTING TORCH

Experiments recently conducted in cutting with oxy-hydrogen and oxy-acetylene cutting torches show that a marked increase in the rate of production is effected by increasing the temperature of the oxygen. The most favorable results secured in this connection show that the increase of speed obtained by preheating the oxgyen is 18 per cent, while the saving in the amount of oxygen used was 55 per cent. As an increase in temperature means a corresponding increase in the pressure of the oxygen, it seemed possible that merely increasing the pressure would have the same effect. Experiments along this line proved that this reasoning was correct. Where the pressure was steadily increased, it was found that the rate of cutting increased in direct proportion. It was found, however, that the higher pressures had a tendency to round the upper edge of the cut. A pressure of 35.5 pounds per square inch seems to be about the maximum amount with which perfect work could be produced. With very low pressures, the rate of cutting was not only very slow, but the cut itself was defective. Experiments were also tried in changing the ratio of hydrogen to oxygen, and it was found that where this ratio was 15 to 4 instead of the customary 4 to 1, the rate of cutting was exceptionally high in cases where the pressure of the oxygen was about the maximum of 35.5 pounds per square inch.

* * *

Careful measurements were made during the past year by means of which it was determined that the soot fall in Pittsburg ranges from 595 to 1950 tons per square mile per year. London has been considered one of the "gloomiest" cities in the world, yet the soot fall in London is only 426 tons per square mile per year.

CRANKSHAFT GRINDING*

PRACTICE OF THE REO MOTOR CAR CO.

BY ROSS HOLMES†

THERE is in existence a great deal of valuable data relative to feeds, speeds and depths of cut for the best modern lathe practice. Knowing the depth of cut, it is possible to determine the best relation of speed and feed, by reference to this data which has been collected in the form of charts and tables. In attempting to do the same thing in connection with grinding methods, I was unable to find any information on the subject. Work of that kind had been arranged by cut-and-try methods, the production being recorded

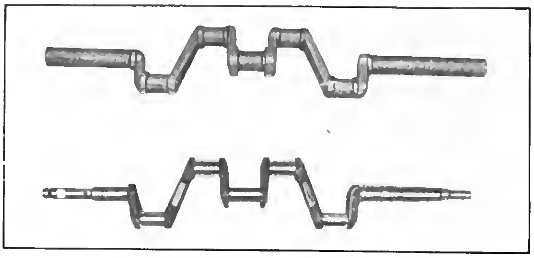


Fig. 1. One of the Finished Crankshafts and the Rough Drop-forging

and the maximum speeds obtained in that way. To obtain such data, the crankshaft used in the "Reo the Fifth" motor was chosen for observation and time study. It is drop-forged from manganese steel and heat-treated. The crankpins are ground from the rough, while the bearings and pilot ends are rough-turned on a lathe. The rough forgings are first sawed to length and centered, and then the center bearing is ground for a space somewhat narrower than the bearing. This is to provide a bearing for the steadyrest on the lathe. The end bearings are now rough-turned and the pins are next rough- and finish-ground. Then the bearings are finish-ground, and also the end pilots, the tapering portion on which the flywheel is forced, and the "gear fit" which is so called since it receives the timer gear. The next operation is on a lathe, which cuts the gear fit off to the exact length and cuts the threads on it with a Geometric die. Holes are drilled in the centers of the crankpins to roughly balance the crankshaft and an emery wheel grinds the shaft to a perfect running balance. A flat spot and a keyway are

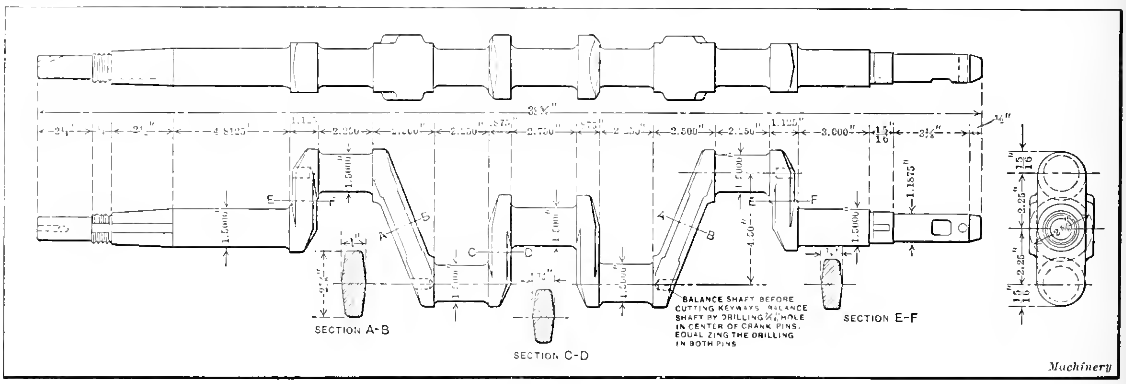


Fig. 2. Important Dimensions of the Crankshaft shown in Fig. 1

next milled out, and a keyway is cut for the flywheel key. A drill press completes the series of operations by drilling the oil and pin holes.

In this investigation the roughing speeds on the pins and the first grinding operation on the center bearing were found to be within 2 per cent of each other, while the material handling and adjustment times varied less than 5 per cent. The first of the grinding operations—spot-centering the bearing—is done on a 14 by 50-inch Norton grinder with a Norton 24-N flanged wheel. This wheel is dressed by a diamond, using the hand motion and not the traverse. Such a dressing is required for every four shafts, and gives a good roughing wheel surface which is square but not too smooth. A driver similar to the one illustrated is a time-saving substitute for the grinder dog. The feed is by hand, the wheel being advanced every revolution as nearly 0.02 inch as possible.

The cutting time averaged 1 minute 48.75 seconds and the changing time 27 seconds. The time required for dressing the wheel was 66 seconds, which, distributed over the four crankshafts, gives an average of 16½ seconds. This gives a total of 2 minutes 32.25 seconds each as the fastest continuous speed that it is possible to maintain. It is possible to hurry the work for short intervals and reduce the cutting time from 108.75 seconds to about 90 seconds, but this soon leads to the belts crowding off and when this occurs it involves about 100 seconds to readjust the machine and have the wheel gather up the requisite speed, which more than counterbalances the reduced cutting time. At the time of this observation, the wheel was 19⅝ inches in diameter, which at 1170 R. P. M. gives a surface velocity of 6020 feet per minute. The bearing is 1.73 inch in diameter and must be ground down to 1.52 inch. With the work turning at 27 R. P. M., a surface velocity of 12.3 feet per minute is obtained. The approximate volume of metal removed is 0.105 (depth of cut) by 2.75 (width) by 1.625 inch (mean diameter) which gives a volume of 1.48 cubic inch or 0.415 pound.

Following this spot-centering operation, the shaft goes to the shouldering lathe, shown in Fig. 3, which is an engine lathe fitted with a turret on the tool-slide and also two additional tool-slides. The center tool machines the center bearing to the correct width, while the other two tools are run in just outside of the crank throws to leave the rough fillet on the end bearings ready for the grinder. The turret tools are split, thus being accurately adjusted for width. The end or line bearings are rough-turned on the lathe shown in Fig. 4. This lathe uses a side-cutting tool with a broad blunt nose instead of the customary round-nosed tool. This avoids any tendency to "draw in," and at the same time it can take a cut the full length of the tool, making it possible to rough-size the bearing in one cut instead of needing two or three to reduce it to the correct size. This tool, shown in the foreground of the illustration, is ground flat on top, with a groove parallel to one side made with the corner of the wheel, allowing clearance for the steel shaving. The cut of this tool is square with the work, and it is for this reason that the two narrow, round-nosed tools are used in the previous operation to round the fillets and mark the end of the cut.

* For additional information on grinding crankshafts and allied subjects published in MACHINERY see also "Efficient Production of Cylindrical Work," December, 1912; "Rough Turning vs. Rough Grinding of Crankshaft Pins," March, 1911; "The Field for Grinding," January, 1911; "Precision Grinding," January, 1911; "Grinding Economy," July, 1910; "Economy in Grinding," May, 1910; "The Manufacture of Crankshafts," July, 1909; "Grinding a Large Crankshaft," April, 1907; "Grinding Crankshafts," March, 1907; and "The Cost of Grinding," October, 1906.

† Care of Reo Motor Car Co., Lansing, Mich.

The other rough-grinding operation, namely on the crank-pins, is done with a 24-inch Grade O wheel which requires dressing for every third crankshaft. This wheel was 23½ inches in diameter at the time of the test, the exact width of pin 2¼ inches and the speed 955 R. P. M., which gives a surface speed of 5890 feet per minute. The standard Norton offset for crankshafts which was used was removed and set up by a helper. In setting up, use is made of a metal-balancing plate which has tapering wedges that force the pins equidistant from a surface plate; and this locates the crankshaft centrally in the offset, so that the same amount of stock is removed from all the pins. In placing this work in the grinder, a gage is put on the shaft and the work shifted until the wheel touches the gage. It is now in position for grinding the first pin. A standard spacing bar is set from this position and the other pins are thus accurately spaced. On the first revolution of the work 0.02 inch is cut from the forged fillet before the work gathers up motion. The hand feed is about 0.02 inch per revolution of the work. In operating the machine, two pins on a line are first ground; and then the offset is shifted to the other center and the other two pins are ground. The time required is as follows:

Grinding time per pin.........	1 minute 26.375	seconds
Change centers	29	seconds
Change work	1 minute 23.50	seconds
Dress wheel	2 minutes 2	seconds
Dress wheel, per shaft.........	40.66	seconds
Total time for grinding four pins, changing and dressing wheel	8 minutes 18.6	seconds

The volume of stock removed is approximately 1.625 inch (mean diameter) by 2¼ inches (width) by 0.105 inch (depth

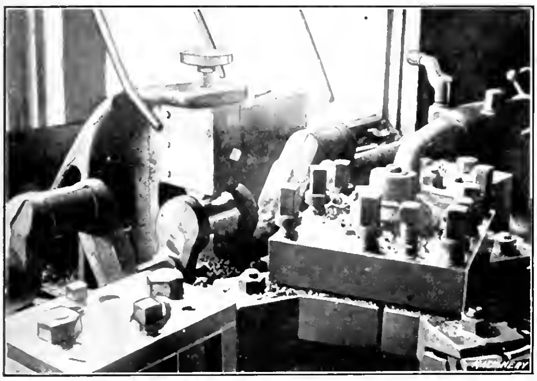


Fig. 3. Facing up Crankshafts to provide the Necessary Wheel Clearance

of cut) which gives a volume of 1.210 cubic inch. For the four pins the volume of metal removed is 4.840 cubic inches or 1.35 pound. From this data and the total cutting time for four pins of 5 minutes 45.4 seconds, the time required to remove one cubic inch of metal is found to be 71.4 seconds. Doing the same for the spot-centering operation on the center bearing, the time per cubic inch of metal is found to be 73.5 seconds. These calculations are based on cutting time only. In the first case, 40¼ per cent must be added to the cutting time to get the total time. In the second case, 44½ per cent must be added. These percentages represent the average of many sets of data, which, however, run surprisingly uniform, so much so as to establish 45 per cent as the limit of the ratio of "lost time" to "cutting time."

It was found that with the shortest finishing operations, such as took a total of thirty to forty seconds, elementary standards were impractical. These operations were performed so quickly that the changing and calipering occupied from 70 to 90 per cent of the time, and so only standard totals for these operations on the crankshaft were arrived at, which are as follows:

Grinding taper	42.5 seconds
Grinding gear fit	33.4 seconds
Grinding short pilot on flywheel end.......	31.4 seconds
Grinding long pilot on front end..........	43.6 seconds

In fact, the finish-grinding is found to be quite different from roughing. The amount of metal left for this operation was 0.040 inch on the diameter. However, the depth is so small and the surface covered so carefully in order to produce the finish that it is area rather than volume which must be considered. The finishing operations involving a larger area were found to have a nearly constant handling time ratio. An allowance of 77½ per cent was added to the actual grinding time on the pins and 71 per cent on the bearings. These are well within the 5 per cent limit of variations, though they are much larger than the additions to

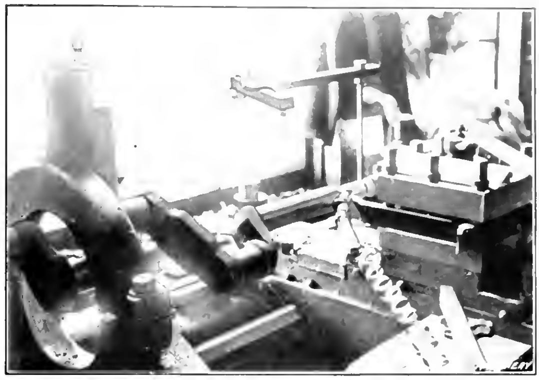


Fig. 4. Roughing out the End Bearings on the Lathe

the roughing time. This is undoubtedly due to the additional care necessary in grinding to the quarter thousandth limit placed on this class of work.

As to the cutting time, those operations involving no longitudinal motion of the wheel were found to require considerably more time per unit of area than those where the wheel could be run in to a certain depth of cut and then the whole length of bearing reduced to that finished dimension by a longitudinal motion. The first class of operation, such as finish-grinding the pins, is done on a 14 by 50 inch Norton grinding machine with a 24-N wheel. At the time of the test, the actual diameter was 23¼ inches, and when running at 955 R. P. M. a surface speed of 5820 feet per minute is attained. The work is revolved at 316 R. P. M., which, with a diameter of 1½ inch, gives 124 feet per minute as the surface speed. After grinding six shafts it is necessary to dress the wheel. A "Star" dresser is used to rough-dress it, since the wheel must be cut down half the depth of the 3/16 inch fillet in the angles. The surface is finished by a diamond held in the traverse. Finally, the fillet is hand-finished with the diamond until a test made by grinding a thin piece of board exactly fits the templet. This takes 10 minutes 12 seconds or 1 minute 42 seconds per shaft. The average

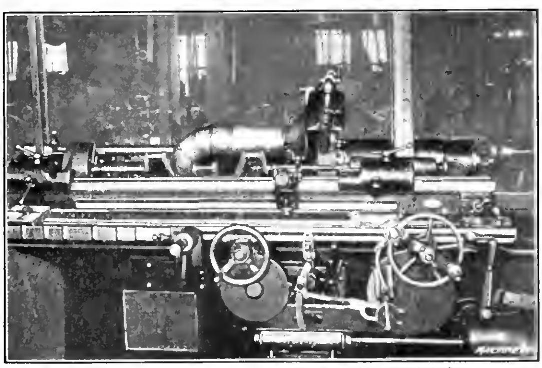


Fig. 5. Grinding the Gear Fit on the Norton Grinder

cutting time per pin was 1 minute 11.25 seconds, making a total of 4 minutes 45 seconds. The total time including changing the work and wheel dressing was 8 minutes 26 seconds. Each pin is 2¼ inches long by 1½ inch in diameter, which gives a surface of 10.6 square inches. This gives a cutting time of 6.73 seconds per square inch for finish-grinding to a depth of 0.020 inch. For this operation, no spacing bar is used, since the lateral limits on the position of the bearings are not close.

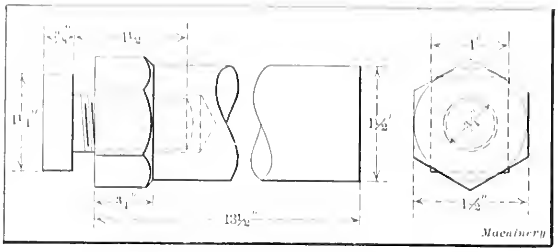


Fig. 6. Detail of the Driver shown in Operation in Fig. 5

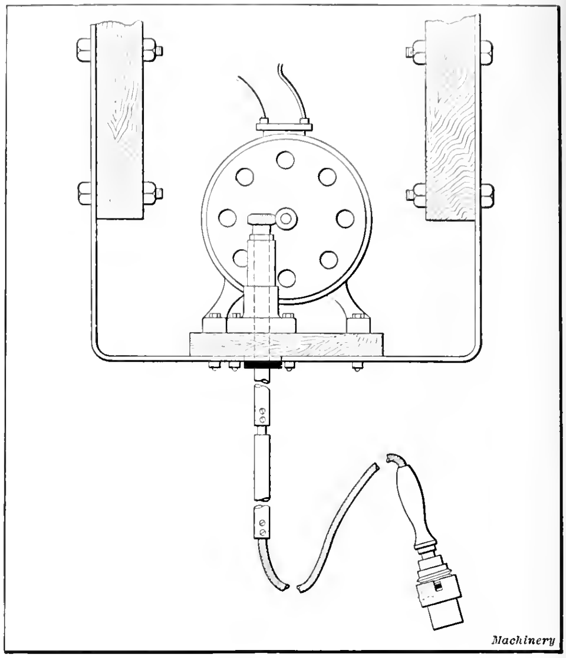
The other finishing operation is made up of both of these types of work. The wide end bearings are finished by moving the work lengthwise in front of the wheel. The center bearing involves the "running in" cut, but here the lateral limits of position are close and so it becomes necessary to work much more carefully. A standard cutting time of 7.93 seconds per square inch is the best speed consistent with good workmanship. The bearing is 2¾ inches long and 1½ inch in diameter, giving an area of 13 square inches. This work is done on a 10 by 50 inch Norton grinding machine, using an N grade wheel 18¾ inches in diameter revolving at 1170 R. P. M. or 5745 feet per minute. The work is 1½ inch in diameter and runs at 150 R. P. M., which gives a surface speed of 58.8 feet per minute. The wheel is dressed every ten shafts and the time required is 9 minutes 21 seconds.

If the forgings are coming very regular a somewhat different procedure is followed: Twenty-five shafts are ground and then the wheel is dressed for the fillets and the whole twenty-five shafts are then re-run to check up the fillets. This reduces the wheel cost and dressing time per crankshaft and gives fully as good a fillet. A grinding dog is used in this operation and the feed is by hand. The cutting time on the center bearing is 1 minute 43 seconds. For the end bearings, the times are 59 seconds and 49 seconds, respectively. The long one is 4.8125 inches long and the other 3 inches long. The total area is 7.8125 inches in length by 1½ inch in diameter or 36.9 square inches. The time is 1 minute 48 seconds or 2.93 seconds per square inch. The reason this time per square inch is so much less than the other standard is that the longitudinal motion covers the area far more quickly. The total time for grinding the three bearings, including changing and dressing the wheel, is 6 minutes 7.5 seconds.

The total time involved in machining each of these crankshafts is approximately 69 minutes, the time being distributed as shown in the accompanying table. Those times given in minutes and fractions are averages for irregular operations where the work varies for each individual crankshaft. Those given in minutes and seconds are for operations of a uniform character, which allow an exact duplication of motions in performing the work on each shaft. It may be of interest in this connection to mention the diamond cost which was $0.02375 per crankshaft; the wheel cost which was $0.075 and the scrap cost, which was $0.06927. These figures are arrived at by dividing the average seasonal cost by the average seasonal production. During all this test, no attempt was made to speed the work beyond limits which could be kept up indefinitely. The whole endeavor was to determine a standard rate for grinding surfaces and to observe the conditions under which this is done.

AN ELECTRICAL NUT SETTING ARRANGEMENT

In assembling the Witherbee igniter in the company's factory at Springfield, Mass., an ingenious arrangement is employed for setting the nuts on the hard rubber cases by power. The illustration shows the method of mounting the ¼ horsepower electric motor from the ceiling. This motor is speeded to 1800 R. P. M. and from the end of the armature shaft a worm meshes with a worm-gear on a vertically positioned shaft that extends down toward the floor. From the end of this shaft is extended a flexible shaft, and at the end



Electrically-driven Nut-setter

of the flexible shaft is an Errington nut setter. This nut setter works on the friction principle, so that when the nuts have been set up to the correct tension, the friction slips. With this device a man is able to do a large number of nuts per day, and in addition to being faster, the work is more thoroughly done and there is no danger of cracking the hard rubber plates. C. L. L.

TIME REQUIRED FOR MACHINING CRANKSHAFTS

No. of Operation	Name of Operation	Type of Machine Used	Time Minutes	Time Seconds
1	Snag	Emery wheel	1	
2	Cut off and center	Saw and centering lathe	4	
3	Straighten	Straightening press	3	
4	Spot center bearing	Grinding machine	2	32.25
5	Turn shoulders and short line bearing	Lathe	7	37.00
6	Turn long line bearing	Lathe	8	2.50
7	Rough pins	Grinding machine	8	18.70
8	Finish grind pins	Grinding machine	8	26.00
9	Finish grind bearings	Grinding machine	6	7.50
10	Finish grind short pilot	Grinding machine		31.40
11	Finish grind short pilot	Grinding machine		43.60
12	Finish grind taper	Grinding machine		42.50
13	Finish grind gear fit	Grinding machine		33.40
14	Cut off and thread	Lathe	1	30
15	Drill balance	Drill press	5	
16	Grind balance	Emery wheel	5	
17	Mill flat spot	Milling machine	1⅓	
18	Mill Woodruff keyway	Milling machine	1⅓	
19	Flywheel keyway	Milling machine	1	
20	Drill oil hole	Drill press	1	
21	Drill pin hole	Drill press	1	
			68	50.85

Machinery

PRODUCTION TOOLS FOR REO ENGINE CYLINDERS*—1

SPECIAL JIGS AND FIXTURES, AND MACHINING METHODS USED BY THE REO MOTOR CAR CO., LANSING, MICH.

BY DOUGLAS T. HAMILTON†

No better example of interchangeable manufacture and the development of special jigs and fixtures is obtainable than can be found in the production of automobile engine cylinders. When we consider the number of operations necessary on an automobile engine cylinder casting and the exactness to which the various surfaces must be machined, it is little short of marvelous that this work can be accomplished in such a short time and at such a low unit cost. The methods and jigs and fixtures employed by the Reo Motor Car Co., Lansing, Mich., are described in the following. The manufacturing steps from the time that the casting is received from the foundry until it is ready for assembling in the completed engine are described in detail. Fig. 1 shows the automobile engine casting. It is of the two-cylinder *en bloc* type and is used in a four-cylinder 30-horsepower engine.

Preliminary Operations on the Automobile Engine Casting

The first operations on the automobile engine casting after it is received from the foundry are inspecting, snagging and removing all objectionable fins. After it has passed through these preliminary operations it is placed in a testing fixture and given a water test at a pressure varying from 200 to 210 pounds per square inch, which exceeds, by about 175 pounds, the normal pressure in the water jacket when the engine is in use.

Milling Top and Bottom Faces of Casting

The preliminary machining operation, which consists in milling the top and bottom faces *O* and *P* of the cylinder casting, see Fig. 1, is accomplished, as shown in Fig. 2, in a Pratt & Whitney Lincoln type milling machine. Two castings *A* are held in this fixture at a time, but it is not of the reciprocal type. Fig. 3 shows in detail the construction of this milling fixture, and by referring to the latter illustration, the method of holding the cylinder castings will be clearly understood. The casting is located between four jaws *B* and *C*, which are operated by left- and right-hand screws, actuated by two handwheels *D*, only one of which is shown. The base of these jaws slides in T-slots formed by machine steel strips which are fastened to the top face of the base casting of the fixture, and the vees of these jaws grip the cylinder casting around the circular portion, as indicated in Fig. 2. To prevent the thrust of the cut from loosening the jaws, a special clamping strap *E*, operated by the lever *F*, as shown in Fig. 2, is provided. This is put in place and tightened after the casting has been located and clamped in the fixture.

The milling is accomplished by two $5\frac{1}{2}$-inch diameter inserted-tooth high-speed steel milling cutters which take a depth of cut varying from 3/16 to 1/8 inch. The cutters are rotated at a peripheral speed of 30 R. P. M. and the table travels at a rate of 1/16 inch per revolution of the cutters. The jigs held on this table are of the individual type, and in operating it is necessary to mill the two castings before starting on a second cut. However, the time of operating is reduced by unloading the first casting that is milled while the second one is being operated upon, and loading the second

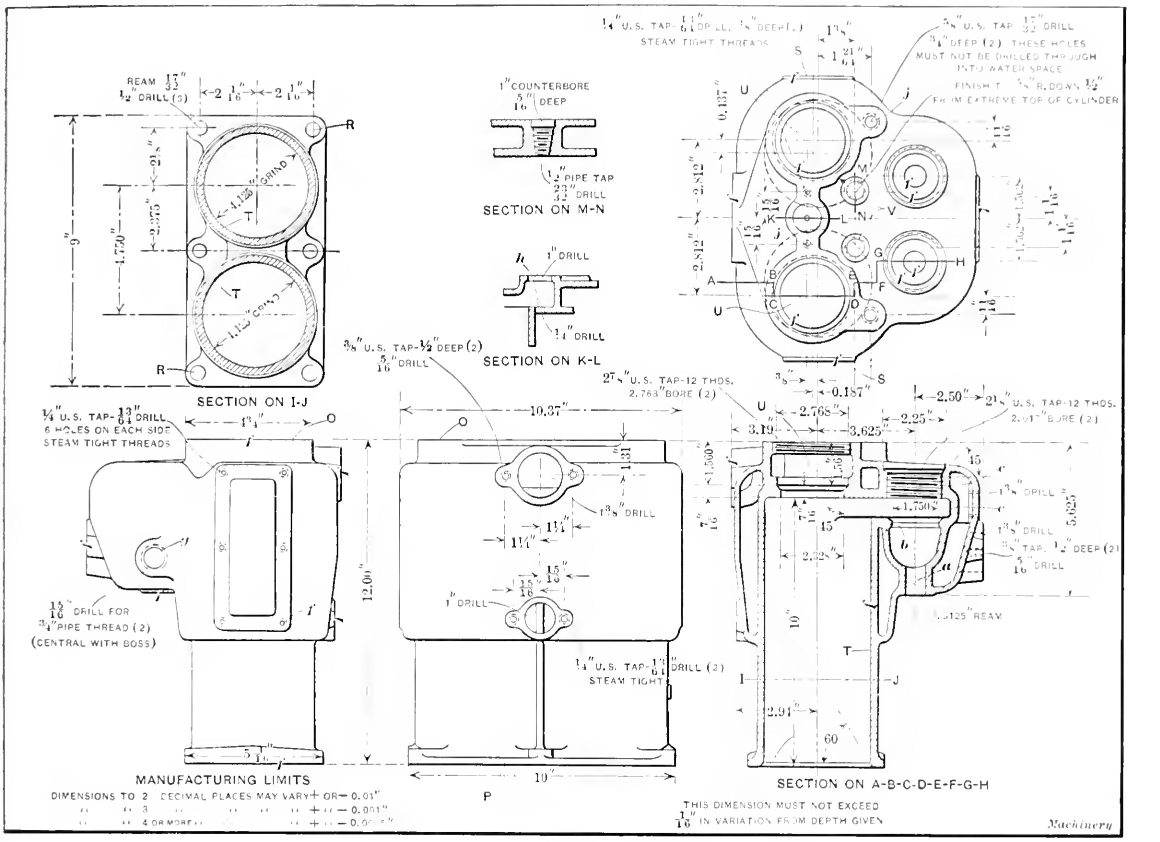


Fig. 1. The Reo Engine Cylinder—the Subject of this Article

* For information on automobile shop practice previously published in MACHINERY, see "Forging and Machining Automobile Front Axles," December, 1913; "Automobile Manufacturing Methods," July, 1913; "Shop Practice of the Willys Overland Co.," February, 1913; "Some Tools used by the Gramm Motor Car Co.," January, 1913; "Processes in Production of Automobile Transmission Gears," July, 1912; "Methods, Machines and Fixtures for Automobile Manufacture," December, 1911, and articles there referred to.

† Associate Editor of MACHINERY.

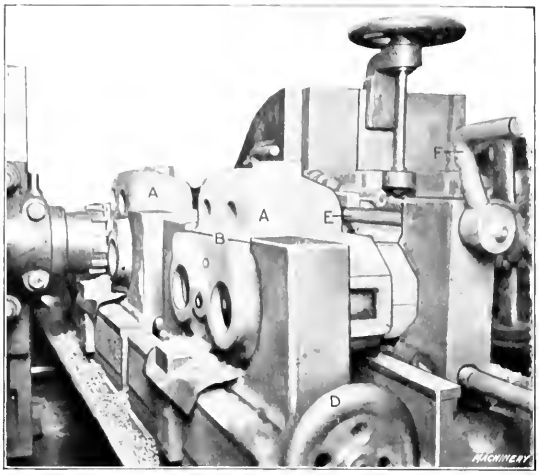


Fig. 2. Milling the Top and Bottom Surfaces of the Cylinder Casting

fixture when the casting in the first one is being machined. The casting in the first fixture, however, cannot be replaced until the table of the machine has been brought back to the starting point. Nevertheless, very little time is lost in operating, as a production of one hundred and thirty-four completed castings in nine hours evidences.

Drilling and Reaming the Flange Holes in the Base of the Cylinder Casting

Upon the completion of the milling operations just described, the next step is to drill the holes in the flange, through which the bolts pass that fasten the cylinder castings to the crank-case. These holes also act as locating points in all subsequent operations. Although this operation is of a simple character, the method of accomplishing it is rather interesting, as Fig. 4 will show. The drilling and reaming of the six flange holes *R* (Fig. 1) is accomplished progressively in a Baush multiple spindle drilling machine. The type

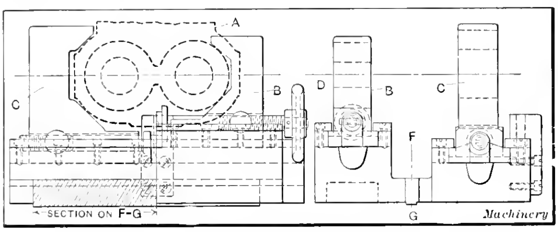


Fig. 3. Milling Fixture used for holding the Cylinder Castings in the Machine shown in Fig. 2

of fixture used is not only of novel construction, but incorporates some points in design that facilitate interchangeable manufacture. As will be seen upon reference to Fig. 4, this fixture is of open construction and consists primarily of a frame *A*, to the top faces of which two rails *B* are fastened. Sliding upon these rails are the work-holding fixtures to which the cylinder is clamped bottom side up.

A more detailed view of the construction is shown in Fig. 5, to which reference should now be made. Upon referring to this illustration, it will be seen that the cylinder casting *D* is held to the bottom face of the sliding portion *E* of the jig by two long clamping bolts *F* and a cross-bar *G*, in which a clamping screw *H* is located. This screw is used to hold the cylinder casting up tight against the bottom face of the jig. The casting is located in the proper relation to the bushings in the top face of the jig by two jaws *I* operated by means of a left- and right-hand screw that receives motion from the handle *J*. These jaw members slide on the top edges of the jig, and have under ledges on which the flange of the cylinder base rests.

Referring now to Fig. 4, the method of operating the fixture is as follows: three work-holding jigs of the type illustrated are in use. The operator first places one jig under the six drills which are 1/2 inch in diameter, and are rotated at 220 R. P. M. The machine is then operated and the drills pass through the 5/8-inch flange. This first jig is then shifted over into the reaming position and the second jig put into place. The machine is again operated and while the holes in the second casting are being drilled the holes in the first casting are reamed by six reamers 17/32 inch diameter; these are

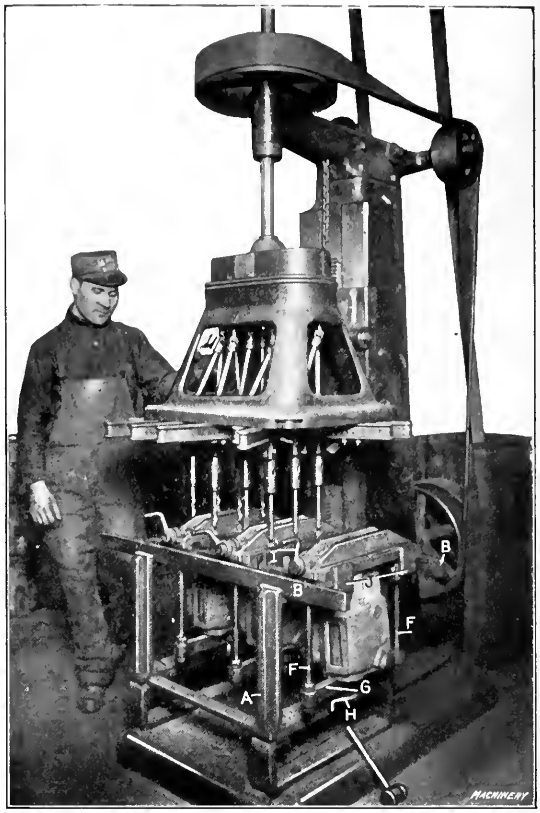


Fig. 4. Progressive Drilling and Reaming of Flange Holes in the Base of the Cylinder Casting

rotated at 220 R. P. M. and the downward travel of the head is 0.005 inch per revolution of the reamers. The third or extra jig is then brought into position and the operations repeated. When the fixture has once started to work in this order, a casting is drilled and reamed at each downward movement of the head. The third jig enables the operator to remove and clamp another casting in position while the machine is

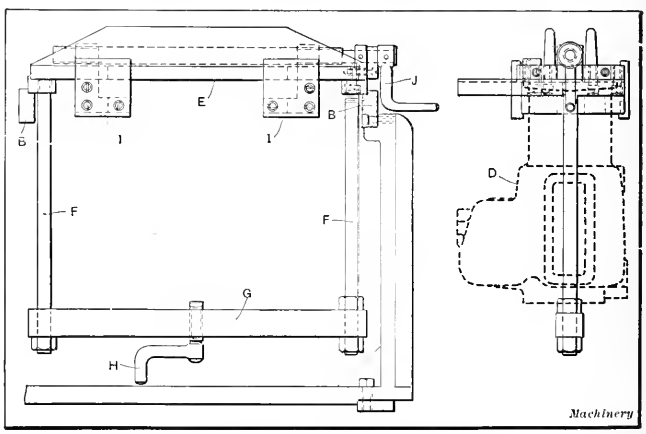


Fig. 5. The Progressive Drilling and Reaming Jig

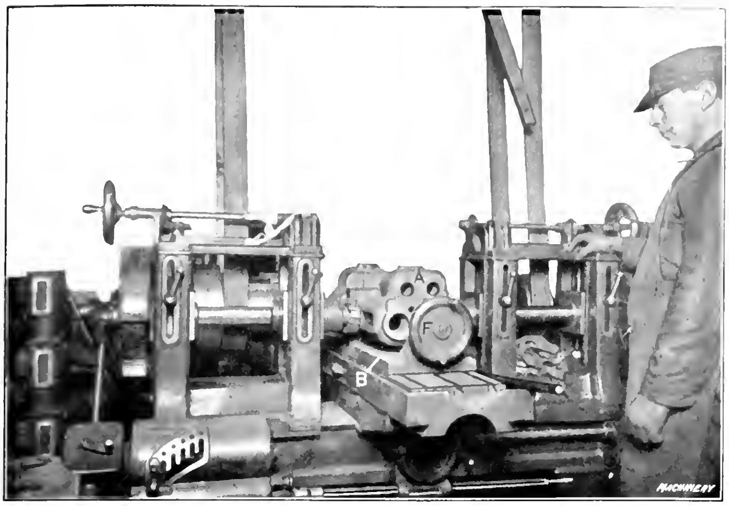


Fig. 6. Reciprocal Milling of Bosses for Waterjacket Plates

in operation, so that the drilling and reaming of the castings is practically continuous. The production from this machine is high, averaging about 210 completed cylinder castings in nine hours. The method of handling the work is, of course, largely responsible for this production. The jigs are provided with removable bushings so that they can be run along progressively on the rack and allow the drilling and reaming operations to be accomplished through the same jig simply by changing the guiding bushings.

Milling Bosses for Water Connection Plates

Following the drilling and reaming of the six holes in the flange of the cylinder casting, the next operation is to face

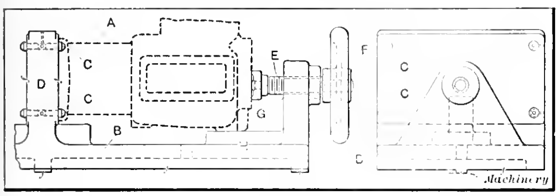


Fig. 7. Detail of Reciprocal Milling Jig shown in Fig. 6

off the bosses *S*, Fig. 1, for the water connection plates. There are two surfaces machined on each casting and this work is accomplished in the Lincoln type milling machine shown in Fig. 6. Two high-speed steel inserted-tooth milling cutters are used for this purpose, and two castings are machined at one setting. This fixture is of the reciprocal milling type, enabling the milling operation to be carried on practically continuously. Fig. 7 shows the type of fixture that is used, and upon reference to this illustration it will be seen that the bed of the fixture consists of one casting *B* which is fastened to the table of the milling machine. The cylinder casting is located in the correct position by four hardened studs *C*, fitting in the previously reamed holes in the flange, and is held tight up against the center bracket *D* of the fixture by the screw *E* operated by handwheel *F*. The forward end of this screw is provided with an adjusting clamping head *G* which accommodates itself to the surface of the cylinder casting, holding it tight against the machined face of the fixture. The casting *A* also rests on a projecting boss *H* on the fixture. As this fixture is worked on the reciprocal principle, it is evident that the production will be greater than that shown in Fig. 2. In this case 140 of these castings are machined in nine hours as against 134 in the first milling operation. The depth of cut taken from each side varies from 1/8 to 3/16 inch and the length of surface milled on each casting is approximately 6 1/16 inches.

Rough- and Finish-boring Cylinder Operations

In order to avoid the difficulties that would result from striking hard and soft castings when boring, the Reo Motor Car Co. has followed the plan of testing all the castings before boring with a scleroscope. The average run of castings strike between 30 and 40 on the scleroscope, and any that strike higher than this are laid aside, marked as hard and machined separately. By following this plan, it is possible to get an average product from the machine each day without running up against any serious difficulties because of hard cylinders. The operator also has less trouble with the cutters because he knows before he puts the casting in the machine whether it is hard or of a uniform density. The same operator who runs the Foote-Burt cylinder boring machine shown in Fig. 8 also tests the cylinders for hardness before clamping them in the jig. The boring machine illustrated is of the four-spindle construction, and machines two cylinder castings or four bores in one setting. On an average, 5/16 inch of material is removed from the diameter of the cylinder bores *T*, Fig. 1, at a rate of feed of 0.063 inch per revolution, leaving it 3.965 inches in diameter by 10 inches deep.

The type of fixture used for holding the castings while rough-boring the cylinders is shown in Fig. 9. Referring to this illustration, it will be seen that the fixture *A*, which consists primarily of a cast frame, is of open construction and is provided with work-holding slides *B* which fit in V-ways provided in the top part of the frame of the fixture. The cylinder castings are located on these slides from the previously drilled and reamed holes in the flange, and are held in position by heel-clamps *C*. The slides *B* are then pushed into the fixture and located by the plug *D* that fits in a bushed hole in the slide and serves to locate the slide in the correct relation to the boring spindles of the machine. In order to provide a support for the casting at its lower end, two tapered wedges *E* and *F* are added to the fixture which assist in holding the casting tight against the slide, and prevent any twisting action due to the boring tool shifting the casting when the bore is eccentric. The top part of this fixture is tied with a tie-bolt *G*, which holds the slides rigidly and prevents any side motion. The nuts on these tie-bolts are released when removing the work-holding slides.


Fig. 8. Rough-boring the Cylinder in a Foote-Burt Cylinder Boring Machine

This rough-boring cut is extremely hard on the machine and cutters because of the large amount of material removed, and also because of the fact that the skin material or surface is much more difficult to cut than the interior or softer metal. Considering this, 124 completed cylinder castings in nine hours shows that the method of machining is about as complete as it could be. Four work-holding slides are provided for this machine so that while the machine is in motion the operator can be removing two finished cylinder castings and clamping two rough ones on the extra slides, thus reducing to a minimum the time that the machine stands idle between loadings.

The second rough-boring cut is accomplished on a Moline four-spindle cylinder boring machine which is equipped with a fixture similar in construction to that shown in Fig. 9. In this case, a cut 0.105 inch on the diameter is taken, and the fixture instead of being loaded from the front as was the case with the rough-boring fixture shown in Fig. 8, is loaded from the end. The production from this machine is 134 completed cylinder castings in nine hours. Before taking the finish-boring cut on the cylinder, the other operations on the valve seats and similar parts are performed and the finish-

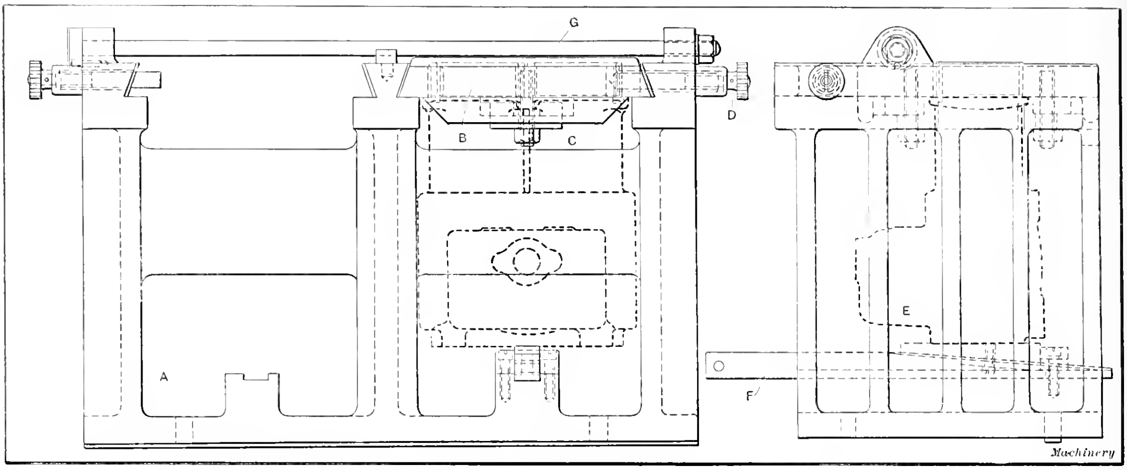


Fig. 9. The Rough-boring Jig which carries Two Cylinder Castings and is used in the Machine shown in Fig. 8

boring is left until last before the castings are taken to the cylinder grinding machine. These operations will be described in a following article.

* * *

METHOD OF SECURING CELLULOID TO WOOD

BY G. G.

I recently had occasion to fasten pieces of sheet celluloid to some narrow strips of wood. One side of these strips was completely covered with fine graduation lines and figures so that it was impossible to use small brads to secure them in place. I tried several different kinds of mucilage and glue but met with little success, as the best glue that I found only held for two days.

If the reader ever happens to run across a job of this kind he need not give up hope, as it is quite an easy matter to deal with if you know the proper way to proceed. The method I finally hit upon is as follows: After scraping the wood and celluloid absolutely clean, heat some grain alcohol to the boiling point. As alcohol boils at a relatively low temperature and is very inflammable, it should be held at a considerable distance from the source of heat. When the alcohol has been warmed to the desired point, it is applied to the under side of the celluloid with a small brush. The celluloid is then pressed down on the wooden strip to which it is to be secured and held tightly in place for about two minutes. After that time, nothing except fire will ever make the celluloid come off. The same method may be used for sticking celluloid to celluloid, celluloid to hard rubber and celluloid to glass.

HOW SOME UNUSUAL JOBS WERE HANDLED

BY W. D. FORBES*

In every machine shop in the country there are certain jobs which can be done more or less rapidly and more or less well, as they present no great difficulties. For instance, a pair of parallels 2 inches square could be gotten out so that they would be perfectly serviceable and parallel by any shop that has a planer, as, of course, the work would be accomplished by planing up a long strip and then parting it. This, of necessity, would produce two similar pieces. But when it comes to certain classes of work, the question of how it is done or whether it can be done at all in the shop is interesting.

How many shops could produce a strip of steel ½ inch wide by 0.0015 inch thick and do it commercially? I once tried this very job and made a big failure of it as far as the commercial side went, although I managed to get a couple of strips down to the 0.0015 inch dimension. I had just installed a new surface grinder and felt that I could grind anything that could be ground, so I accepted the job of making two of these thin pieces. I made a cast-iron block and planed it up, filed off the two ends to an easy curve and stretched the strip, which was about 0.0025 inch thick, across it. I thought this would work all right, but after several trials found that, even with a good supply of water, the heat generated was too great. Finally I resorted to hitching a stout spring to one end of the strip, that is, the end where the emery wheel left the work, and by putting a tension on the spring and on the strip, I finally managed to get a couple of pieces down to size at a cost of about eight or ten times what I got for them. Upon telling a friend of my experience, he said that my grinder should have been replaced by a pair of rolls, and that if I had used these I could have gotten down to size without any trouble. This may be perfectly practical for those who understand rolling metals, but it isn't really a machine shop job.

Another job which would puzzle a machine shop would be to put a ⅜-inch hole through a piece of steel 28 inches long, and have the hole true and to size; yet any gun barrel maker would do this without difficulty. Probably everybody who has run a machine shop has had a customer tell him that he is quite privileged to suggest any change in the work which will reduce the cost of machining. This really means that the change will allow the person wanting the work done to make a little more money and the manufacturer, himself, to get less work as a result. It is most magnanimous, of course, but the manufacturer usually rather fails to see the point.

A certain firm required a number of cross-head guides, which were to be used in some horizontal air-compressors, and the job was being estimated on by a shop that was very

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anxious to get the work. The privilege of suggesting changes in the design was offered, and after considering what could be done, the shop put in a bid and was successful in obtaining the work. The following alteration was made: The castings weighed about forty pounds each and were of a channel form; they had to be planed off on the top to receive the gibs, and down in the channel to receive the cross-head shoe which was of composition. The original design had oil pockets at each end of the channel, which the draftsman had shown with a lip projecting above the bottom of the channel. This would have made it necessary to machine these cross-head guides singly if a planer was used as, of course, these lips interfered with a continuous cut when several of the cross-head guides were set up together on a planer. These oil pockets were cut off the pattern and a separate pattern made; the pockets were then screwed into position on the finished guides. It is clear that by stringing the cross-head guides along the table the planer tool could sweep through the whole group, making them all alike and saving considerable time, the planer having to be reversed only once for half a dozen guides for each cut. Just as many reversals would have had to be made for each guide had the oil pocket been left as originally designed, to say nothing of the multiplicity of measurements when handling the cross-head guides singly.

Now how is it that a machine shop is so often confronted by just such a condition as the one here noted? It will be admitted at once that, when looking over the men in most drafting offices, you will see very few gray heads; and while gray hairs are a great objection they do, at times, denote experience, and that is of value. The young draftsman usually comes from a technical school and can make good drawings, but his lack of shop experience seems to me to give a clear reason why impractical designs are so often met with. Yet where is the chief draftsman? What is the superintendent doing to allow designs to be gotten out by inexperienced men without thoroughly overhauling them with a view of obviating unnecessary work? Most superintendents and chief draftsmen will say in answer to this question that if they were twins they might be able to look over all the details; in other words, that they have no time to properly consider the work of those they employ. This is all well enough in a way, but in every machine shop there are bright men, not necessarily young, who know all the tools in the shop, just what can be done on them and what is a good practical way to do it.

Another illustration in connection with these very cross-head guides: The gibs were designed to have countersunk fillister head screws to hold them in place and the tapped holes in the cast-iron cross-heads were shown to go down about seven-eighths into the cast iron for tapping. A quarter of an inch more drilling and there would have been a through hole. Now everybody knows that a through hole can be more quickly drilled than a depth hole and that it can also be more quickly tapped. Some will not quite agree with this but the practical man who is doing the work will. He will tell you that, with all care, stops on a drill-press slip and that tapping machines sometimes don't reverse just when they should. The countersinking for fillister heads was quite unnecessary, as there was nothing to interfere with the use of cap-screws which saved counterboring and such screws are infinitely handier than the slotted head affairs.

Speaking of slotted heads in screws, I have always wondered how it was that an English patent on screw-heads never became popular. It was shown me years ago by Mr. T. A. Weston, of differential pulley-block fame, and in my opinion he ought to have a monument erected to him for his invention. This screw-head would be more generally used for wood screws than for machine screws. Instead of having a single slot cut across the head, it had two slots at right angles, forming a Greek cross. If this was all it would not have amounted to much; but these slots converged toward the center and were sunk deep in the screw-head, the slots themselves tapering in width from the center to the edge of the screw-head. The screw-driver was of a form to fit down into these recesses, and as they were tapering and converging one size of screw-driver answered for several sizes of screws. You could put a screw on a screw-driver held vertically and the screw would not drop off; and a screw could be gotten out or else the entire body twisted off. Mr. Weston told me that these slotted screw-heads were made by being struck up in the machine that made the head and at the same time the head was formed. I never saw the machine work but I saw samples of this screw and I certainly wish that it had come into existence. Perhaps some of the readers can shed further light on what seems to be the sidetracking of a valuable idea.

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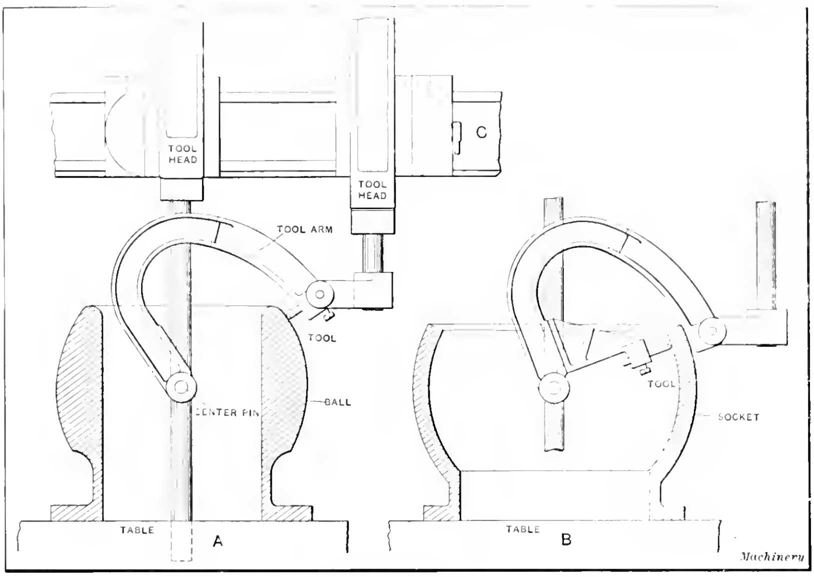
BALL AND SOCKET TURNING DEVICE

BY L. D. PEIK*



Device for turning a 36-inch Ball and Socket on the Boring Mill

In the shop where the writer is employed the operation of turning a ball was one which usually gave considerable trouble, and this was especially true of balls of any considerable size. In the accompanying illustration *A* shows the ball and *B* the socket for a ball and socket joint 36 inches in diameter, which was used on a suction pipe line. This ball and socket were both finished on a boring mill by means of the device which forms the subject of this article. The left-hand tool-head holds the bar which centers the tool-arm, this bar being supported at its lower end by a bushing in the table. It will be seen that the center pin holds the split tool-arm, the opposite end of this arm being supported by a yoke fastened to the right-hand tool-head. The right-hand tool-head is loosened slightly on the saddle and the screw *C* is removed to give the feed motion a free swing on the saddle, to allow it to follow the arc described by the tool-arm.

The proper arc of the ball is made by feeding down the right-hand tool-head while the left-hand head remains stationary. The socket is bored in a similar manner by means of a tool-holder bolted to the arm on the inside as illustrated at *B*. This device has been in use for some time and the writer has found that there is very little chattering of the tool on the finishing cut if the bolts on the saddle are kept adjusted.

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COMPOUND STRESSES

ELASTIC LIMIT WITH COMPOUND STRESSES, AND THE MAXIMUM SHEAR THEORY

BY SANFORD A. MOSS*

The elastic limit of a material is found by subjecting it to direct tension or compression in a testing machine. It gives a value which must be borne in mind in using the material in engineering structures. It is obvious that the conditions must be the same as existed in the testing machine, that is, there must be simple tension or compression. Examples of such stresses are found in the bursting stresses in thin pipes, centrifugal force stresses in rotating thin rings, tension on wire ropes and bending stresses in beams near the places where the stresses are maximum. In each of these cases the conditions are exactly the same as in the case of a specimen in a testing machine, so that the values of elastic limit are directly applicable. These are cases of simple stress.

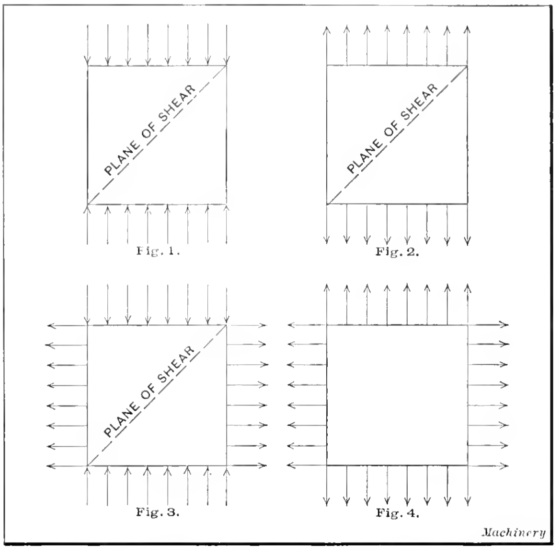

Fig. 1. Shear due to Compression. Fig. 2. Shear due to Tension. Fig. 3. Shear due to Combined Tension and Compression. Fig. 4. Tension in Two Directions. Maximum Shear is inclined at Angle of 45 Degrees to Plane of Paper

Another class of cases arise, however, in which there are stresses in two or three directions at the same time. These are called compound stresses. An example of this is found in a long thin cylinder closed at each end and subjected to internal fluid pressure. There is a tangential stress which tends to burst the cylinder along a line parallel with the axis, as well as a longitudinal stress, due to pressure on the heads, which tends to tear the cylinder apart in a plane perpendicular to the axis; that is to say, a small square in the wall of the cylinder is subjected to stress in two directions, each at right angles to the other. Examples of similar cases are found in stresses due to combined bending and twisting in a shaft, stresses due to centrifugal force in a rotating wheel disk, and stresses in a hub pressed on a shaft.

The Elastic Limit Question With Compound Stresses

The question then arises, What is the criterion for safety in the cases above, equivalent to the value of the elastic limit in cases of simple stress?

A very unfortunate thing in engineering has been the fact that it has not been realized until very recently that there is any necessity for a criterion. Two different classes of engineers have each tacitly assumed a certain criterion, discussed later as the "maximum stress theory" and the "maximum strain theory," without realizing that they have made an assumption in the matter, supposing that their ideas were *apriori* correct, and that there was no other possibility. As an actual fact, no *apriori* assumption is possible, and the matter is one which must be made the subject of very careful experiment. It has only been in very recent years that such experiments have been made. Most engineers who have studied the existing experiments carefully have agreed that neither of the old theories is correct, but that a new one, the "maximum shear theory," must be adopted. The fundamental principles at the root of the whole matter are not popularly understood, and it is the purpose of this article to go into details regarding them. In the writer's opinion, it is completely settled that the maximum shear theory is the proper one for ductile materials such as steel. The writer believes that any engineer who will take the time to investigate the matter completely will be convinced of this. Many engineers use the older theories for the reason that they have started out this way, and have never realized that there was any question in the matter.

Cross Contraction and Net Strain

A simple tensile stress causes elongation in its own direction, as given by the modulus of elasticity. That is, if E is the modulus of elasticity, the total elongation l produced in a piece of length L by a stress S is given by the well known law:

$$E = \frac{S}{l \div L}.$$

Not only does the stress in the given direction produce the extension mentioned in the direction of the stress, but there is also produced a contraction in each direction at right angles to the stress. That is, if we have a square bar stressed in the testing machine in the direction of its length, so that the length increases according to the above formula, there is a contraction in each opposite direction, which produces decrease in the thickness of the bar. The ratio of the contraction at right angles to a stress, to the direct extension, is called Poisson's ratio. For ordinary kinds of steel this has a value of 0.3. If the direct stress is a compressive stress, so as to cause decrease of length in the direction of the stress, then there will be an expansion in each direction at right angles equal to 0.3 times the compression. Suppose we have a bar 1 inch square, in compression, with such stress that every inch of its length is compressed 0.001 inch. Due to this compression the thickness of the bar will be increased in each direction 0.0003 inch.

This action of extension in one direction and contraction in the other, due to a simple tensile stress, exists for each such stress. When there are stresses in two directions at once, that is to say, when we have compound stresses, each of the individual stresses produces its deformation regardless of the existence of the other stresses. The total deformation produced is due to the sum of such individual deformations. Consider the case of a hub pressed onto a shaft. There is a stress in the radial direction which compresses the fibers in this radial direction. Due to this radial compression, there is extension in the tangential direction. There is also a stress in the tangential direction which tends to burst the hub across the diameter. This stress produces extension in the tangential direction and also compression in the radial direction. Consider now the material in that portion of the hub immediately next to the bore. This is a thin ring of metal the circumference of which is increased directly by the tangential stress. However, the compressive radial stress also tends to produce extension in the tangential direction, so that the total increase of circumference exceeds that produced by the tangential stress, if acting alone, by an amount which is 0.3 of the direct compression produced by the radial stress acting alone. Similarly, there is a decrease in thickness of the ring due to the radial stress directly, and a further decrease in the thickness due to the tangential stress.

In the case just considered one of the stresses was a tensile stress and the other a compressive stress, and the deformation in each direction was greater than that pro-

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duced by each stress acting alone. We may, however, have both stresses in the same direction, as in the case of a rotating disk, where there are both radial and tangential tensile stresses. The tangential stress tends to increase the circumference of any thin ring in the interior of the disk, but the radial stress, which causes extension in the radial direction, causes contraction in the tangential direction, so that the net increase in circumference is less than that due to the tangential stress acting alone. Similarly, the net increase in the thickness of any thin ring is less than that produced by the radial stress acting alone. If we have a direct stress S_1 it produces a deformation or increase in length in each unit of length, called "strain," amounting to $\frac{S_1}{E}$. If now we have another stress at right angles to the stress S_1 amounting to S_2, this stress produces, in its own direction, an extension in unit length, or strain, amounting to $\frac{S_2}{E}$. At the same time, this stress S_2 produces in the direction of the stress S_1 a contraction equal to $\frac{0.3\,S_2}{E}$. Hence the total extension per unit length, or strain, in the direction of the stress S_1 is:

$$\frac{1}{E}\,(S_1 - 0.3\,S_2).$$

If there are stresses in a third direction, we have to subtract still another term to get the net strain. If the three stresses are equal and of the same kind, the net strain is $(1.0 - 0.3 - 0.3)$ or 0.4 times that due to one stress.

In order to produce the same deformation in unit length, or strain, due to the stresses S_1 and S_2, we would have to have a simple stress equal to $S_1 - 0.3\,S_2$. Such an equivalent simple stress which would produce the same strain as the actual strain existing at any point due to the actual compound stresses, used to be called the "true stress." The actual stresses which we have been discussing and which are given directly by the forces acting on our material were then called the "apparent stresses."

Shear

When a short specimen is compressed in a testing machine, it fails by sliding of the upper part on the lower part at an angle of 45 degrees; that is, the direct compressive stress produces a tendency for the two parts to slide one on the other as shown by Fig. 1. This tendency to slide is called a shearing stress. A tensile stress also causes a tendency to slide. If a tension break in a homogeneous material is closely examined, it will be seen that the actual failure has been due to sliding at an angle of 45 degrees along a number of different faces, some inclined one way and some inclined another. In other words a tensile stress produces a tendency to slide, as shown in Fig. 2. Suppose now that we have in the same cube both tensile and compressive stresses at right angles. Then there is a combined tendency to slide, as shown in Fig. 3. If these stresses are both the same, the tendency to slide is double that produced by either stress if acting alone. It is obvious that in any case of a tensile stress in one direction and a compressive stress at right angles, there is a tendency to slide equal to that produced by a simple stress of an amount equal to the sum of the two existing stresses. That is to say, the shear produced by two stresses of opposite kinds in directions at right angles, is equal to the shear produced by a simple stress which is equal to the sum of the two stresses. When there are three stresses the shear is computed in a similar way which we will discuss later.

Stress Computation

The mathematical theory of elasticity, as it has existed for years, gives means for computing the actual stresses existing at any point of a body, or the "apparent stresses," as they are sometimes called, as well as the simple stresses which would produce equivalent strains, or the "true stresses," and the simple stresses which would produce equivalent shears. There is no difference of opinion about such computation. There are many matters in the theory of elasticity which are difficult of solution but such problems as can be solved are universally agreed upon. Hence, the matters which are not generally handled satisfactorily are not matters of theory of elasticity computation.

Criterion for Equivalent Simple Stress with Compound Stresses

If we had only to deal with simple stresses we would raise no question as to just what happens when the elastic limit is reached. The elastic limit and the beginning of failure may be a matter merely of the stress, or it may be a matter of the strain, or it may be a matter of the shear. However, conditions would be just the same in a piece in which we are interested as they are in the testing machine, so that we know that the beginning of failure, whatever it may be due to, would occur when the testing machine stress is reached. In the case of compound stresses, there is quite a different condition. We may have in a piece in which we are interested a stress which is safe in the testing machine and which would be safe if it existed alone. However, we have in addition stresses in other directions. If it were the direct stress only which counted, and if the existence of stress in other directions did not cause weakening in the direction of the greatest stress, such stress in other directions would be immaterial. On the contrary, if the limit of safety is fixed by the amount of strain or deformation which is permissible, then we would have to take account of stresses in all directions, since each of these produces a strain in any given direction. We would then have to compute the net strain in a given direction, due to all of the stresses taken together.

Suppose that if we had a direct tensile stress of 30,000 pounds alone, we would just be at the elastic limit. If now we have in addition a tensile stress at right angles, this would diminish the strain produced by the first stress, so that the net strain would be less than that corresponding to a simple stress of 30,000 pounds. Hence if net strain counts, our material would be strengthened by the existence of this second tensile stress at right angles to the first. On the contrary, if the second stress were a compressive stress, it would cause a strain which would have to be added to the original strain, so that weakening would result. A similar situation exists if it is shear which we have to attend to. A direct stress produces a certain shear and the existence of a stress at right angles produces additional shear which is to be added to or subtracted from the first, according to the direction of the second stress. The strain produced by two equal stresses at right angles, one tensile and one compressive, is 1.3 times the strain produced by either stress alone, while the shear produced by two such stresses is twice that produced by either stress alone.

It is obvious then that we must decide just what sort of action causes failure and just what conditions we are interested in, whether merely the stress itself, the strain, or the shear. Having decided this question, the theory of elasticity gives us more or less easy means for determining the value of a simple stress which in a testing machine would produce the same conditions as those existing in any case of compound stresses.

Maximum Strain Theory

The theory that has in the past been generally accepted is the maximum strain theory. So far as the writer knows there were never any experiments made to demonstrate its validity. It was probably reasoned out by some of the older elasticians purely as a matter of abstract philosophy, and probably considered by them as self-evident. The theory thus crept into use in an unobtrusive way without realization that there had been made an assumption that was not axiomatic. This theory is used in most of the older textbooks and writings, without discussion. This theory supposes that the thing which causes failure and which must be used as a criterion for safety is the amount of deformation or strain. With a modulus of elasticity, E, of 30,000,000, there is a deformation or strain of 0.001 inch in every inch of length with a simple stress of 30,000 pounds. If now 30,000 pounds is the elastic limit, then when we have compound stresses, failure will begin to occur whenever the net strain due to the action of all the stresses together becomes 0.001

inch per inch. This will occur, for instance, with a tensile stress of 39,000 pounds in one direction and a tensile stress of 30,000 pounds in a direction at right angles. Due to the first stress there will be an extension or strain in its own direction of 0.0013 inch in every inch of length. The stress of 30,000 pounds in the opposite direction will produce an extension in that direction of 0.001 inch per inch of length, and hence a contraction in the direction of the first stress equal to 0.3 of this, or 0.0003 inch. The net extension or strain in the first direction will therefore be 0.0013—0.0003, or 0.001. This is the same strain as produced by a simple stress of 30,000 pounds. In the same way a tensile stress of 24,000 pounds in one direction and a compressive stress of 20,000 pounds in an opposite direction may be shown to produce a strain of 0.001 inch in every inch of length. That is to say, according to the maximum strain theory a simple stress of 30,000 pounds per square inch is the stress equivalent in the results produced, so far as failure is concerned, to tensile stresses at right angles of 39,000 pounds and 30,000 pounds, or to a tensile stress of 24,000 pounds in one direction and a compressive stress of 20,000 pounds in the other direction. The well known formulas for stresses in a gun or thick tube, due to Clavarino for the case where there are heads in the end, and to Birnie for the case where there are no heads, are examples of formulas based on the maximum strain theory.

Maximum Stress Theory

The maximum stress theory supposes that failure and elastic limit are purely matters of stress in a given direction regardless of the existence of stresses in other directions. That is to say, if a stress of 30,000 pounds is the elastic limit for a simple stress in a testing machine, it will also be the elastic limit in any case of compound stresses if the stress in one direction is 30,000 pounds and regardless of the existence of lesser stresses, whether tension or compression, in directions at right angles. The formula attributed to Lamé for a thick tube or gun is an example of the application of the maximum stress theory.

Maximum Shear Theory

As a result of some brilliant experiments published in the *Philosophical Magazine*, May, 1900, Mr. J. J. Guest formulated the maximum shear theory. This publication formed an epoch in this subject, and the paper will undoubtedly go down in history as a classic. Mohr, in Germany, reached similar conclusions at about the same time, his publication being in the *Zeitschrift des Vereines deutscher Ingenieure* in January and November, 1900. Since this time, many explanations and discussions have been published on this subject in Great Britain.*

This theory states that the cause of an elastic limit and the criterion for the beginning of failure is the sliding of particles past each other due to shear, and that failure in ductile materials is due to this sliding and not to direct tension. Hence, any case of direct tension or compression produces a tendency to slide and the failure is due to this. A compression failure illustrates this directly. A tension failure if carefully examined will show the same point. It was also known for many years before Guest's publication that at about the time the elastic limit was reached in a tension specimen, lines at an angle of 45 degrees began to appear. It has been shown that this is the indication of failure by shear. The evidence presented by investigators seems to the writer conclusive that this theory must be adopted to the exclusion of the maximum strain and maximum stress theories. It shows that failure by tension and failure by compression are really only different aspects of failure by shear. Failure means the beginning of sliding which is not recovered when the stress is removed and gives permanent set, thus indicating the "elastic limit." It follows, therefore, that the elastic limit will be the same for tension as for compression. This is true for steel and other ductile materials and is in itself a point of evidence in favor of the maximum shear theory.

Cast iron has no elastic limit and the actions referred to do not occur, so that elastic failure does not exist in cast iron as called for by the maximum shear theory. As is well known, the action of cast iron is quite different in tension and compression. Some experimental work on cast iron indicates that rupture with compound stresses occurs when the maximum stress reaches the value causing rupture with simple tension. This, of course, may not mean that a safe compound stress with cast iron occurs when the maximum stress reaches the safe value for tension.

As an example of computation of equivalent simple stress by the maximum shear theory we will take the case of Fig. 3, supposing equal tension and compression stresses of 20,000 pounds per square inch. The equivalent simple stress is 40,000 pounds per square inch. This may be compared with the equivalent simple stresses by the maximum stress and strain theories, respectively, which are 20,000 and 26,000 pounds per square inch. In the case of Fig. 4, the maximum shear theory gives as the equivalent simple stress 20,000 pounds per square inch, and the maximum stress and strain theories give 20,000 and 14,000 pounds per square inch, respectively.

According to the maximum shear theory, a body compressed equally in three directions at once will never fail, no matter how great the stress, since the shear is zero. Some experiments seem to indicate the accuracy of this theory, and the inaccuracy of the maximum stress or strain theories, which call for failure with stresses equal to, and 2½ times, the elastic limit, respectively.

Use of Maximum Shear Theory

From the discussion above of computation of shear, the following rules for computation of the simple stress equivalent to any case of compound stresses follow directly, and these rules should be used in determining failure according to the maximum shear theory. When there are stresses in two directions at right angles, with no stress in the third direction, and with both stresses of the same kind, that is, both compression or both tension, the equivalent simple stress is equal to the greater of the two stresses. In this case the maximum stress theory gives exactly the same results.

When there are stresses in two directions at right angles, with no stress in the third direction, and with the stresses of opposite kinds, that is, one tension and one compression, the sum of the numbers giving the two stresses gives the equivalent simple stress. That is to say, if we have tension of 10,000 pounds in one direction and compression of 5000 pounds in another direction, the situation so far as failure is concerned is exactly the same as if we had a simple stress in a testing machine of 15,000 pounds per square inch.

When there are stresses in all three directions at the same time and all of the same kind, that is, all tension or all compression, we subtract the minimum from the maximum of the three stresses to obtain the equivalent simple stress.

When there are stresses in three directions at the same time, one or more tension and one or more compression, the sum of the numbers giving maximum compression and maximum tension stress gives the greatest equivalent simple stress.

In the case of a beam at the point of maximum stress there is usually stress in a single direction, so that this stress is a simple one and we need make no use of the maximum shear theory. In case of a rotating shaft subject to bending and twisting at the same time, that bending moment which, if existing alone, would give the same conditions so far as failure is concerned, is the square root of the sum of the squares of the actual bending and twisting moments. This is also equal to that twisting moment which, if existing alone, would give the same conditions so far as failure is concerned. In the case of a rotating wheel, such as a turbine disk, there are radial and tangential stresses which are both tensile stresses. Hence, the greater of the two gives the equivalent simple stress, the same as if the maximum stress theory were used. For the case of a thick tube or cannon with

* See "Engineering," July 10, August 21, September 4, October 23, November 6, November 13, November 20, and November 27, 1908; February 5 and August 20, 1909; December 15 and December 29, 1910; "Report of the British Association," Section G, 1913; "Philosophical Magazine," July and December, 1906; "Proceedings of the Physical Society of London," Volume 20; "Proceedings of the Royal Society," Volume 49.

internal fluid pressure P, and ratio of outside to inside diameter R, the maximum equivalent simple stress is

$$\frac{2PR^2}{R^2-1}$$

If a hub is pressed on a solid shaft of the same material, the original difference in diameters being Y inch per inch of bore, with modulus of elasticity E, the maximum equivalent simple stress is EY.

* * *

WORK-HOLDING FIXTURES FOR THE VERTICAL SURFACE GRINDER

The Ritter Dental Mfg. Co. of Rochester, N. Y., makes extensive use of the vertical surface grinder for machining operations in the factory. Some of the work done is quite unusual, yet with the fixtures which have been provided the vertical surface method of finish-grinding has worked out well.

Fig. 1 shows an installation of the Blanchard vertical surface grinder in the shop, and the operator is shown surface-grinding the halves of ball-and-socket joint sections for the Ritter dental engine. These pieces, which are drop-forgings, are held by catching the front ends in V-blocks at the central part of the fixture, while the outer ends are clamped by the hand clamps seen in front of each piece. These act on simple levers, clamping the pieces inward and downward at the same time. After the forgings are located, it is an easy matter to grind them to an even bearing surface, the finish of which is much better than could be obtained by ordinary milling methods. Especially is grinding advantageous as the scale due to the drop-forging operation is difficult to mill.

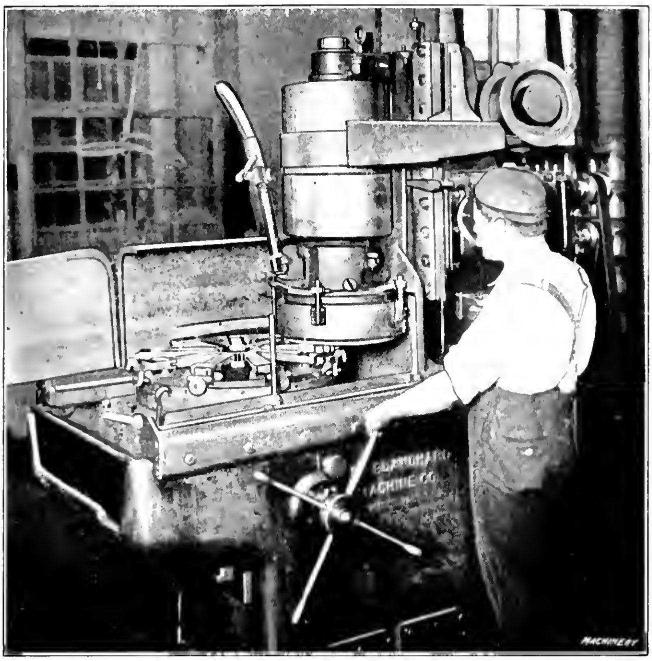

Fig. 1. Facing Forgings on a Vertical Surface Grinder

In Fig. 2 are shown six other grinding fixtures used upon the vertical surface grinder. At A is a fixture for holding small sections of extruded brass. Because of the fact that this metal is extruded, the outlines are all exactly alike; therefore they can be held by the pin method as shown. The pins are located so that several different sizes may be held on the same fixture. In the illustration only a few of the parts to be ground are shown in place, but these are sufficient to illustrate the principle involved.

At B is an unusual fixture for a surface grinder. On this plate there are provisions for holding ten engine castings so that the ends of the cylinders may be faced off. The castings are located with four pins each and are clamped at the sides to hold them firmly down against the fixture.

At C is shown the only magnetic fixture in this lot. This is for holding small thin disks. The disks are made of steel and are grouped in the channels provided on the plate. After one side has been faced off they are turned over and similarly treated on the other side.

At D is shown a fixture for holding the engine bodies in inclined positions for facing off the section which may be seen in the vertical plane on the casting shown on the fixture. This fixture provides for holding six castings, and the method is the best and quickest way of finishing this surface on the casting.

A similar fixture is shown at E. This, however, provides for holding the cylinder castings in a reverse position from that shown in the fixture at D, and is for the purpose of grinding the bases. Ten of the castings are held on this fixture, being bolted with straps between each two pieces.

The fixture shown at F is also for holding extruded brass sections, being of the same design as the fixture illustrated at A. Here, again, a few of the sections are shown in place, only enough being shown to illustrate the principle. C. L. L.

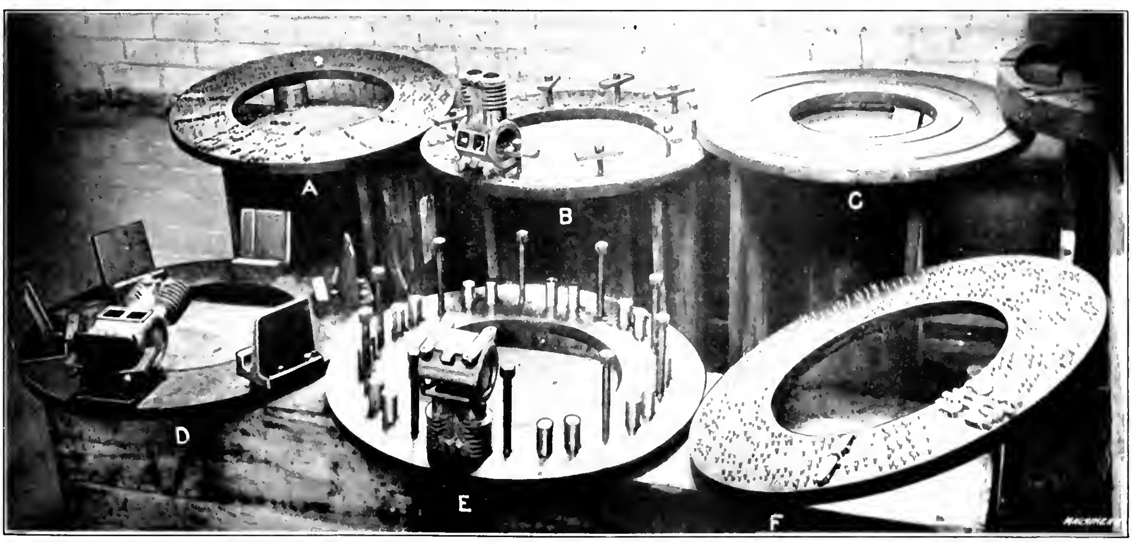

Fig. 2. Six Work-holding Fixtures for a Blanchard Grinder

SOME RECENT IMPROVEMENTS IN CASEHARDENING PRACTICE*

MATERIALS USED FOR CARBURIZING—ACTION OF DIFFERENT MATERIALS—MEANS OF CONTROLLING HEATING FURNACES AND MEASURING HARDNESS OF WORK

THE experiments in casehardening practice referred to in the following were for investigating the materials used for carburizing, the action of different materials, and the means of controlling the heating furnaces, and of measuring the resultant hardness of the work. The experiments began at the furnace end of the problem. At first it was decided to install pyrometers, but this was not done, owing to the high cost of an efficient pyrometric outfit for a battery of thirteen muffles; moreover, it was thought that such an outfit might be too expensive to keep in working order. There was also doubt as to whether thermo-electric and resistance pyrometers would be suitable for a system starting with a hot furnace full of cold work or for ascertaining the temperature of an isolated article.

Optical Pyrometers

Finally, after considerable experimenting, an optical form of pyrometer was adopted containing a dye solution capable of absorbing the rays emitted by the hot steel at various

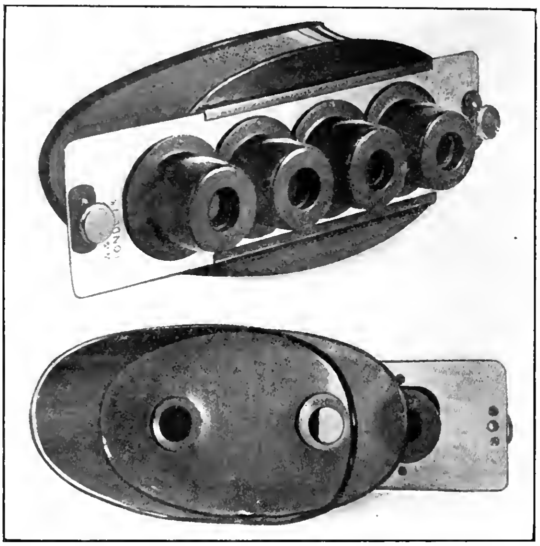

Fig. 1. Front and Rear Views of an Optical Pyrometer having Two Pairs of Cells containing Dye Solution through which Heated Work is observed

temperatures. Front and rear views of one of these pyrometers are shown in Fig. 1. It has an eye-shield to guard the eyes from extraneous light, and instead of two lenses, there are two pairs of dye solutions well protected by caps which also serve to keep out the light. This form is suitable when some particular temperature is required. For instance, the casehardening temperature is controlled by means of an instrument like this, having one pair of cells containing dye solution adjusted to 900 degrees C. and another pair adjusted to 925 degrees C. If the pots containing the parts to be casehardened are visible through the 900-degree pair and invisible through the 925-degree pair, the temperature is considered correct. There is no need to remove the eyes while the pairs are being changed, as the aluminum carrier can be shifted from one side to the other.

For reheating work, and for hardening tools, a single pair is all that is necessary. The hardening temperature is attained as soon as the work appears just visibly red. For double reheating two pairs are, of course, necessary. The cells can be interchanged and are readily detachable, so one instrument can be used to ascertain any temperature, provided the object be visibly red hot. The actual container is a glass tube less than one inch long, with accurately fitting glass ends held together on rubber rings by two telescoping brass tubes. In form, the cell is much like a short polarimeter tube. The caps on the aluminum slides are provided with springs to prevent the cells from falling out.

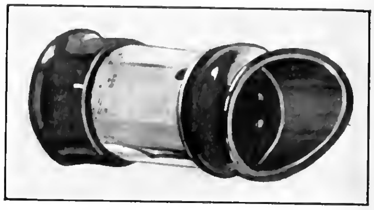

Fig. 2. Adjustable Form of Optical Pyrometer for Temperatures over 400 Degrees C.

In another form the instrument is adjustable and is either monocular or binocular. The dye solution is contained in expansible cells, and a range of absorptive powers is obtained by altering the length of the column. The first pyrometer of this form was made with two thick glass ends and a length of inner tube from a bicycle tire. On squeezing the glass ends together, the rubber sides bulge outward. This is an example of the present form seen in Fig. 2. The actual container is enclosed in the tube, which is provided at one end with an eye-piece, and at the other with a screw which serves to lengthen the cell until the added part is sufficient to just absorb the light. The temperature is indicated by a scale engraved on the tube. This form of pyrometer is perhaps not quite so accurate as the form with each cell especially made to one temperature. According to a National Physical Laboratory report the error may be ± 10 degrees C. The form shown in Fig. 2 is three inches long by one and one-half inch diameter and is very convenient to use.

The method of determining temperatures is a zero method and is, therefore, more accurate than one involving a comparison of colors; furthermore, the critical point occurs when the eye is shaded from extraneous light, that is, when the pupil is dilated and the retina is in its most sensitive condition. In judging temperatures by the unaided eye errors are caused by (1) extraneous light falling on the eye; (2) the difficulty of remembering close shades of color; (3) errors of judgment in comparing the image of the color observed with a series of mental images of colors previously seen.

All these chances of error are eliminated by an instrument of the kind shown in Figs. 1 and 2. No extraneous light falls on the eyes and no recollection is required; the hardener has simply to look through, wait about half a minute until his eyes have become accustomed to the darkness, and then see whether the object is visible as a dark red patch or invisible. Hardeners seem to prefer to use their eyes for telling the temperature, and these instruments provide pyrometric equivalents for limit gages and micrometers, and at the same time screen the eyes from the

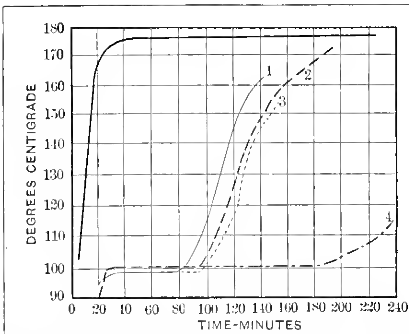

Fig. 3. Curves showing Rise of Temperature in Casehardening Pots filled with Granular Charcoal of Various Sizes containing 6 Per Cent Moisture

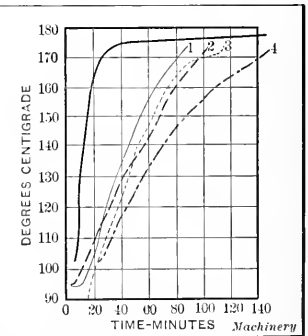

Fig. 4. Rise of Temperature of Dry Charcoal of Various Sizes—compare with Fig. 3

* Abstract of a paper presented before the Iron and Steel Institute, London, by Henry L. Heathcote.

glare and heat of the furnace. The readings are admittedly dependent on the sensitiveness of the eye; if this varies with different workmen, the temperature readings will vary accordingly, being lower the more sensitive the eye. These variations, however, do not greatly affect the accuracy, and from actual experiments it is believed that the variation in sensitiveness, under the actual working conditions of these instruments, is not nearly so great as might be expected.

If the object be a large one, it is advisable to interpose a perforated screen between it and the instrument. One way to make an observation is to adjust the instrument to a lower

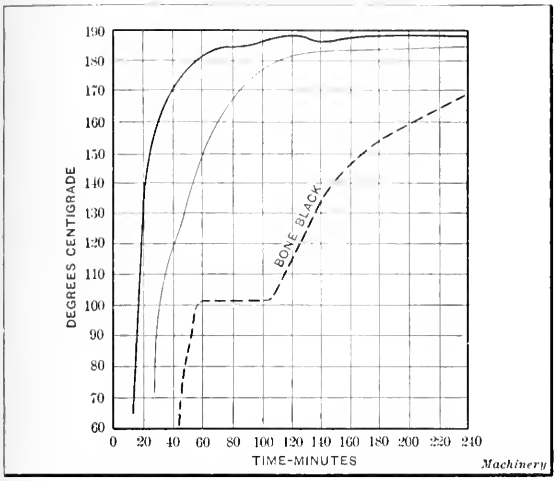

Fig. 5. Comparison in Rise of Temperature of Soda-ash Charcoal Mixture and Bone-black Bone-dust Mixture

temperature than that expected, and then, by sliding darker cells into position, or by unscrewing (if of the adjustable form), darken the image until it just ceases to appear colored. The temperatures engraved on the cell or the body of the instrument will then indicate the temperature of the hot body, provided the conditions of the test are as nearly "black body" as those obtaining when the calibration was effected. These instruments have been applied with satisfactory results to the heat-treatment of steel, carburizing, reheating, annealing, and hardening tools of all kinds.

Casehardening Composition

Having provided a simple and effective device for ascertaining the temperature of red-hot bodies, the nature, mode of action, and effect of casehardening compositions were next investigated. Obviously for carburizing to occur (1) the heat must first penetrate to the steel and raise it to the proper condition; (2) it must liberate and maintain a supply of the carburizing ingredients; (3) the peripheral layers of the steel must combine with (or dissolve) these ingredients; (4) the carbide must diffuse from the periphery inward.

The composition of casehardening materials varies very widely. The following table shows the range of variation in seventeen commercial compositions tested:

TABLE I. VARIATION IN CASEHARDENING COMPOSITIONS

	Per Cent
Moisture	2.68 to 26.17
Oil	0.17 to 20.76
Carbon (organic)	6.7 to 54.19
Calcium phosphate	0.32 to 74.75
Calcium carbonate	1.2 to 11.57
Barium carbonate	nil to 42.0
Zinc oxide	nil to 14.5
Silica	nil to 8.14
Sulphates (SO_3)	trace to 3.45
Sodium chloride	nil to 7.88
Sodium carbonate	nil to 40.0
Sulphides (S)	nil to 2.8

When these experiments were begun the mixture of barium carbonate, 40 per cent, and charcoal, 60 per cent, suggested by Guillet was not in use, and it was usual to use casehardening compositions once only or perhaps twice. Another drawback experienced in commercial operation, for instance, with pots ten inches high by ten inches in diameter, was the difference in the depth of penetration near the middle and the outside of the pot. Some compositions showed as much as 150 degrees C. difference in temperature between the inside and the outside. The author accordingly set out to improve: *Permanence*, and to obviate loss of activity and consequent wastefulness; *permeability* to heat, and to obviate unequal heating and casing.

The supposition that the loss of carburizing power was due to loss of nitrogenous constituents was confirmed by early experiments. Spent hardening mixture may contain 12 per cent organic carbon (total carbon less carbon in carbonates), and yet, under similar conditions, have far less carburizing power than fresh material containing less carbon. Such spent mixture gives indication of only traces of nitrogen.

Experiments extending over a considerable time and range of composition have confirmed the following suppositions: (1) the depth of case depends chiefly on the temperature the steel attains and the duration of the hot condition. On these factors depend the rate and extent of the diffusion of the carbon or carbide. (2) The concentration of the carbon in the case depends chiefly on the "activity" of the mixture, or rate at which it or its products part with carbon to the steel. The concentration of carbon in the surface layers may increase or decrease with temperature, but usually increases as the temperature rises and with the time. (3) The duration of the hot condition for a given time of heating depends chiefly upon the permeability to heat of the casehardening composition.

Comparative depth of penetration has been the subject of a number of investigations, but is so much dependent on factors other than the casehardening composition that the author has sought for some other test. The one finally adopted is to take a known volume of the composition and ascertain the volume of the "case" that can be obtained from it without replenishing.

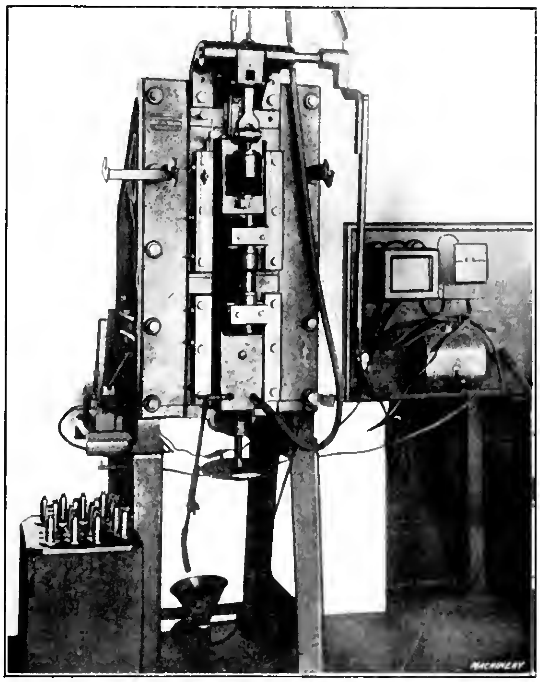

Fig. 6. Electric Welder arranged for tempering Casehardened Articles

The ratio of total volume of case to initial volume of casehardening material affords a good indication of the efficiency of the composition, and is not so dependent as a single penetration measurement on other factors such as size of pot, number and size of the articles it contains, loss of heat from furnace walls when the pot is introduced, etc.

The results of testing some experimental mixtures showed that wood charcoal impregnated with soda ash gave a ratio of 0.116. This mixture is eminently suitable on the score of

permanence, and can be used over and over again indefinitely, provided that the inevitable waste involved in commercial usage is made up from time to time with fresh composition and that the ingredients are well incorporated and in the proper proportions.

Permeability to Heat

Having found a composition far more permanent in its properties than any then in current use, the author proceeded to investigate the factors concerned in permeability to heat. Most commercial mixtures consist of or contain a large proportion of small particles which it seems reasonable to expect will block up all the interstices and prevent the free passage of heat, for it has been shown that the heat conductivity of insulating materials depends chiefly on their air spaces. To test this point, granular charcoal was employed, and two model casehardening pots, 5 inches high, 3.7 inches in diameter and 0.04 inch thick, were made of sheet steel and welded together. One contained the charcoal under investigation, and the other was used empty. A thermometer bulb was placed at the center of each pot and the apparatus placed in an oven at 180 degrees C. Fig. 3 shows the rise of temperature with time. The curve on the left shows the temperature at the middle of the empty pot; those on the right, numbered 1, 2, 3, 4, refer to charcoal of various sizes, each containing approximately the same proportion of moisture and taken from the same sack.

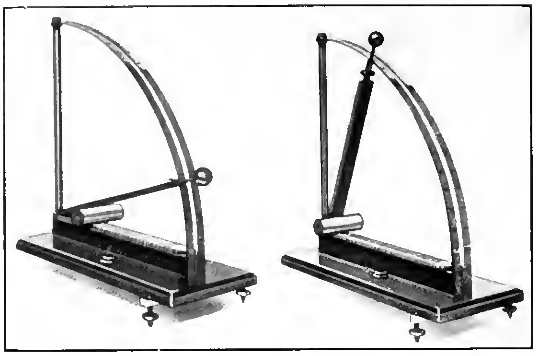

Fig. 7. Quadrant Sclerometer for testing Hard and Soft Bars—Two-file Form

Two striking points are brought out by these results: First, the arrest of temperature at the center at about 100 degrees C. while moisture is being driven off; and second, the effect of size of grain and particularly of dust upon the duration of the arrest. When the same samples were again heated the temperature rose much more quickly (see Fig. 4). The absence of any arrest is, of course, due to the moisture having been expelled during the previous tests.

A mixture which can be used over and over again possesses the great advantage that moisture, oil and other volatile constituents have, for the most part, been already expelled by the previous heatings. This is illustrated by the results plotted in Fig. 5. The curve on the right refers to a mixture of bone-black and bone-dust; and the middle one to the soda ash and charcoal mixture (consisting of three parts used to one part not used) freed from all small particles and dust by means of a sieve with round holes 0.08 inch in diameter. The two mixtures were heated at the same time. The curve on the left shows the rise in temperature of a similar empty pot.

To see if these results represented anything of commercial importance, some tests were made with pots ten inches high by ten inches in diameter, with coarse and fine mixtures having the same composition. The same number and kind of articles were packed in each pot, and test-pieces, 1½ inch by ½ inch square, were placed near the top and bottom and at the middle of the pot. The pots were then heated together for five hours, the maximum temperature being about 925 degrees C. These test-pieces were reheated to 760 degrees C. and quenched in water to show the depth of the case. The following table represents the results:

TABLE II. COMPARATIVE DEPTHS OF CASE WITH FINE AND COARSE MIXTURES

	Top	Middle	Bottom
Fine	0.025" to 0.03"	0.02" to 0.025"	0.03" to 0.03"
Coarse as No. 3	0.045" to 0.05"	0.04" to 0.04"	0.045" to 0.05"

Composition of the Case

Having secured a considerable improvement in both permanence and permeability to heat, it remained to ascertain whether this composition imparted a suitable percentage of carbon and gave uniform results from day to day. W. T. Flather, who has made a great number of determinations of carbon in the successive layers of the case, carburized some bars of "Ubas" steel in his standard pot and under his standard conditions, but using the dust-free charcoal impregnated with soda ash (three parts used to one part fresh). The bars were ⅝ inch in diameter and 6 inches long, and were carburized four hours at 925 degrees C. Successive layers, 0.0025 inch thick, were turned off and the carbon content of each layer determined. The surface layer contained 1.050 per cent of carbon; the twentieth layer, 0.440 per cent; and the fortieth layer, 0.205 per cent. The even gradation of the carbon content from surface to core was noteworthy.

In a test on a commercial scale, extending over twenty-nine days, test-bars one inch in diameter were carburized along with ordinary work at 900 degrees to 925 degrees C., the mixture being replenished once or twice a week to make good the inevitable waste. The bars were cooled in the pots, and the surface layer turned off and analyzed. The results follow:

New mixture	0.967 per cent carbon
End of first day	0.909 per cent carbon
End of fourth day	0.981 per cent carbon
End of twenty-ninth day	1.06 per cent carbon

The author considers 0.9 to 1.1 carbon satisfactory, and preferable to less than 0.9 per cent. The cementite does not appear to form laminæ unless the percentage of carbon is greater than 1.05; and for work that has to be ground a slight degree of supersaturation at the surface is considered necessary. Charred leather at 1000 degrees C. imparts about 1.3 per cent carbon; at 925 degrees C. about 1.2 per cent carbon; and Guillet's composition(barium carbonate, 40 per cent; wood charcoal, 60 per cent) at 925 degrees C. about 1.2 per cent.

These analyses disclose the average carbon content of the layer in question, but they do not give any evidence of uniformity. It is quite possible that a composition having large grains may produce local inequalities in the degree of carburization. To test this point, the author has employed the coloring solution, also the scleroscope and sclerometer referred to later. Even when the case on 1-inch bars of "Ubas" steel was not more than 0.012 inch deep, the color developed showed no indication whatever of local paucity of carbon. These bars were carburized in mixture made with grains of charcoal which would not pass through a sieve having five meshes per linear inch, and the bars were uniformly hard all over, even after grinding off the outside layers of the shallow case. On account of the low specific gravity of the composition and its comparative freedom from dust, oil and moisture, the heating-up period is a smaller proportion of the total time, so less judgment is

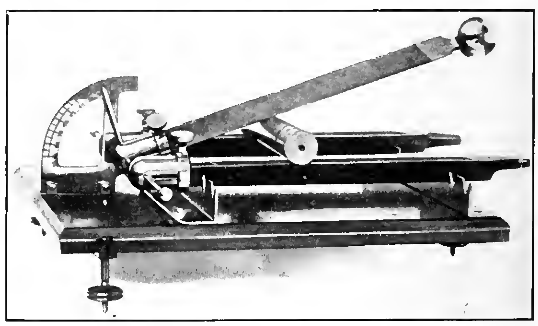

Fig. 8. Quadrant Sclerometer of Adjustable Three-file Form

required in allowing for the size of pots, etc. The productive capacity of the hardening plant and staff is correspondingly increased, and the steel too is all the better for the shorter heating.

An Improvement in Tempering

The use of hot tallow and lead for tempering is, of course, well known; but the application of an electric welder, which, the author believes, was originated by V. A. Holroyd, presents some novel and advantageous features. Fig. 6 shows an electric welder arranged for tempering casehardened articles. It is particularly useful for local softening or tempering, and, unlike tempering in tallow, the core of the article is left softer than the outside. This is especially advantageous for casehardened parts. The operation is a very quick one, and the surface is left quite clean.

Methods of Testing Hardness

So far as the author is aware, very little work has been done to provide commercial means for testing the suitability of casehardened articles. The practice of examining test-pieces carburized, heat-treated and hardened along with each batch is, of course, sound as far as it goes. The Shore scleroscope and Brinell test have their spheres of usefulness, but still the file is the instrument most used, and perhaps rightly, for it does give an idea of the resistance the surface of the article offers to abrasion under pressure, which is what most articles are casehardened to withstand. This and the Brinell test are, we believe, the instruments in commonest use for testing casehardened work and test-pieces.

Fig. 9. (A) Quadrant Sclerometer for testing Flat Surfaces (B) Quadrant Sclerometer for testing Concave Surfaces

For small articles a modified center punch is particularly suitable for rapidly getting a working idea as to whether the case is above the minimum permissible depth. An ordinary six-inch Brown & Sharpe automatic center punch is used. To the end has been fitted a screwed-on container for holding a 1/8-inch bicycle ball. The hard point has been removed and the container screwed on in its place. The ball protrudes just sufficiently to prevent the container from coming into contact with the article under test. This tool is very useful for large as well as small articles, and its readings appear to refer more to the case and less to the core than those obtained with a Brinell testing machine.

An Improved Sclerometer

On account of the variable element in testing resistance to abrasion with a file by hand, the author sought to devise means for measuring the friction under a given load. Small flat articles can be placed on the top of a file, and the hardness gaged by raising one end of the file and observing the angle when the article slides. This led to placing the article under the file so that its weight causes relative motion, which motion ceases (if not too rapid) when the frictional forces are great enough. The instrument shown in Fig. 7 is for testing round surfaces. A soft bar holds the top file up so that it makes an angle of about 70 degrees with the bottom one. A hard bar will not hold the file up until the angle falls to about 15 degrees to 20 degrees. The actual angle is indicated by figures engraved on the slotted quadrant. A hardened and tempered bar gives readings between these angles according to the degree of temper. Another form adapted to take larger articles is made with "three-cornered" files, so that the outer two can be moved further apart at will. This is shown in Fig. 8.

For concave surfaces, such as the ball races of motor-car bearings, a different type (seen at *B*, Fig. 9) is employed. The essential part of this is a short piece of round file which, with its two ends resting on the bearings, slides down one side or is deflected as the bearing is rotated. The angle taken up depends on the hardness and consequent friction, and is measured on a graduated quadrant. For flat surfaces, the instrument shown at *A*, Fig. 9, is used. A short file is mounted in a holder which slides along a smooth bar until friction arrests the motion.

That the quadrant sclerometer is very sensitive is shown by the way it detects slight degrees of tempering. Several are in regular use at both the Rudge-Whitworth Works, where they have to a large extent superseded the cruder hand test with ordinary files. They are handy and capable of dealing with large quantities of work in a short time. Instead of files, carborundum or alundum sticks or pencils may be employed, but files give very good results and last many months without showing any errors due to wear, provided they are properly made and appropriately aged before use. Various standards have been adopted for different articles, and the angle should come between the specified limits.

Production of Colors on Hardened Work

Many articles, such as cups and cones, cannot be conveniently tested with a scleroscope or sclerometer on account of their shape. Realizing the need for some method which would enable articles of all sorts to be tested in bulk, the author turned his attention to the production of colors on hardened surfaces which would afford an indication of the nature of the steel composing such surfaces. The ordinary solutions employed by the metallographer are unsuitable for commercial application; some because of their inflammability, others because they will not flow evenly over a somewhat oily or greasy surface. A suitable solution which has been found to give satisfactory results consists of alcohol, 1 liter; distilled water, 1 liter; nitric acid, pure, 100 cubic centimeters.

Articles ground or polished after hardening and immersed in this for one-quarter to one minute are stained brown or light blue where the structure is martensite; dark blue or dark grey where there is troostite; and hardly stained at all on ferrite or pearlite. By treating hardened articles in this way inequalities are rendered visible and can readily be detected. The fact that the whole of the surface is tested, and not merely the parts touched by the file, sclerometer or scleroscope is an enormous advantage for commercial purposes. The test reveals at once spots that have been splashed before quenching, also superficial tempering due to a glazed surface on the grinding wheel or to excessive pressure. It does not appear to be possible to obtain a colorimetric scale of hardness in this way, but when a number of articles are dipped at the same time, the eye readily detects those that have a different appearance and all that is then necessary is to check the odd ones with a file or sclerometer. This test is also suitable for tools and complicated articles that cannot conveniently be tested with an instrument. It also shows the depth of case if a part is left on and ground away, and should prove useful for ascertaining whether an article has been properly tempered or not.

A PLEA FOR ACCURATE PATTERNMAKING

A DISCUSSION OF THE RELATION BETWEEN THE PATTERN SHOP, FOUNDRY AND MACHINE SHOP

BY HARRY E. HARRIS*

There is probably no factor in machine shop work which causes more uncertainty than the accuracy of the work of the patternmaking department. Where only a few pieces are to be made, a little extra machine work required to correct the result of the patternmaker's lack of foresight or the molder's carelessness does not amount to much. But in the case of interchangeable manufacture on a large scale, where competition makes the price obtained for the work relatively low, it is safe to say that too great refinement in patternmaking is impossible. Proper construction of the pattern, making suitable allowances for coring, shrinkage, rapping and fitting of the core prints, are far more important factors in the cost of production than is generally realized.

The removal of fins frequently left around cored holes is quite an item of expense in the foundry and may be regarded as an indication that the cores were loose in the molds.

DECIMAL EQUIVALENTS OF AN INCH WITH CORRECTIONS FOR SHRINKAGE

Size	Decimal Equivalent	Shrinkage in Inches per Foot $\frac{1}{8}$	Shrinkage in Inches per Foot $\frac{3}{16}$	Size	Decimal Equivalent	Shrinkage in Inches per Foot $\frac{1}{8}$	Shrinkage in Inches per Foot $\frac{3}{16}$
$\frac{1}{64}$	0.01563	0.0158	0.0159	$\frac{33}{64}$	0.51563	0.5210	0.5237
$\frac{1}{32}$	0.03125	0.0316	0.0317	$\frac{17}{32}$	0.53125	0.5368	0.5396
$\frac{3}{64}$	0.04688	0.0474	0.0476	$\frac{35}{64}$	0.54688	0.5526	0.5555
$\frac{1}{16}$	0.0625	0.0632	0.0635	$\frac{9}{16}$	0.5625	0.5684	0.5713
$\frac{5}{64}$	0.07813	0.0789	0.0794	$\frac{37}{64}$	0.57813	0.5842	0.5872
$\frac{3}{32}$	0.09375	0.0947	0.0952	$\frac{19}{32}$	0.59375	0.5999	0.6031
$\frac{7}{64}$	0.10938	0.1105	0.1112	$\frac{39}{64}$	0.60938	0.6157	0.6189
$\frac{1}{8}$	0.125	0.1263	0.1270	$\frac{5}{8}$	0.625	0.6315	0.6348
$\frac{9}{64}$	0.14063	0.1421	0.1428	$\frac{41}{64}$	0.64063	0.6473	0.6507
$\frac{5}{32}$	0.15625	0.1579	0.1587	$\frac{21}{32}$	0.65625	0.6631	0.6665
$\frac{11}{64}$	0.17188	0.1737	0.1746	$\frac{43}{64}$	0.67188	0.6789	0.6824
$\frac{3}{16}$	0.1875	0.1895	0.1904	$\frac{11}{16}$	0.6875	0.6946	0.6983
$\frac{13}{64}$	0.20313	0.2053	0.2063	$\frac{45}{64}$	0.70313	0.7105	0.7142
$\frac{7}{32}$	0.21875	0.2210	0.2222	$\frac{23}{32}$	0.71875	0.7263	0.7300
$\frac{15}{64}$	0.23438	0.2368	0.2381	$\frac{47}{64}$	0.73438	0.7420	0.7459
$\frac{1}{4}$	0.250	0.2526	0.2539	$\frac{3}{4}$	0.750	0.7578	0.7618
$\frac{17}{64}$	0.26563	0.2684	0.2698	$\frac{49}{64}$	0.76563	0.7736	0.7776
$\frac{9}{32}$	0.28125	0.2841	0.2857	$\frac{25}{32}$	0.78125	0.7894	0.7935
$\frac{19}{64}$	0.29688	0.3000	0.3015	$\frac{51}{64}$	0.79688	0.8052	0.8094
$\frac{5}{16}$	0.3125	0.3158	0.3174	$\frac{13}{16}$	0.8125	0.8210	0.8252
$\frac{21}{64}$	0.32813	0.3316	0.3333	$\frac{53}{64}$	0.82813	0.8367	0.8411
$\frac{11}{32}$	0.34375	0.3474	0.3491	$\frac{27}{32}$	0.84375	0.8526	0.8570
$\frac{23}{64}$	0.35938	0.3631	0.3650	$\frac{55}{64}$	0.85938	0.8684	0.8729
$\frac{3}{8}$	0.375	0.3789	0.3809	$\frac{7}{8}$	0.875	0.8841	0.8887
$\frac{25}{64}$	0.39063	0.3947	0.3968	$\frac{57}{64}$	0.89063	0.8999	0.9046
$\frac{13}{32}$	0.40625	0.4105	0.4126	$\frac{29}{32}$	0.90625	0.9157	0.9205
$\frac{27}{64}$	0.42188	0.4263	0.4285	$\frac{59}{64}$	0.92188	0.9315	0.9363
$\frac{7}{16}$	0.4375	0.4421	0.4444	$\frac{15}{16}$	0.9375	0.9471	0.9522
$\frac{29}{64}$	0.45313	0.4579	0.4602	$\frac{61}{64}$	0.95313	0.9631	0.9681
$\frac{15}{32}$	0.46875	0.4736	0.4761	$\frac{31}{32}$	0.96875	0.9789	0.9839
$\frac{31}{64}$	0.48438	0.4894	0.4920	$\frac{63}{64}$	0.98438	0.9946	0.9998
$\frac{1}{2}$	0.500	0.5052	0.5078	1	1.00000	1.0104	1.0157

Machinery

Consequently, when the metal was poured, the cores shifted sufficiently to throw the cored holes off center. The result is that an excessive amount of metal must be allowed for finish so this error may be compensated for in the machining operation, and the removal of this metal often requires two or more cuts to be taken where a single cut might have sufficed. By keeping cored holes to their largest practicable diameter and as close to the central position as possible, the extra metal required and the consequent amount of work in machining is reduced to a minimum. In cases where the hole is to be used for a bearing, a further advantage is secured, owing to the fact that the metal is of much closer grain than it would be if a heavier chip was taken. This is but one instance of the observance of precautions in patternmaking which makes possible material savings in the cost of subsequent machining operations.

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In addition to the saving in machine work, a considerable economy is effected by the reduction in the amount of metal required for the castings. The writer has a case in mind where a certain lever had to have both hubs accurately finished so that they were exactly parallel to each other. This was originally done by leaving 1/16 inch of metal for finishing on each face of the hubs, the machining operation being performed expeditiously by straddle milling. Multiple fixtures were used in connection with high-speed steel cutters and one operator was able to look after three machines. Each of the machines was equipped with two fixtures which were arranged one on each side of the cutter arbor. Thus all three machines were cutting practically continuously, as it was possible for the finished work to be replaced by rough castings in one of the fixtures while the cutters were working on the four levers held in the fixture at the opposite end of the table.

By changing the pattern so that the amount of material to be removed in machining was greatly reduced, it was found possible to finish the faces of these hubs on a double-head disk grinder, and in six months' time the saving of metal and labor effected by this change was sufficient to pay for the new machine. The cost of manufacturing was not only reduced, but the quality of the work produced was better than that which it had been possible to secure by milling. The operator of the grinding machine could remove the few thousandths left on the faces of the hubs almost as fast as he could put the work between the disks and lay it down again. The laborious clamping, cost of cutter up-keep, and trouble with the cutters due to hard scale on the work was eliminated. It was merely necessary for the operator to put fresh abrasive disks on the wheels of his machine every night before going home; this required about fifteen minutes, while the changing of the disks during the day took approximately twenty minutes. In order to secure these advantages, it was necessary for the pattern to be accurately made with proper allowance for rapping and shrinkage. It was also necessary to insist upon good work from the molders. This was obtained by furnishing the foundry with an inexpensive snap gage for testing the castings. These castings were tested again when they reached the machine shop, and any of them which did not check up to the gage were returned and not paid for.

There are many other instances where the ends of hubs and other small surfaces on castings can be economically finished on the disk or surface grinding machine, if the allowance for finishing is reduced to a minimum. This means the saving of a great deal of time which would otherwise be required for planing, milling or facing such parts. The difficulty which lies in the way of taking advantage of these economies is not physical but rather psychological, owing to the fact that the molder does not know much about the use of gages or accurate work until the necessity for it is explained to him. When he once thoroughly grasps the idea, however, that he is to be supplied with accurate patterns and that he can do good work just as quickly as he formerly did inaccurate work, he will be glad to cooperate, particularly when it is explained to him that it will no longer be necessary to file cores and retouch patterns in order to obtain a good job. On the other hand, the demand for good patternmakers who really understand their business far exceeds the supply.

It is usually the case that half the work of the metal patternmaker in the average shop consists of changing the patterns after a run of castings has been made from them, in order to correct slight defects that the molder has managed to develop in the majority of the castings. After the patternmaker has added a little metal at this spot, removed some at other places and bent the pattern a little at certain points, he and his foreman feel satisfied that it is correct. It is more than likely, however, that the next run of castings will show errors, and if such is the case the patternmaker will undoubtedly get the blame. Although it is quite possible that he is not responsible for the error in the castings, he is to blame for not knowing enough about foundry work to know how these errors were developed in castings made from pat-

terns that he knew were accurate. It is quite possible by proper cooperation between the foundry and machine shop, and between the molder and the patternmaker to secure results in the way of economy that should not be overlooked by the management of any progressive plant. It is not claimed that it is always possible to make a pattern the first time so that the castings will leave nothing to be desired; but any necessary changes and corrections should be accurately and intelligently made after conducting a careful study of the conditions which necessitate such modifications.

The writer has intimate knowledge of conditions in a certain firm engaged in the manufacture of relatively small parts, where all allowances and dimensions are figured out by the engineering department, after it had conducted a careful investigation. For instance, with fine sand for light work it was found that the minimum fillet to be allowed on any inside corner must be at least 0.020 inch. A coarser sand would naturally require a larger fillet and *vice versa.* Sharp corners had to be rounded to a corresponding degree. The observance of these directions was found to aid the molders to produce good clean molds. In order to prevent the formation of fins, it was necessary for the cores to be an accurate fit in the core prints in the mold. A print on the pattern made the same size as the core box would not give this result, as the rapping of the pattern and the shrinkage of the cores would be responsible for a serious inaccuracy. To illustrate, it was found that a core print 1 inch in diameter on the pattern enlarged the print in the mold approximately 0.012 inch, due to rapping; and that when the cores were baked, they shrunk 0.008 inch. Thus it is obvious that the metal core box should be made 0.008 inch larger than the desired size of the cored hole, and that the prints on the patterns should be 0.012 inch smaller. Where the print joins the body of the pattern, a 0.020 inch fillet should be provided. Patterns were made according to these specifications and the molders were very much pleased after they had used them.

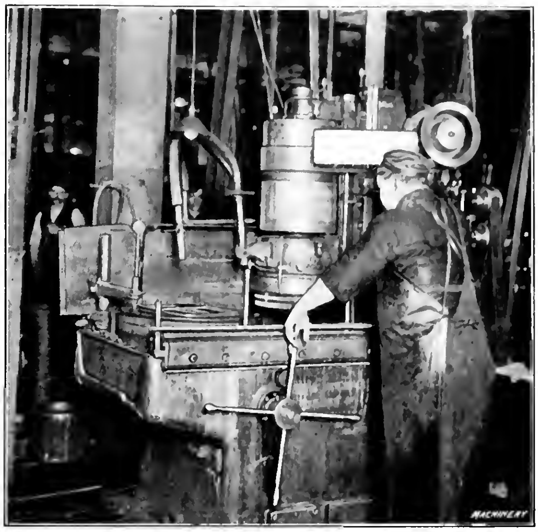
As this method was used on all of the regular manufacturing work done by this company, there was a good deal of calculation to be performed to determine the shrinkage in different cases. To simplify this work, a table of shrinkages was figured out. This table is the means of saving a great deal of mathematical work in determining shrinkage to 0.0001 inch, and it is also the means of avoiding errors in calculation. It is presented herewith in the hope that it may be of value to other readers of MACHINERY. As metal patterns become more generally used, it is possible that micrometers and vernier scales giving readings of over-size dimensions may be developed which are made for use as shrink rules. In this way, dimensions could be taken direct from the work or drawing, instead of requiring to be re-figured to provide for shrinkage.

By way of conclusion, it may not be out of place to say a few words in regard to the composition of metal patterns and core boxes. A long series of experiments in the foundry of the company previously referred to, showed that the cast-iron patterns and core boxes which have rusted on the surface and been subsequently treated with beeswax, were capable of producing the greatest number of castings with the minimum amount of trouble. Brass and white metal patterns and core boxes appeared to get greasy and sticky, and a further disadvantage was due to the fact that they were heavier and more easily bent. Experience has also shown that they are not so easily withdrawn from a sand mold. The chief advantage of brass for use in making metal patterns is the ease with which an error can be corrected or changes made by adding solder patches. White metal is inexpensive and patterns may be quickly made from it for handling "hurry jobs;" but neither of these metals is as durable as iron or steel. They lose their shape and accuracy quite quickly, due to the abrasive action of the sand, and many cases are on record where large quantities of castings have had to be discarded because they were under size, the cause being finally traced to the wear developed in brass or white metal patterns. If properly rusted and waxed, however, cast-iron patterns will last almost forever. They should be re-waxed occasionally, this being done by simply warming them, rubbing the wax over the surface and then rubbing the surface off before the patterns get cold, in order to remove the excess wax.

* * *

HOLDING COPPER ON A MAGNETIC CHUCK

We all know that copper is not magnetic and could not ordinarily be held on a magnetic chuck. Yet in the accompanying illustration is shown the method that the Pierce-Arrow Motor Car Co. of Buffalo, N. Y., employs in holding copper pans on the magnetic chuck of a vertical surface grinder. The grinding operation on the pans consists in facing off the upturned edges to the finished height. The



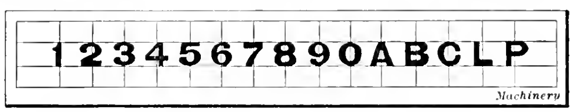
Grinding Copper Radiator Ends on a Blanchard Grinder

metal of the pans is about 1/16 inch thick, and the flange is turned up for a distance of approximately ½ inch. Therefore, in order to hold these pans to the magnetic chuck, steel plates are placed inside the pan, through which the magnetic chuck acts, pulling the blocks and consequently the pan down to the chuck. This is a good method of holding these pieces and the grinding operation is performed without difficulty. C. L. L.

* * *

METHOD OF NUMBERING DRAWINGS

The accompanying illustration shows a method for rapidly placing the drawing numbers on drawings. A small slip of tracing cloth is provided with figures and letters as shown. When the drawing number and symbols for a drawing are to



Figures and Letters on Piece of Tracing Cloth used as a Guide in placing Numbers on Drawings

be printed on it, it is only necessary to slip this piece of tracing cloth underneath the tracing, and copy off the required letters and figures free-hand. In the case shown, only five letters were used in addition to figures to designate the drawing numbers. The whole alphabet, of course, could be treated in the same manner. The vertical and horizontal lines drawn help to locate the piece of tracing cloth in the right position beneath the tracing when numbers consisting of several figures are to be printed.

* * *

An endowment of $2000 has been received by the American Society of Mechanical Engineers from Henry Hess, one of its members, the income from which is to be used for prizes for technical papers prepared by junior and student members.

LOBDELL CALENDER ROLL GRINDING MACHINE

DETAILS OF AN INGENIOUS FORM GRINDING MECHANISM USED IN CROWNING THE TOP AND BOTTOM ROLLS OF A SET

The manufacture of paper requires some of the most ponderous and costly machinery used in any line of manufacture. A continuous paper-making machine of the Fourdrinier type is perhaps 80 to 90 feet long, beginning at the breast box, from which the pulp is deposited on the endless wire screen belt, and ending with the finished roll of paper. The machine is divided into two parts known as the wet and dry ends, respectively. The wet end includes the stuff box, sand table, strainer, breast box, deckel straps, dandy roll, couch rolls, endless felt belts, first-press rolls and second-press rolls. The dry end, as the name implies, dries the wet paper web by passing it over massive drying cylinders, thence to the nip rolls and over more drying cylinders, and finally to the calender rolls which give it uniform thickness, hardness and surface finish.

The great size and weight of the calender rolls, of which there may be two or three stacks, are astonishing to one unfamiliar with paper making. The illustration Fig. 1 shows a stack composed of twelve rolls, the total weight of which is over 40,000 pounds. This stack is a baby, however, compared to some that have been made. Rolls 200 inches long and 30 inches in diameter have been made for some of the largest paper-making machines. Now, when it is taken into account that these rolls must be as hard as the traditional "hub of Hades" and perfectly round and highly polished, the problem of production seems sufficiently difficult, but when, in addition, it is considered that the bottom and top rolls have to be ground large in the middle, tapering to the ends, in order to compensate for deflection, the problem becomes still more difficult. But like many other tasks which appear very difficult to the layman, it is handled with precision and certainty in several plants in the United States that make a specialty of grinding calender rolls.

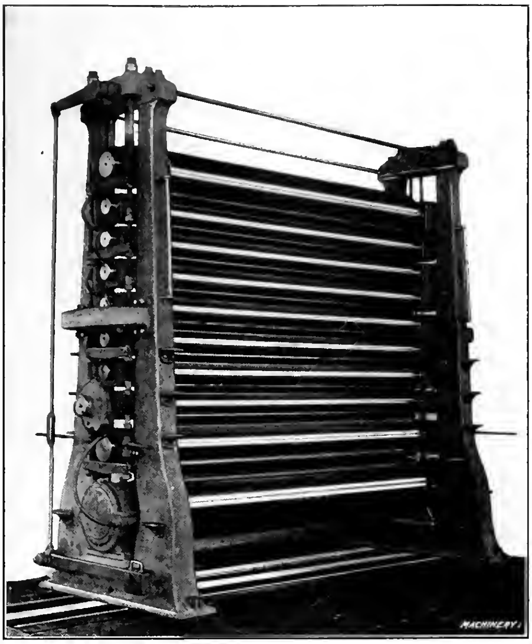


Fig. 1. Stack of Twelve Ground Paper Calender Rolls

The Lobdell roll grinding machine of the electrically-driven type, made by the Lobdell Car Wheel Co., Wilmington, Del., is shown in Fig. 2. This machine is built in three sizes, the smallest having capacity for rolls up to 18 inches diameter, and the largest, for rolls up to 30 inches diameter. The length of calender rolls varies, a not uncommon length being about 100 inches. Some of the rolls are hollow for steam coils, but as many are solid castings it is evident that the machine must be of massive construction to support the great weight of the roll. The largest size machine has a bed 23 feet 6 inches long and weighs 30,000 pounds.

The rolls are supported on their journals by V-blocks which are adjustable on the bed for various lengths. The V-blocks have been found best for this work, inasmuch as the journal automatically centers itself and requires no lateral adjustment. Two grinding wheels are provided, one on each side of the roll. The wheels are each driven by two belts. The spindle bearings are a plain taper and are supported in phosphor-bronze bearings, a construction peculiar to the Lobdell roll grinding machine and the result of many years' experience with this peculiar type of grinding. Calender rolls must be ground with great accuracy and to the utmost smoothness, and the metal is dense chilled cast iron. The grinding wheels are mounted on a carriage, and in the case of the motor-driven machine the carriage also carries the motors overhead. In the case of the belt-driven machines, two overhead drums are provided of a length equal to the longest traverse required.

The grinding wheels are mounted on opposite sides of the roll and the thrusts of the wheels against the roll are bal-

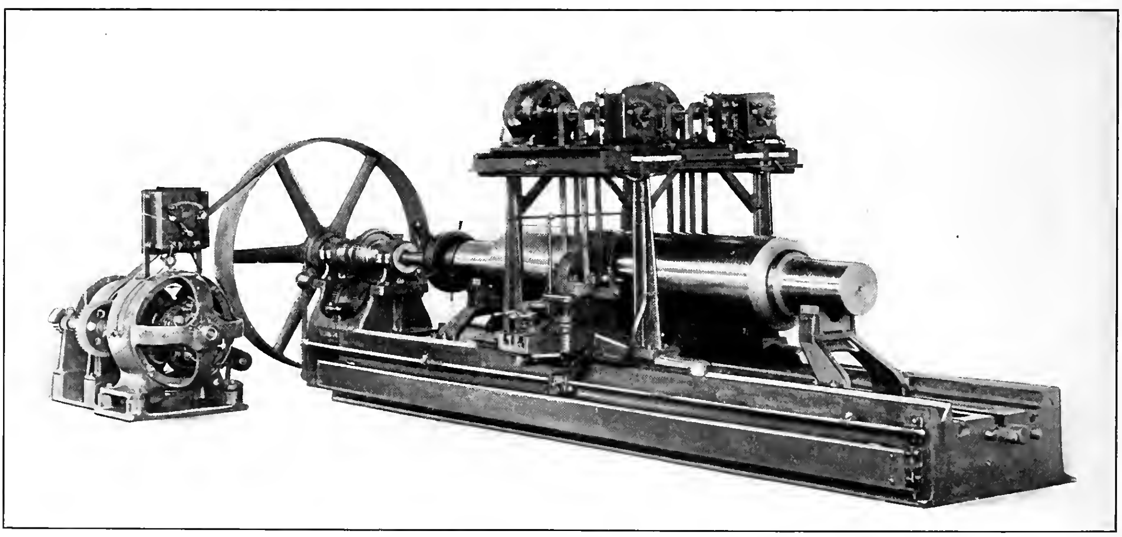


Fig. 2. Lobdell electrically driven Roll Grinding Machine

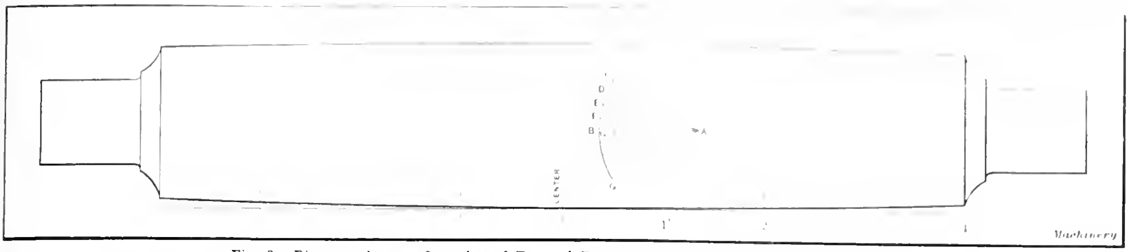


Fig. 3. Diagram showing Crowning of Top and Bottom Rolls to compensate for Deflection

anced. The wheels are comparatively narrow, the usual width being about 1½ inch, and the feed of the carriage is somewhat less than the wheel width, of course, as is usual in all cylindrical grinding operations. The roll is flooded during grinding.

As will be noted in Fig. 1, a stack of calender rolls is erected so that the entire weight is carried on the bottom roll. Besides this, additional load is imposed by weights acting through a system of multiplying levers. The effect of the superimposed load, which may amount to 50,000 pounds, is to deflect both the top and the bottom rolls an appreciable amount. To compensate for this deflection, both the top and the bottom rolls must be ground with a "crown," that is, larger in the center than at the ends. The amount of crown varies with the diameter and length of roll, being 0.010 inch in the case of 16-inch rolls, 116 inches long.

It is evident that an ordinary former or guide for producing the crown is open to several objections. The crown is so small that it would be difficult to make a long guide with the required amount accurately apportioned to each foot of

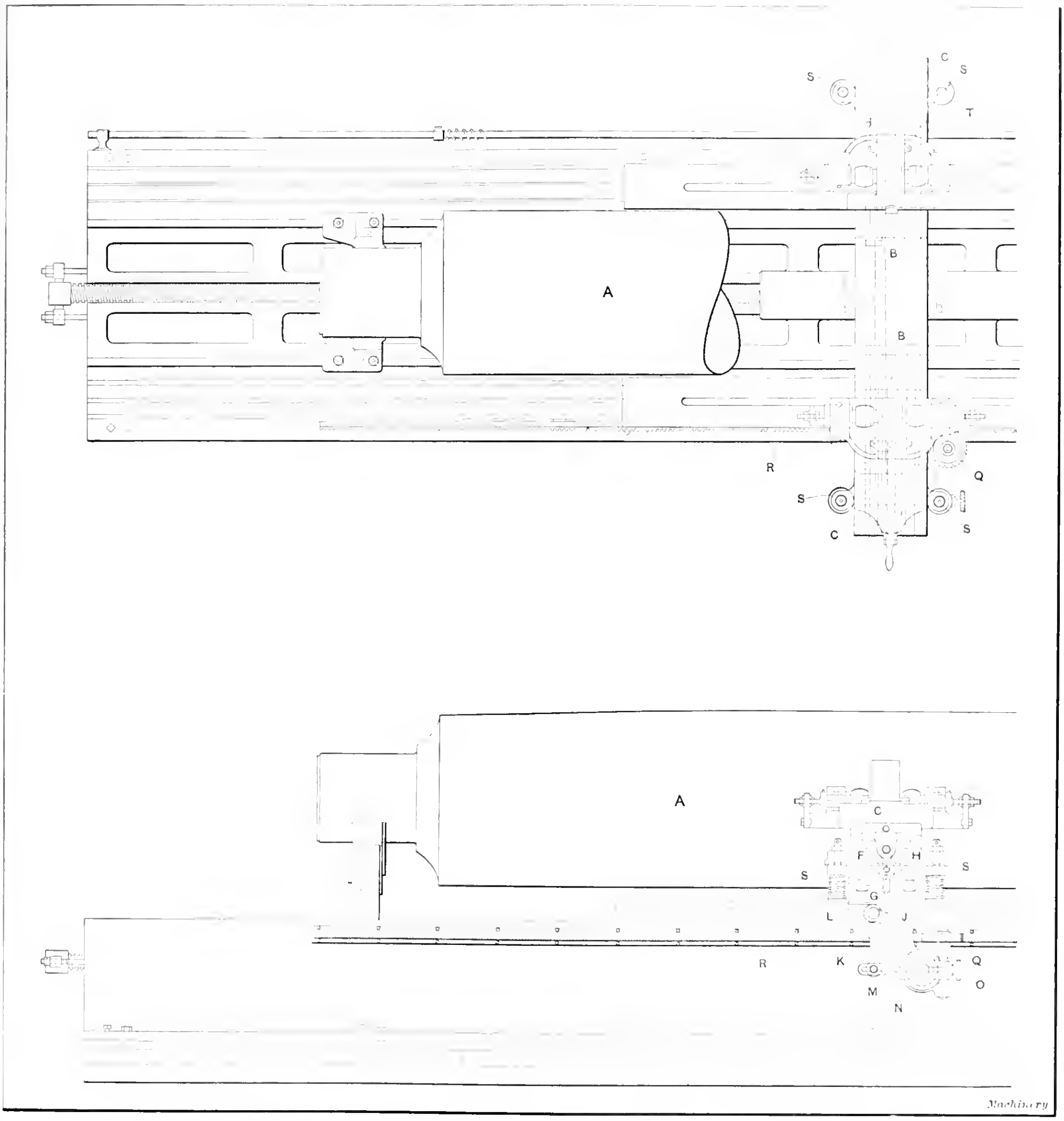


Fig. 4. Plan and Elevation of Lobdell Roll Grinding Machine showing Construction of Carriage and Crowning Device

its length. (See Fig. 3.) The crown being so small, the wear of the guide shoes and deflections would tend to destroy its accuracy. Another objection is that either a large number of formers or guides must be provided or means for changing the shape of the guide by set-screws. The latter are objectionable because of the practical impossibility of making the crown uniform. When these difficulties are understood, the fine points of the Lobdell crowning device will be better appreciated.

The construction of the roll crowning device is shown in Figs. 4 and 5. The roll *A* is mounted by the ends in V-blocks and is ground by the opposite wheels *B*. The wheels are given a slight in-and-out movement which makes the roll of the shape indicated in Fig. 3, the movement being controlled by the mechanism about to be described.

The rack *R* is bolted to the front of the bed, and engages with a pinion *Q*. This pinion carries a worm which drives the worm-wheel *N*. On the worm-wheel is a crankpin whose throw is adjustable by means of a screw *O*. The crankpin is connected to the lever *K* by connecting-rod *M*. The lever *K* is mounted on a transverse shaft *L* extending across the bed under the carriage bridge. At each end are two short horizontal levers mounted on *L* on which rest vertical pins *J*, which, in turn, support a bar *G*.

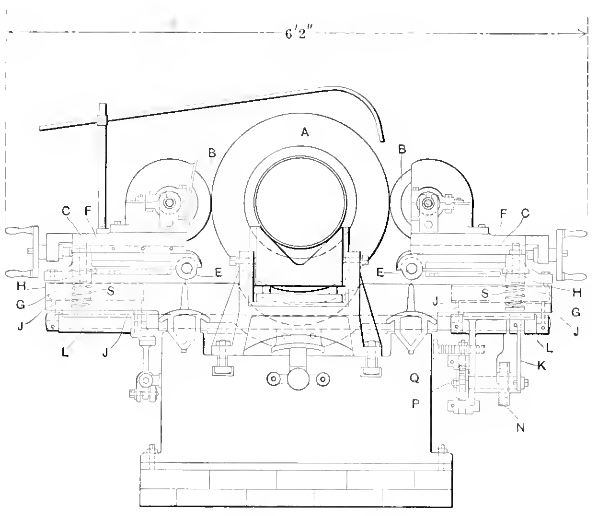


Fig. 5. End View of Lobdell Roll Grinding Machine showing Carriage Construction

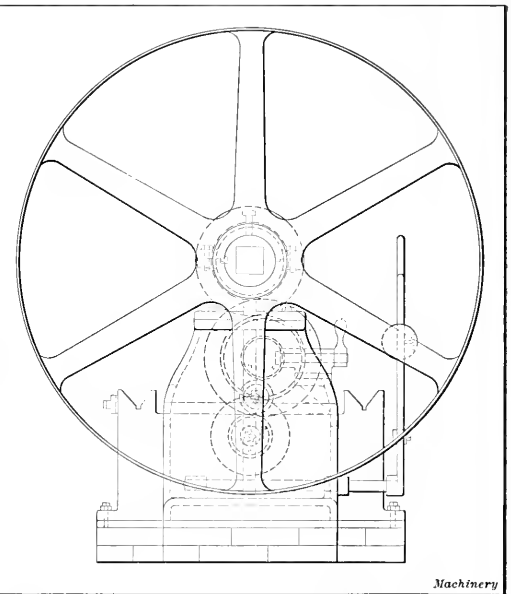


Fig. 6. End View of Lobdell Roll Grinding Machine showing Driving Gear for Roll and Carriage

The function of this train of mechanism is to raise and lower the grinding wheel heads on the pivots *E* and to provide means for making the angular movement the same for a given adjustment for any diameter of roll within the capacity of the machine. The point of contact between the bars *G* and the grinding wheel cross-slide heads is at *H*. It is evident that the rise and fall will be the same for a given adjustment no matter at what point *H* contacts with *G*. The wheel slides have two lateral adjustments, one being by means of the screw and handle which moves the top slide on which the wheel is mounted and a lower slide, the base of which is bolted to the carriage but provided with tee-slots for changing the position laterally. The springs *S* are provided to take up the slack in the mechanism and insure the movement of the wheels in the crowning operation following exactly the curve determined by the design of the mechanism.

The operator is provided with a table of roll lengths, diameters, crowns and crankpin adjustments, from which he can read the adjustment necessary for screw *O* to control the position of the crankpin on worm-wheel *N*. The amount of calender or crown has been carefully determined for all lengths and diameters of calender rolls within commercial limits. For example, 0.010 inch crown is given to a 16-inch roll, 116 inches long. The adjustment required for the crankpin is 0.339 inch eccentricity, that is, it is set to swing in a circle of 0.678 inch diameter. The crown produced is a true arc of a circle in the direction of its length, this fact being indicated by the small diagram within the outline of the roll, Fig. 3.

The carriage is traversed by a square feed-screw which bears throughout its entire length in a groove in the bed. The groove is planed accurately to shape in order to form a solid support throughout the length. A half-nut of phosphor-bronze is engaged with the screw. The screw is reversed at the end of the travel by a feed-rod *T* having adjustable collars which shift the reversing gears into engagement.

F. E. R.

* * *

BLUEPRINT MARKING FLUID

A very useful and absolutely permanent marking fluid for writing in white on blueprints, may be made by taking a little soda ash and making a saturated water solution. This may be done as follows: Take a small bottle and nearly fill it with water; then add the soda ash, shaking the bottle from time to time, until the water will not dissolve any more of the crystals. Next strain the solution to remove the undissolved crystals and any dirt which may be present, and then pour it back into the bottle ready for use. This may be kept indefinitely.

This solution may be applied to the blueprint with either a drawing pen or ordinary writing pen. It works equally well in either case. Where the liquid is applied it bleaches the blue color of the print and leaves it a clear white. It sometimes happens that if the solution has been made too strong, a white powder forms on the lines when they are dry, but this may be brushed off. In such cases, if a little water is added to the bleaching solution there will not be any difficulty of this kind the next time it is used.

If soda ash is not available, an efficient substitute can be prepared by using common baking soda. In this case, however, the lines are not quite so clear and sharp as those produced with the solution of soda ash. If it is desired to make colored lines, a preparation for this purpose may be made by adding ink to a solution prepared according to the preceding instructions. When this is done, the solution bleaches the blueprints so that the colored ink shows up well.

A. C. N.

* * *

Remember that to pull a man down you must get below him.

SCREW MACHINE TOOL EQUIPMENT—2

STANDARD TYPE OF TOOLS USED ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON*

In the following various types of counterbore, boring tool and reamer holders, together with box-tools for straight and taper turning, will be described.

Standard Adjustable Counterbore, Boring and Recessing Tool-holders

A counterbore holder of the adjustable type is shown at *A* in Fig. 8. The front holder or plate *a* is bolted firmly to the shank *b*, and is adjusted by means of four set-screws *c*, only two of which are shown. This holder is made adjustable in order to set the cutting tool perfectly concentric with the hole in the work.

A somewhat similar type of holder is shown at *B*, but in this case it is used for retaining a boring tool. The front part of this tool is adjustable only by means of two set-screws *d*, which work through the shank of the clamping bolt *e*, and in this way secure the desired adjustment to set the boring tool concentric or to the correct diameter. *C* shows a standard type of recessing tool for use in enlarging a hole back from the end. It comprises a shank *f*, to which is fulcrumed a holder *g* on a stud *h*. This tool is operated by means of a cam *i* held in an arm *j* that is clamped to the cross-slide of the machine. Cam *i* comes in contact with the pin *k* on the holder and operates it after the tool has advanced into the hole in the work. A stud in the sliding part of this holder is spring-controlled and contacts with the screw *k* which acts as a stop for setting the cutting tool in a concentric position to enter the hole in the work.

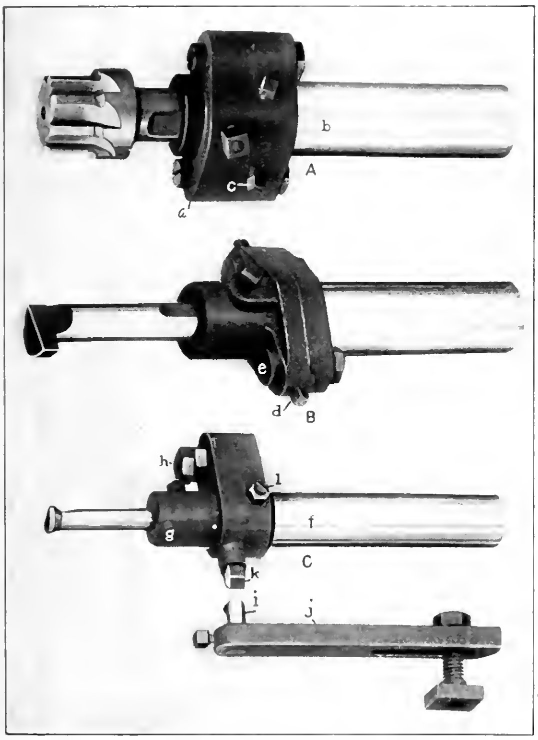


Fig. 8. Standard Adjustable Counterbore Boring and Recessing Tool-holders

High-speed Drill, Boring and Reaming Tool-holders

A high-speed drill-holder that can be used on the larger sizes of machines for increasing the speed of small drills in the turret is shown in Fig. 9. The revolving spindle *a* is mounted in two bronze bearings with the driving gear *b* shown at *B*. The thrust is taken on the ball bearing *c* shown at *C*. The drill chuck *d* is of the spring collet type. The shank *e* is ground to fit the tool hole in the turret and the rear end of this shank is a reservoir for oil which lubricates all the bearings in the holder. Sufficient oil should be put in at the point *f* to completely fill the reservoir. For holding small reamers the spindle *a* is especially constructed to receive a floating type of reamer-holder instead of the drill-holder shown. This holder is driven by a shaft running through the turret shaft and a small pulley belted to the overhead works.

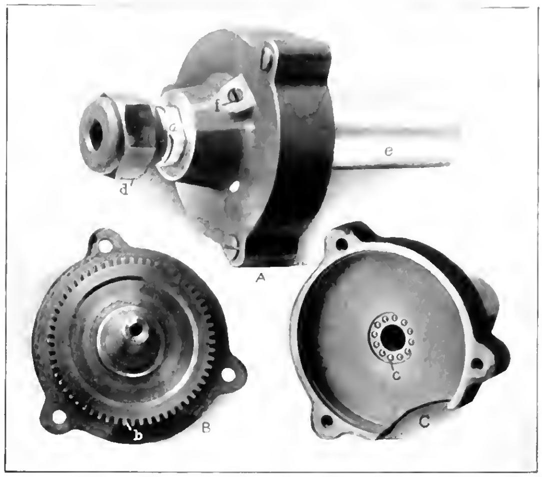


Fig. 9. High-speed Drill-holder

The holder just described is also made up to use with a boring tool and it is shown fitted up in this manner in Fig. 10. In this case the front end of the holder comprises a chuck *a* which is dovetailed to the front part of the holder and is held in position by two studs on which nuts, as illustrated, are fastened. The boring tool is held in this holder by means of a hollow hexagon set-screw. This tool enables boring to be accomplished at a high rate of speed and also gives sufficient adjustment so that the boring tool can be set to bore accurately to size. It is especially adapted for driving small boring tools at a high rate of speed when all the other tools in the turret are larger and require a slow spindle speed for the work.

Roller Steadyrest, Shaving and Roughing Box-tools

A simple steadyrest of the roller support type is shown at *A* in Fig. 11. The roller supports *a* are held in slides *b* which are adjusted by means of screws *c*. The slides are then clamped in the desired position by means of the clamp bolts *d*. A simple type of shaving box-tool is shown at *B* in Fig. 11. This tool is provided with V-supports as illustrated, which are adjusted by the collar-head screw *e* and are clamped in position by means of the clamp bolts *f*. The turning tool *g* is adjusted by a collar-head screw *h* and is held in position by a set-screw *i*. This tool is of very simple construction and is used where only one diameter is to be turned at a time.

C in Fig. 11 shows the standard roughing box-tool. This tool is provided with roller supports which are held and operated in a similar manner to that shown at *A* in Fig. 11, and the turning tool *j* is held in a square hole provided in the stud *k*; this stud clamps the turning tool against the face of the box-tool holder. Adjustment for height is secured by means of the set-screw *l*. Two set-screws, one shown at *m*, act as an adjustment for stud *k*.

The type of box-tool shown at *A* in Fig. 12 accommodates three turning tools, and can also carry a centering tool or drill, which is held in the shank of the holder. The flat arm or member *a* of this box-tool has two splines cut in its face

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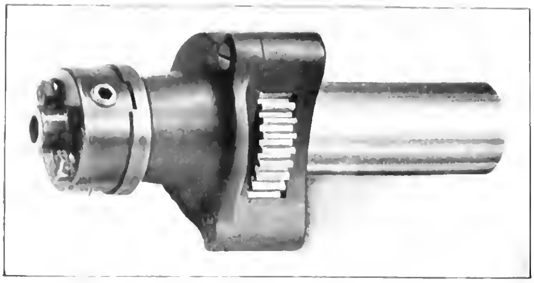


Fig. 10. High-speed Adjustable Boring Tool

the full length, in one of which the three holders *b* for the cutting tools are held, and in the other two the brackets *c* for roller supports. The roller supports are held in the same manner as previously described. This box-tool can be used for turning three different diameters at one setting and is used for roughing or finishing purposes. The roller supports may be adjusted to lead or follow the cutting tools by simply moving them along the slot in the holder. The brackets carrying the supports can be placed in any desired position and the holders for the cutting tools can also be adjusted to suit the various diameters and lengths of shoulders on the work.

An adjustable type of roughing hollow mill is shown at *B* in Fig. 12. This is supplied with four cutters *d* which are

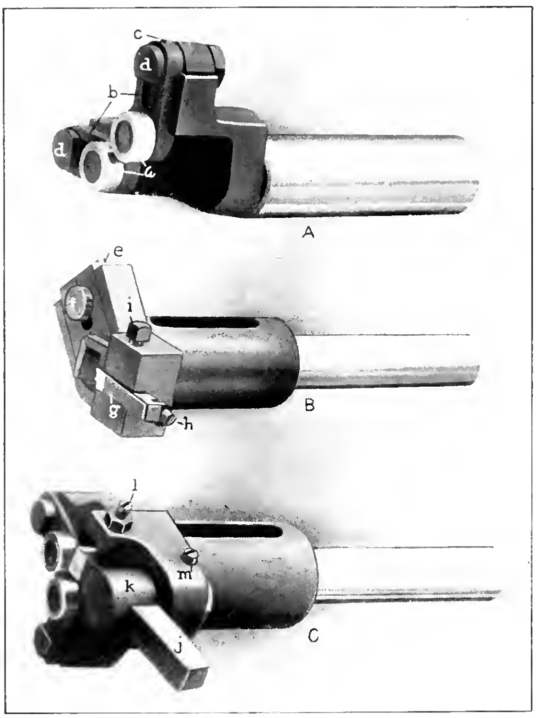


Fig. 11. Roller Steadyrest, Shaving and Roughing Box-tools

adjusted as shown. The flat arm *e* of the box-tool has a spline cut the full length, and also a slot through which the studs enter. The studs are made integral with the cutter-heads and are clamped by nuts as shown. The four cutters in the head are adjusted by removing the head from the arm and placing it on a stand fitted with a plug gage of the same diameter as the work to be turned. This stand holds the cutter-head in the correct relation to the plug gage so that the tools can be brought into contact with the plug gage and then clamped. This tool is also supplied with a hole in the shank for holding a centering tool or drill. The heads for the cutters are adjustable along the body of the holder.

Another type of box-tool is shown at *C* in Fig. 12. This is of open-type construction and is supplied with one turning tool clamped to its face as illustrated, the work being supported at this point by roller supports. The second tool, which is set at an angle and held down by a heel clamp, can be used for turning a second diameter on the work; the work is supported with V-supports held in the projection of the holder as illustrated. This tool-holder is of simple construction and embodies the general principles incorporated in the other holders previously described.

Taper Turning Box-tools

The taper turning box-tool shown in Fig. 13 is held by a shank in the turret of the machine and is supplied with a bushing on the front end which guides the work. The

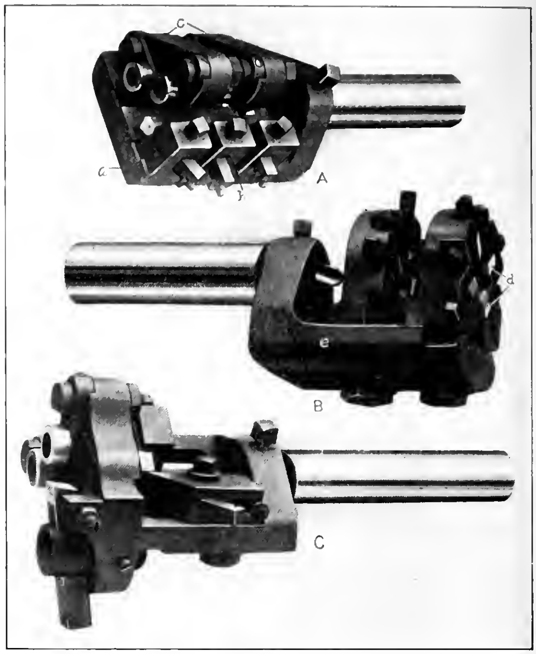


Fig. 12. Multiple Turning Tool, Adjustable Hollow Mill and Standard Three-tool Box-mill

circular slide *A* carries the turning tool *B* and is fitted with a pin *C* which comes in contact with the adjustable guide *D* held on the cross-slide. When the turning operation is completed, the cross-slide recedes, allowing a spring located inside the holder to move the slide *A* back to its original position. The guide *D* held on the holder *E* which is attached to the cross-slide can be made of any shape so that any irregular form as well as tapered work can be secured. This guide is fulcrumed on a pin in the bracket and is supported and adjusted by two set-screws as illustrated.

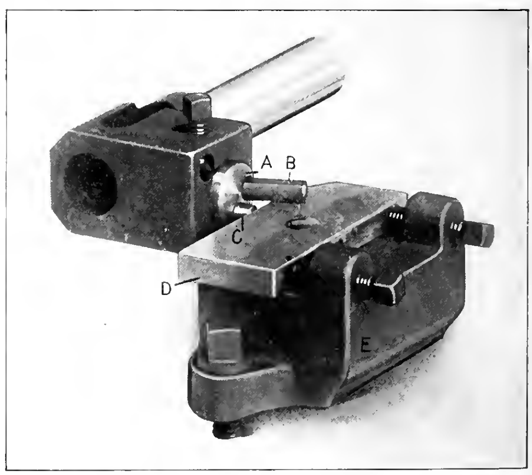


Fig. 13. Turning Tool for Taper or Irregular Shapes

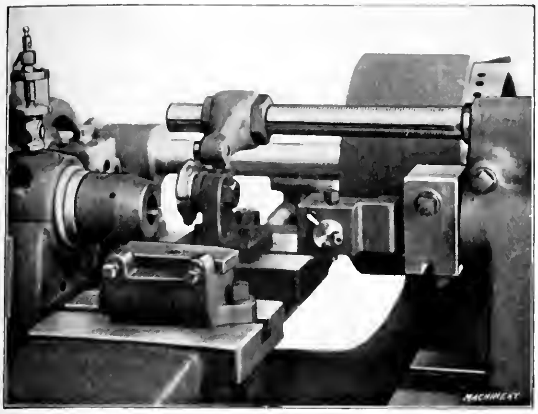


Fig. 14. Illustration showing Application of Taper Turning Tool presented in Fig. 13

Fig. 14 shows how this taper turning box-tool is operated. Here it can be seen that the guide is fastened to the cross-slide of the machine. The taper turning tool in this case, however, is held in the spindle of the plain type of machine, not the turret type.

The peripheral speeds in feet per minute recommended for box-tools and external cutting tools, in general, when provided with high-speed cutters, are as follows:

Brass	180—250
Cold-rolled Steel	120—150
Tool Steel	50— 60

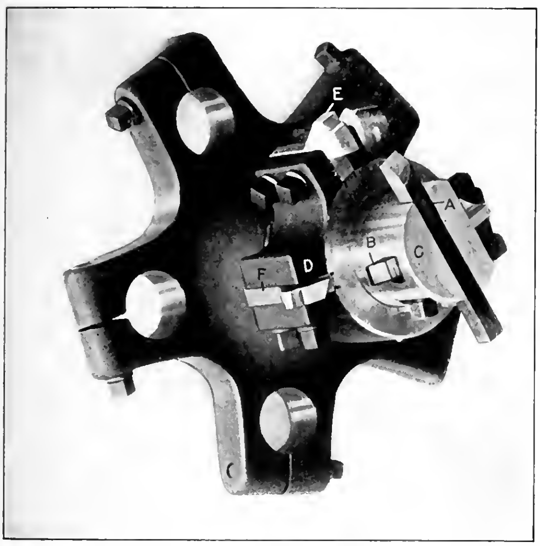


Fig. 15. Overhanging Turning Attachment with Extra Cutter-head

Overhanging Turning Attachment

The turning attachment shown in Fig. 15 is attached to the face of the turret by a clamp which surrounds the shanks of the turret tools. This attachment is put in position before any of the other tools in the turret so that the shanks of the other tools can pass through the holes in the five arms of the holder. The various arms, which are split, are then clamped by the set-screws shown. This type of tool can be used for performing a multiplicity of operations. In this particular case it is set up with roughing and finishing tools. The roughing tool *A* and the finishing tool *B* are mounted in the stem *C*. Also an extra cutter-head *D* is supplied with cutters *E* and *F* for rough- and finish-counterboring. The cutter-head can be adjusted longitudinally so that any desired relation can be obtained between the cutter *A* and the cutters in the cutter-head *D*. Attachments of this type are particularly adapted for over turning in connection with flat forming tools, and for this work it is sometimes necessary to have the shank much longer than is shown in the illustration. This part is therefore made according to the requirements

Die- and Tap-holders

The types of die- and tap-holders used in the Cleveland automatics do not differ from those on any other type of automatic screw machine; two representative types are shown in Fig. 17. That at *A* is a releasing button die-holder, while that shown at *B* is a releasing tap- or die-holder. The tap-holder, of course, is provided with bushings for holding taps having shanks of different diameters. As a rule, automatic opening dies are used on Cleveland automatics, but spring or button dies of the type shown at *C* and *D* can be used to good advantage, especially on brass work.

Adjustable Knurling Tool-holders

At *C* in Fig. 2 is shown a knurling tool-holder that can be used on the cross-slide for knurling thumb-screws or for straight knurling. It cannot, however, be used for longitudinal knurling. This knurling tool-holder consists simply of a base carrying an arm fulcrumed on a pin. Adjustment for height is secured by the set-screw *c* and the knurl is held

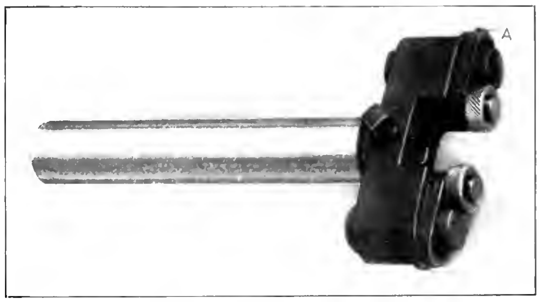


Fig. 16. Adjustable Knurling Tool used in the Turret for Spiral or Diamond Knurling

on a stud by a nut, the stud passing through the arm as illustrated.

A knurling tool-holder which can be used for diamond or straight knurling is shown in Fig. 16. This holder is carried in the turret and is provided with two adjustable knurling holders that are held in a groove in the face of the shank by a stud and nut as shown. Adjustment is secured by means of the headless screws *A*. The knurls are held on plain studs which are driven into the adjusting members and held from turning by the small set-screws shown. This type of holder is used exclusively for knurling longitudinally.

* * *

It may be a surprise to many to know that there are in the United States not less than 37,000 electric vehicles in use. Of these nearly 3000 are registered in Chicago, 2000 in New York, and 1800 in Cleveland.

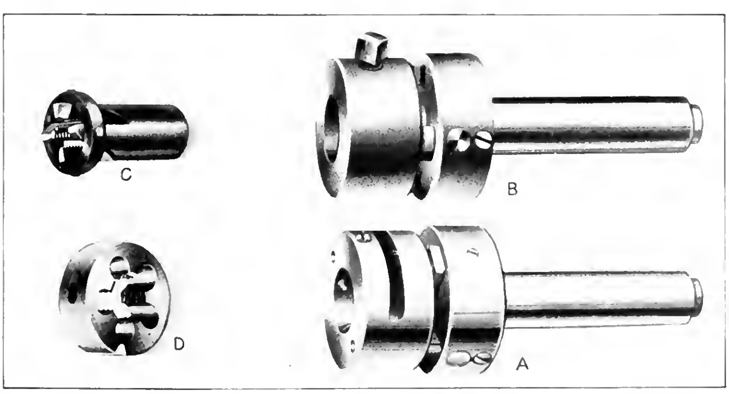


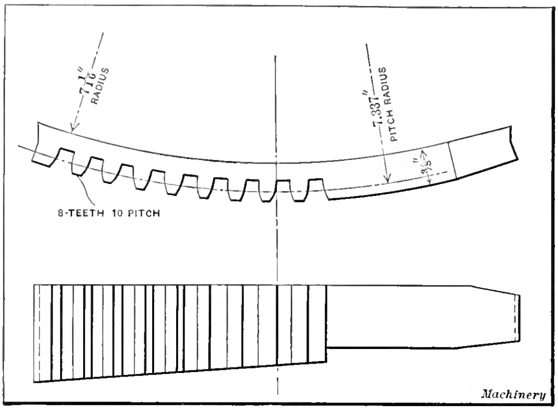
Fig. 17. Releasing Tap- and Die-holders

INDEXING MOVEMENTS FOR SMALL ANGLES ON MILLING MACHINE

BY P. J. RYAN*

Ordinarily, it is assumed that the only method for exactly indexing small angles is by moving the indexing pin one hole in the 27-hole circle, which gives an indexing movement of 20 minutes, or one hole in the 18-hole circle, which gives an indexing movement of 30 minutes. However, the writer has used a very simple method for a number of years which makes it possible to index angles accurately to 1 minute. This consists of using the rear pin which is a part of every dividing head, and which is used for holding the index plate in a fixed position while indexing in the usual way. This pin may also be used to index in an opposite direction to that of the regular indexing-arm pin, in a different circle, or to index in the same direction, thus adding to or subtracting from the movement made by the indexing-arm pin.

The method is very simple. For instance, if we use the plate with the 20-hole circle on the outside, the back pin will be in the 20-hole circle and the regular indexing pin may be



Circular Rack on which Method No. 3 is used for spacing the Teeth

placed in the 18-hole circle; by simply withdrawing the rear pin from the 20-hole circle and turning the plate backward or counter-clockwise one hole, and again inserting the pin, and then withdrawing the regular indexing pin from the 18-hole circle and moving it one hole in the 18-hole circle clockwise, we will have moved the work through an arc of exactly three minutes, and can, therefore, index any angle within a maximum error of 1½ minute. In this way, any part of an angle greater than 30 minutes may be indexed by first moving one hole in the 18-hole circle for each 30 minutes and then indexing the remainder within 1½ minute by moving one hole backward in the 20-hole circle and one hole forward in the 18-hole circle for every three minutes.

A still more accurate result may be obtained by placing the plate having the 27-hole circle on the outside of the 20-hole plate and pinning the two together through any two holes which happen to come opposite each other. This is equivalent to having a plate with both a 20- and a 27-hole circle. With this arrangement an exact movement of 1 minute may be had by moving the pins three holes in the 20-hole circle in a clockwise direction and then the regular index-arm pin four holes in the 27-hole circle in a counter-clockwise direction. This gives a movement to the dividing head of 1 minute in a clockwise direction, so that all angles may be thus indexed with an error which cannot exceed 30 seconds.

Table I shows the two methods outlined above for angles less than 30 or 20 minutes, respectively. It is not necessary

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TABLE I. INDEXING MOVEMENTS FOR SMALL ANGLES

Method No. 1 Using 20-hole index plate only			Method No. 2 Using 20-hole index plate inside and 27-hole index plate outside, pinned together through any two opposite holes					
Angle in Minutes	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Clockwise	Angle in Minutes	First Indexing Movement; Back Pin; Clockwise	Second Movement; Index Arm Pin in 27-hole Circle; Counterclockwise	Angle in Minutes	First Indexing Movement; Back Pin; Clockwise	Second Movement; Index Arm Pin in 27-hole Circle; Counterclockwise
3	1/20	1/18	1	3/20	4/27	11	13/20	17/27
6	2/20	2/18	2	6/20	8/27	12	16/20	21/27
9	3/20	3/18	3	9/20	12/27	13	19/20	25/27
12	4/20	4/18	4	12/20	16/27	14	2/20	2/27
15	5/20	5/18	5	15/20	20/27	15	5/20	6/27
18	6/20	6/18	6	18/20	24/27	16	8/20	10/27
21	7/20	7/18	7	1/20	1/27	17	11/20	14/27
24	8/20	8/18	8	4/20	5/27	18	14/20	18/27
27	9/20	9/18	9	7/20	9/27	19	17/20	22/27
30	..	1/18	10	10/20	13/27	20	..	1/27*

Machinery

*Clockwise movement in this case

TABLE II. INDEXING MOVEMENTS FOR SMALL ANGLES

Method No. 3. Using 20-hole index plate inside and 27-hole index plate outside, pinned together through any hole in the outside plate and the 16-hole circle in the inside plate

Angle Min. Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise	Angle Min. Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise	Angle Min. Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise	Angle Min. Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise
15	3/20	1/27	3/16	5 15	3/20	21/27	15/16	10 15	3/20	14/27	11/16	15 15	3/20	7/27	7/16
30	6/20	2/27	6/16	5 30	6/20	22/27	1 2/16	10 30	6/20	15/27	14/16	15 30	6/20	8/27	10/16
45	9/20	3/27	9/16	5 45	9/20	23/27	1 5/16	10 45	9/20	16/27	1 1/16	15 45	9/20	9/27	13/16
1	3/20*	4/27	..	6	18/20*	24/27	...	11	13/20*	17/27	...	16	8/20*	10/27	...
1 15	15/20	5/27	15/16	6 15	15/20	25/27	1 11/16	11 15	15/20	18/27	1 7/16	16 15	15/20	11/27	1 3/16
1 30	18/20	6/27	1 2/16	6 30	18/20	26/27	1 14/16	11 30	18/20	19/27	1 10/16	16 30	18/20	12/27	1 6/16
1 45	1/20	7/27	5/16	6 45	1/20	..	1/16	11 45	1/20	20/27	13/16	16 45	1/20	13/27	9/16
2	6/20*	8/27	..	7	1/20*	1/27	..	12	16/20*	21/27	...	17	11/20*	14/27	...
2 15	7/20	9/27	11/16	7 15	7/20	2/27	7/16	12 15	7/20	22/27	1 3/16	17 15	7/20	15/27	15/16
2 30	10/20	10/27	14/16	7 30	10/20	3/27	10/16	12 30	10/20	23/27	1 6/16	17 30	10/20	16/27	1 2/16
2 45	13/20	11/27	1 1/16	7 45	13/20	4/27	13/16	12 45	13/20	24/27	1 9/16	17 45	13/20	17/27	1 5/16
3	9/20*	12/27	..	8	4/20*	5/27	..	13	19/20*	25/27	...	18	14/20*	18/27	...
3 15	19/20	13/27	1 7/16	8 15	18/20	6/27	1 3/16	13 15	19/20	26/27	1 15/16	18 15	19/20	19/27	1 11/16
3 30	2/20	14/27	10/16	8 30	2/20	7/27	6/16	13 30	2/20	..	2/16	18 30	2/20	20/27	14/16
3 45	5/20	15/27	13/16	8 45	5/20	8/27	9/16	13 45	5/20	1/27	5/16	18 45	5/20	21/27	1 1/16
4	12/20*	16/27	..	9	7/20*	9/27	..	14	2/20*	2/27	...	19	17/20*	22/27	...
4 15	11/20	17/27	1 3/16	9 15	11/20	10/27	15/16	14 15	11/20	3/27	11/16	19 15	11/20	23/27	1 7/16
4 30	14/20	18/27	1 6/16	9 30	14/20	11/27	1 2/16	14 30	14/20	4/27	14/16	19 30	14/20	24/27	1 10/16
4 45	17/20	19/27	1 9/16	9 45	17/20	12/27	1 5/16	14 45	17/20	5/27	1 1/16	19 45	17/20	25/27	1 13/16
5	15/20*	20/27	..	10	10/20*	13/27	...	15	5/20*	6/27	...	20	1/27*	..	...

Machinery

*Clockwise movements in these cases

to show figures for any greater angle than 30 minutes by method No. 1 or 20 minutes by method No. 2, as any angle greater than these may be indexed directly either in the 18-hole or 27-hole circles by well-known methods. (These methods are explained in MACHINERY'S Reference Book No. 18, "Shop Arithmetic for the Machinist," and in MACHINERY'S HANDBOOK, pages 935 to 937, inclusive.)

When it is possible to use the No. 1 method, it should be employed because of its simplicity, provided a degree of accuracy within 1½ minute is sufficient. For all ordinary work, this is the case. If a greater degree of accuracy is desired, the No. 2 method should be employed. As an example of the No. 2 method, assume that it is required to index for an angle of 39 degrees 56 minutes. First index by the usual methods, as referred to above, 39 degrees and 40 minutes by direct indexing in the 27-hole circle; the movement in this case would be four complete turns, and then 11 holes in the 27-hole circle. Next index for 16 minutes by moving the back pin 8 holes in the 20-hole circle in a clockwise direction, and then moving the indexing-arm pin 10 holes in the 27-hole circle in a counter-clockwise direction. This will give a total movement of the work of 39 degrees 56 minutes.

Table II gives the movements necessary for method No. 3, which enables smaller angles to be indexed than are obtained by either of the preceding methods. While this table is arranged for indexing angles, it can also be used to obtain any number of divisions or fractions of a division by simply dividing the number of seconds in a circle, *i. e.*, 1,296,000, by the required number of divisions, the quotient being the required angle to index for expressed in seconds. The maximum error of the result obtained in this way never exceeds 7½ seconds.

This method consists of using two index plates as in the case of method No. 2, but an additional movement is obtained by moving the outside plate in its relation with the inside plate, by means of the small plug in the 16-hole circle, which is employed in method No. 2 to lock the plates together. The illustration shows a piece of work which we recently handled by this method. It was necessary to cut 10-pitch teeth on a circular rack or segment which was to operate in a slot 14.875 inches outside diameter. On this diameter we would have had to index for 146.75 teeth if the teeth had been accurately cut. Converting this result to an angular movement, it is found that it would be necessary to index through an angle of $1,296,000 \div 146.75 = 8835.8$ seconds $= 2$ degrees, 27 minutes, 15.8 seconds for each tooth.

The larger part of this angle, *i. e.*, 2 degrees 20 minutes, was first indexed directly in the 27-hole circle, by moving through seven holes in a clockwise direction. This leaves an angle of 7 minutes 15.8 seconds to be indexed. The necessary movement can be obtained from Table II and a result secured which is within 0.8 second of accurate. The necessary movement for this angle of 7 minutes 15 seconds is first, 7 holes counter-clockwise in the 20-hole circle; second, 2 holes counter-clockwise in the 27-hole circle; third, 7 holes clockwise in the 16-hole circle. Canceling the opposite movements in the 27-hole circle we find that the resulting movement necessary to obtain an angle of 2 degrees 27 minutes and 15 seconds is first, 7 holes counter-clockwise in the 20-hole circle; second, 5 holes clockwise in the 27-hole circle; third, 7 holes clockwise in the 16-hole circle. The error should never exceed 7½ seconds, as when this error occurs it is only necessary to index for 15 seconds and wait for the error to accumulate again. This method may appear complicated, but in reality it is quite simple when it has once been thoroughly mastered.

* * *

ANNEALING STEEL CASTINGS

The following method of annealing steel castings was adopted by the American Society for Testing Materials, and referred to the members for letter ballot at the Atlantic City meeting.

1. The castings should preferably be sufficiently cleaned of adhering sand before annealing to insure thorough and uniform heating.

2. The castings should be heated slowly and uniformly to temperatures (in degrees C.) varying with the carbon content of the steel, and approximately as follows:

Up to 0.16	925
0.16 to 0.34	875
0.35 to 0.54	850
0.55 to 0.79	830

Nothing in these recommendations shall operate against the temperatures aimed at being 50 and, in special cases, 100 degrees C. higher than those given in the table, when necessary to attain the desired result.

3. The castings should be kept at the maximum temperature a sufficient length of time to insure the refining of the grain. In general, the heavier the sections of the casting, the longer must be the time of exposure to the maximum temperature.

4. (*a*) The castings should be cooled slowly and uniformly in the furnace, when it is desired that the steel shall possess the maximum softness.

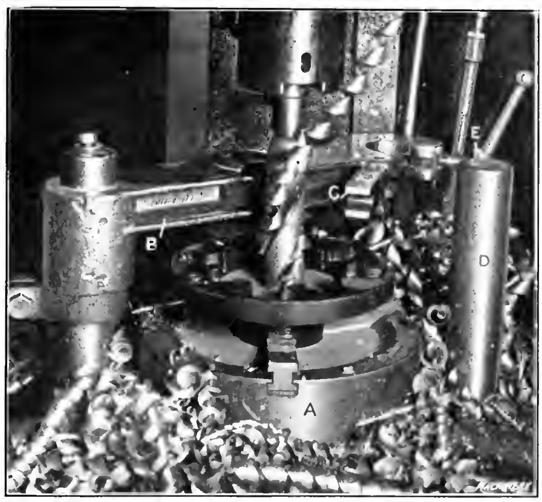
(*b*) The castings may be cooled at an accelerated rate, when it is desired that the steel possess rather higher tensile strength and elastic limit than can be procured by very slow cooling. This cooling must be so conducted as to leave the steel reasonably free from cooling stresses.

The manner of carrying out this accelerated cooling should be such as will attain the desired result. For instance, the castings may be withdrawn from the furnace and buried in a bed of material that is a poor conductor of heat; or the annealing furnace may be so thrown open that it will cool more rapidly than if left closed. Should the castings be of such uneven section that they cool at unequal rates at various points when the furnace is opened, especially if the carbon of the steel is high, the furnace should be closed after the castings have become black, and their further cooling so retarded that the stresses set up by the unequal rates of cooling are relieved.

* * *

A SPOTTING JIG

In the drilling department of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., a spotting or centering jig for drilling heavy work is employed. This is shown in the illustration and its purpose is to locate the drill while it is spotting the work, after which it may be swung aside to allow the chips to emerge freely. In the illustration the work has been spotted and the arm swung clear to permit the chips to leave



Spotting Jig with Arm clear of the Work

the drill freely. On the job in question the work is circular, and is held in the universal chuck *A*. After locating the work, the arm of the jig *B* that has a bushing at the center is swung into position and latch *C* is thrown around the post *D* and held there by lock *E*. After the hole has been spotted, the lock is loosened, the latch opened and arm *B* is swung out of the way, thus allowing plenty of chip room. C. L. L.

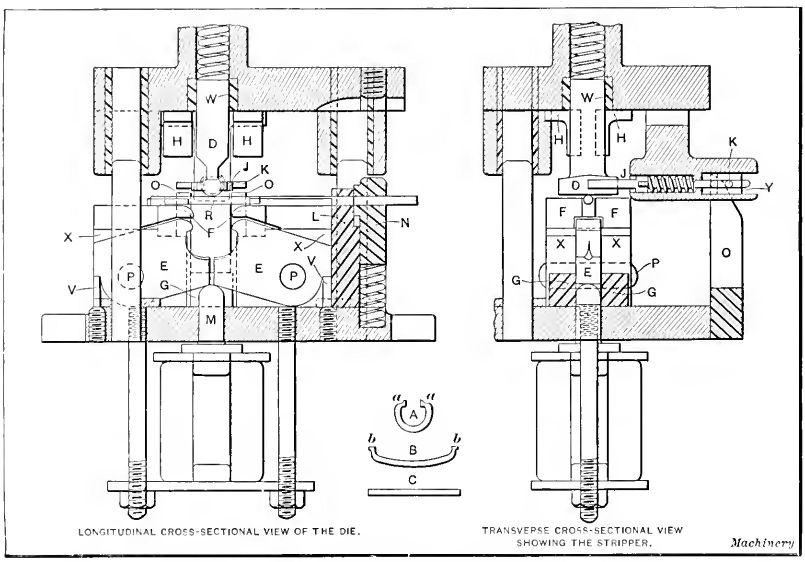
A CUTTING AND BENDING DIE

BY SPRING CRAIG*

The part shown at A in the accompanying illustration is used to support an electric light fixture. These parts are sold in lots of from 10,000 to 100,000; they are made of 7/32-inch polished brass rod, and a particularly interesting punch and die is employed for cutting off the blanks and bending them to the required shape.

It frequently happens that difficult problems in die work find their way to jobbing shops which are the headquarters of traveling tool- and die-makers. These men seldom stay in one place for any great length of time; they keep moving from place to place, and I have known those who have worked in upward of one hundred different shops. Likewise, some of the traveling mechanics whom I have met have been across the continent and back; and in at least one case I came across a man who had worked his way around the world and was familiar with more languages than English and profanity.

At that time I was somewhat of a nomad myself and the job of making the punch and die for producing these parts was turned over to me after several men had failed to produce a satisfactory tool. The only requirement was that the work should be produced in not more than three operations. The idea was to cut off blanks of the form shown at C, and then bend them to shape in two operations, as shown at B and A. Difficulty was experienced in bending the ends a and after some experimenting we came to the conclusion that in performing the second operation the ends b would have to be bent in to more than a right angle. To accomplish this, a very expensive punch and die would have been necessary, even if the desired result could have been obtained under any circumstances.



Combination Cutting and Bending Die for making the Piece shown at A

After working on the problem for eight or nine days, I decided to discard this method. The proprietor of the shop had put the job up to me and given me a free hand to work my own way. The result was that I finally managed to develop the punch and die which form the subject of the present article. This tool finishes the work complete in one operation and has a capacity for producing 10,000 pieces a day.

The design will be readily understood from the accompanying illustration which shows longitudinal and transverse cross-sectional views through the punch and die. The bed is made of cast iron and has four upright members X cast integral with it. The two upright pieces at the right-hand end of the die have slots milled in them at an angle of 60 degrees, these slots being employed to control the movement of the cut-off slide N. The two parts E are fitted between the uprights X and are machined to the form of the work which it is required to produce. These members E are carried by two hardened and ground pivots P about which they swing to bend the work around the punch. The two screws V are adjusted to hold the dies E, so that they cannot swing open too far. The plunger M is actuated by a rubber bumper which holds the dies E open except when the punch comes down; this bumper also opens the dies after the punch has completed its working stroke.

The cut-off mechanism consists of two members L and N which are made of tool steel and have a hole drilled through them a little larger than the stock which is to be cut off. The member L is held stationary while the slide N is free to move up and down, its movement being controlled by the 60-degree slots in the pieces X, which were referred to in a previous paragraph. When the ram of the press descends, a screw in the punch-holder is adjusted so that it pushes the slide N through a sufficient distance to cut off the blank. After the shearing operation has been completed, the spring under the slide N returns it to the starting point, where the holes in the members N and L are in line ready to have the stock for the next piece fed through.

The two pieces F are made of tool steel. They are mounted on top of the uprights X, above the dies E. These pieces have a groove on their upper face of the required size to receive the stock that is to be bent in the die. It will be seen from the illustration that the ends of the pieces F are machined in such a way that the work will be bent smoothly over them when the punch D comes down. The same ends are cut away on the sides a short distance back to allow the blocks H to straddle the pieces F. As the ram descends, the punch carries the work down between the dies E, and continued movement of the ram causes the blocks H to come in contact with the dies E. This causes the dies E to be forced inward with the result that the ends a of the work are bent to the required form around the core on the punch D. The punch works in a steel bushing W and is backed up by a heavy compression spring. The downward travel of the punch is limited by having its ends come in contact with the blocks G which are clearly shown in the transverse sectional view. The press continues its travel for another 1/16 inch, and it is this 1/16 inch of over travel which causes the blocks H to engage the dies E and set the ends of the work a to the required form.

On the up-stroke of the press the stripper J is released and pushes the work off the punch. This stripper is made in the form of a fork, its design being clearly shown in the transverse sectional view. It is placed at the back of the die because it would be in the operator's way if it were located at the front. The stripper J straddles the punch, and the piece Y is threaded at the small end to screw into the boss connecting the two prongs. A hole is drilled in the opposite end of the stripper and a hardened piece of drill rod K is driven into it. This piece of drill rod comes in contact with the forked cam O. When the punch-holder comes down, the cam O engages the pin K and pulls the stripper out of the way, causing the spring behind it to be compressed. This spring is released on the up-stroke of the press, thereby moving the stripper forward and knocking the piece of work off the punch. This tool has given most satisfactory results. It requires very little care to maintain it in operating condition and, as previously stated, has a capacity for producing 10,000 pieces per day.

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LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

UNIFICATION OF WEIGHTS AND MEASURES —FOR AND AGAINST

We notice with a great deal of pleasure in the July number of MACHINERY your editorial, "Unification of Weights and Measures," and wish to thank you for the very sensible stand you are taking in the matter, and without, as you say, going into the merits of the controversy "Metric vs. English System."

We here have adopted the metric system and apply it to such things and operations as we can conveniently, though it is still necessary to purchase many materials and to do many things with the English system, but we shall welcome the day that will surely come when the metric system is universal.

It is only too true, as you say, that the longer the change is put off the more difficult it will be, and so we hope the changing will not be put off much longer.

THE DELAVAL SEPARATOR CO.,
Poughkeepsie, N. Y. T. H. Miller, Supt.

To put it mildly, I was surprised to see the editorial favoring the metric system in the July number. You should have known better than to express an opinion favorable to the system, and assuming that your words were intended to mean what they appear to mean, you should have known better than to repeat the stale untruth "It is already used by three-fourths of the civilized world." Have you forgotten the official "confession" of the French minister of Commerce, Industry and Labor, published in the transactions of the American Society of Mechanical Engineers, Vol. XXVIII, page 877? Let me remind you that this official is charged with the enforcement of the law for the suppression of old units of measurements in France, and that in this confession he acknowledges himself powerless to do it, and plaintively appeals to local chambers of commerce to use their influence to persuade where the law is unable to compel. This official confession confirms all that has been said regarding the continued use of old units in France after more than a century of effort to suppress them. Explain if you can in any way creditable to the system this continued preference for old units by the French people.

This state of things exists, although the metric system was introduced in France before the large development of organized industry and when the change was, comparatively speaking, easy. Among the few organized industries in existence there at that time was the manufacture of silk fabrics, and this is precisely the industry which adheres most tenaciously to its old units and which illustrates most forcibly the impossibility of changing units of measurement in organized industry. Another and wider illustration is the lumber industry, for throughout metric Europe lumber is sawn to the inch and to nothing else; and similar illustrations can be repeated indefinitely.

Wherever the adoption of the system has been attempted, the result has been a partial adoption—adoption in fields of use in which the change is easy, and failure to adopt in other fields. Now the entire metric case is based on the tacit assumption that the old units are to disappear, but this they have not done in any metric country on earth. If the old units are to continue, every metric argument is annulled and inverted. Instead of uniformity the result is confusion; instead of ratios between units being simpler and more uniform, they become more complex and diverse; instead of calculations being simplified they become more complex by reason of the repeated conversions required between old and new units. Witness the extended conversion tables of English and metric units with which reference books are burdened and which are made necessary by the use of two systems side by side. You should read Mr. Dale's exposition of the effect of the superposition of metric commercial units on the old factory units of the textile industry of all metric Europe. The result is a state of chaos that defies description, and it is precisely to this state that the "adoption" of the metric system in our mechanical industries would lead. So far as "academic discussion" is concerned it is the metric party that is made up of academicians. It is the metric party that chases rainbows while the anti-metric party studies facts. The metric party presents the system as imagination conceives it to be, while the anti-metric party presents the case as it is.

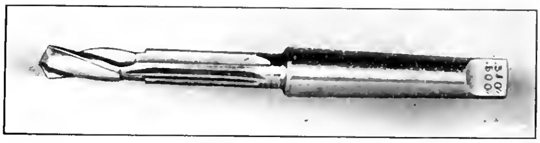
I have, however, no intention of presenting an extended argument here. My forthcoming book, "Methods of Machine Shop Work," contains a discussion of this subject as releated to the machine shop, and I refer you and your readers to it in lieu of a repetition of the same facts here. Let me add, however, that no candid man can study the metric system, not as it is conceived to be, but as it is, and fail to decide against it, for there never was a case in which the theory and the facts are so opposed. F. A. HALSEY

New York City Editor Emeritus, *American Machinist*

COMBINATION DRILL AND REAMER

In modern machine shop practice, one of the most fruitful methods of increasing efficiency consists of the elimination of unnecessary handling of the parts to be machined. If it is possible to combine two tools so that their work is done in a single operation, the handling and time required to set up the work is reduced in direct proportion, and there is also a reduction in the machining time. It was to secure these advantages that the combination drill and reamer shown in the accompanying illustration was designed.

This tool consists primarily of an ordinary reamer with a standard taper shank and tang to fit in the spindle of an



Tool for drilling and reaming a Hole in One Operation

upright drill press. The cutting end of the reamer has been lengthened and formed into a regular two-lipped twist drill, this drill first entering a cored hole in the casting, cutting away the metal and enlarging the hole to such a size that the reamer may easily follow it. In this way the hole is finished to the standard size in a single operation. It has been found in practice that by combining the two operations in this way, they can be done almost as quickly as either of the individual operations was formerly performed, with the result that a great saving of time has been effected.

A. C. NELLA

COLLEGE OF THE MIDNIGHT LAMP

In these summer months, when schools and colleges are sending out their thousands of graduates, one's thoughts turn naturally to the army of men who do not celebrate commencement nor join the friendly reunions and revels of "class day"—men who perhaps left school at an early age to take their places in the workaday world. Yet many of these men must be classed among the educated, because they have trained minds as well as skilled hands, and are students in one of the largest and best of colleges—the one that grants no degrees, issues no diplomas, and has no alumni, for no man worth his salt who has once enrolled as a student in the College of the Midnight Lamp, ever graduates.

In many other points this college differs from its sister educational institutions. It publishes no list of its faculty, yet on its teaching staff are many honored names, for it includes every man who publishes, in trade papers or elsewhere,

information of value and interest to any of its students. This college has no students entered in obedience to paternal mandate and supported by paternal checks. Its tuition fees are small and are paid from the students' daily earnings. Its pupils, at entrance, are often of mature age, with very definite ideas of what they wish to learn. They are men accustomed to daily labor, who have found that mere labor brings small returns of pleasure or profits, while the work of the skilled hand, directed by the trained mind, yields not only a fatter pay envelope, but the keen and lasting satisfaction of mental growth and accomplishment.

Some there are, as in all schools, who start bravely but soon fall out of the ranks, but there remain those in whom are the insatiable thirst for knowledge and the firm and steadfast resolution that will hold them unflinchingly to the arduous program of nightly study after daily toil. What are they studying? Most of those I have met have begun with some subject directly related to their daily work, but they do not stop when the first topic is mastered. The curriculum is wide, and as all courses are elective every student is free to follow his own tastes and inclinations.

One man, who hesitatingly took up geometry and trigonometry soon after completing his apprenticeship in the machine shop, followed on through higher mathematics, then, wishing to know more of the materials on which he worked, studied deeply the chemistry of steel, meanwhile "as a diversion," he says, acquiring a reading knowledge of three languages, and learning shorthand "to save time in keeping notebooks." It can hardly be charged that his devotion to study has seriously interfered with his regular work, for he has risen step by step to the head of the mechanical department of the corporation by which he has been employed for thirty years, and has lately received a year's leave of absence, that he may give to a similar concern in another country the benefit of his expert knowledge. This, of course, is an exceptional instance. What does the ordinary student gain? To what end does he employ in study the hours which others spend in amusement or in sleep?

While these questions can be only partially answered in terms of dollars and cents, the consciousness of increased knowledge and broader outlook being a large part of the compensation, still the effect on the pay envelope is of prime importance to all of us who earn our living by our trade. One often reads tales of men who have gained large increases of wages after taking a course in a correspondence school, and sometimes hears these ridiculed as extravagant, but I have yet to see one which I cannot duplicate from my own observation. The machinist who doubles his earning power in two short years is no figment of an ad. writer's vivid imagination. I've seen it done. Does what he learns lead to his advancement? Not that alone, but study added to the unrelaxing bulldog strain in his make-up that led him to begin the study and kept him at it, and if his case seems unusual, it is only because most of us lack just that quality.

We often hear pessimistic talk of the decadence of our trade—that it is poorly paid, offers no future for a young man, etc., but it seems to me that it depends, mainly, on the young man himself. He may look enviously at those who are able to secure the well-rounded, symmetrical training which he thinks a properly equipped technical school bestows; he may regret his inability to spare even the moderate fees for a correspondence school course, but *if he has it in him* he can obtain all the education he wants, all the mental training he desires, almost without money cost, from the institution that has given us so many of our best men—the College of the Midnight Lamp.

New London, N. H. GUY H. GARDNER

POWER PRESS PUSH GUARDS

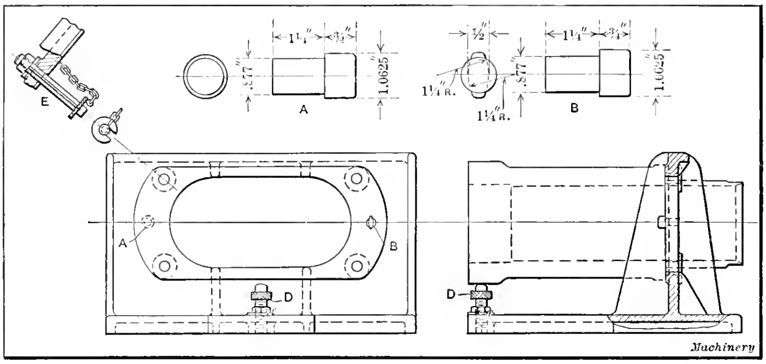
We noticed in the July number of MACHINERY, engineering edition, that credit was not given where credit is due. The so-called Hemphill push guard device for safeguarding a power punching press was exhibited by the Stiles & Parker Press Co. at the Centennial Exposition in Philadelphia in 1876. The E. W. Bliss Co., since buying the Stiles & Parker press business, has put a number of these devices on presses. Mr. Hemphill simply copied the Bliss device on a press fitted up for the Travelers' Insurance Co. by us in 1908.

We enclose a photograph showing this identical press from which he made his copy; also a photograph showing a cutting press made by us over twenty years ago for a Baltimore concern, on which the same device was applied.

Brooklyn, N. Y. E. W. BLISS CO.

GRINDING FIXTURE FOR HOLDING TWIN CYLINDERS

A grinding fixture for holding gasoline engine cylinders that are cast in pairs is illustrated herewith. This fixture was designed for a large internal grinder having a table equipped with an indexing cross-slide. As the movement of this cross-slide was sufficient for indexing from one cylinder bore to the other, it was possible to design a comparatively simple fixture, but owing to the size of the cylinders the fixture had to be very strong and rigid as well as easy to operate. The cylinder casting is shown in outline in the side view.



Grinding Fixture for Twin Cylinders

The cylinders are first bored and all other necessary machine work is done before grinding. The holes in the base are also drilled and reamed by a jig located from the two bores. The fixture is provided with two dowel pins *A* and *B*, one of which is round and the other oval. These pins fit into the reamed holes and accurately locate the cylinder in relation to the bores. Pin *B* is made oval (see also enlarged view) to avoid the binding which might occur in case both pins were round. In other words, with the oval pin the distance between the drilled holes can vary slightly, whereas if both pins were round and fitted the holes closely there might be trouble from center-to-center variations.

The jack-screw *D* which supports the outer ends of the cylinders is adjustable. The four bolts engaging the four holes in the base hold the cylinder firmly in position. These bolts, one of which is shown in detail at *E*, have keyways which engage tongues or keys on washers that are screwed to the back of the fixture. This arrangement prevents the bolts from turning when being tightened or released. The slip washers which form the heads are attached to the fixture by chains which prevents their being lost. When these washers are removed the bolts can, of course, be passed through the holes when inserting or removing work. M. W. W.

A DIAL COMPAROMETER

We recently came to the conclusion that the usual form of commercial indicators were not accurate enough for measuring such work as size blocks, plug gages, type and a variety

of other parts where great accuracy is essential, and to meet the requirements of such cases the indicator shown in Fig. 1 was designed. The case of this instrument measures about 2.75 inches in diameter, and the dial indicates 0.010 inch for one complete revolution of the pointer. The arrangement of the working parts is as follows: Lever *A* is 2 inches long from the fulcrum screw *B* to the pin *C*, and is 1/8 inch long from the screw *B* to the flange on the plunger *D*. This means that when plunger *D* is moved through 0.010 inch, the end of lever *A* in contact with the pin *C* moves through a distance of 0.160 inch, as the length of the lever from *B* to *C* is sixteen times the length from *B* to the flange on the plunger *D*. The segment gear *E* measures 1.125 inch from the pivot *F* to the pitch line, and the pinion *G* is 1/4-inch pitch diameter or 0.7854 inch in circumference. As it is desired to have one complete revolution of the pointer over the dial represent a movement of 0.010 inch of the plunger in contact with the work, the pin *C* must be located on the segment gear at such a distance from the pivot *F* that this movement of 0.010 inch of the contact point will produce a movement of 0.7854 inch at the pitch line of the segment gear *E*. This, in turn, will cause the pinion *G* to make one complete revolution.

Fig. 2 shows the method of arriving at the result. We know from geometry that corresponding sides of similar triangles

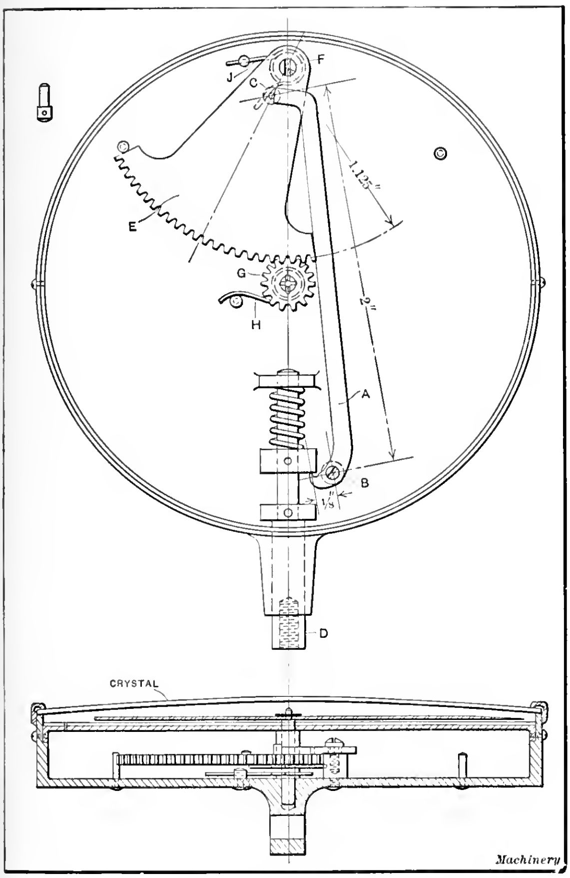


Fig. 1. Dial Comparometer for measuring Size Blocks and Other very Accurate Work

are proportional to each other, and applying this principle to the present case, we have:

$$\frac{FC}{0.160} = \frac{1.125}{0.7854}$$

$$FC = \frac{0.160 \times 1.125}{0.7854} = 0.229 \text{ inch.}$$

In Fig. 2, *F* and *C* represent the pivot on which the segment gear is carried, and the contact point of the lever *A*, respectively. The value 0.229 inch represents the distance at which the pin *C* must be located on the pivot *F*. The dial of the instrument is graduated to 100 equal parts, each of which represents 0.0001 inch. The spaces between consecutive graduations are sufficiently large so that half and quarter spaces may be readily estimated. This instrument is very sensitive and is practically "fool proof" as far as breaking the mechanism by forcing in the plunger *D* is concerned. It will be seen that two small pins are provided to limit the movement of the segment gear *E* in either direction. The pinion is always in mesh with one side of the teeth on the segment gear owing to the action of the hair spring *H*.

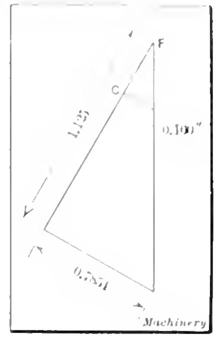


Fig. 2. Method of computing Required Leverage

The operation of the comparometer may be briefly described as follows: A movement of the contact point on the work moves the plunger *D*, and the flange on this plunger moves the short end of the lever *A* with which it is kept in contact by the action of a spring *J* on the segment gear and the spiral spring on the plunger. In this way a uniform contact is maintained between the long end of the lever *A* and the pin *C*, and also between the flange on the plunger and the short end of the lever *A*. The movement of the lever *A* in contact with the pin *C* causes the required movement of the segment gear which turns the pinion and the pointer that is carried on its shaft. The operation of this indicator is absolutely smooth, there being no tendency for the pointer to "hesitate" or "jump."

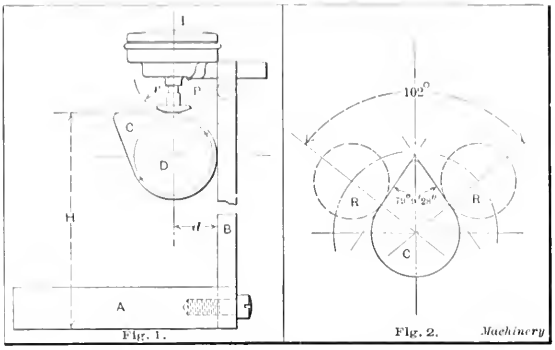
New Britain, Conn. W. C. Betz

CHECKING A CAMSHAFT WITH THE DIAL INDICATOR

Whether or not a camshaft, made from a carefully planned design, will perform just what it is intended to do may remain a matter of uncertainty until it is tried out. Of this much, however, we are assured: if after a careful checking it meets all predetermined conditions every one interested is relieved. With a new design it is not always possible or convenient to make an actual test on a motor, and any method that makes it possible to accurately check up the vital points of the camshaft will be welcome. As the measurements for length, diameter, etc., are easily made with regular tools, this article will be confined to a method of measuring the relation of the opening and closing points of the cams, with reference to some starting point as, for instance, the keyway for the camshaft gear.

Fig. 1 shows a stand of simple construction, which was made to carry a Starrett dial indicator. Its design could have been elaborated by providing vertical and lateral adjustments, but these were unnecessary. The base *A* is made sufficiently heavy to stand firmly, and the vertical support *B* is notched into the base and secured by screws. The upper end of the support is drilled and reamed to receive the shank of the indicator *I*, and also split and provided with a screw to clamp the shank. The indicator contact point *P* is a spherical segment whose radius *r* is one-half the diameter of the cam roll. The center line of the indicator must stand in the same relation with the camshaft, as the roll would occupy in the motor, which in this case is on the center line of the camshaft. The distance *d* is then one-half of *D*, and the height *H* is such as to give a good contact between the point *P* and the cam *C* and allow the full limit of the indicator movement.

With the camshaft suitably dogged and mounted between the index centers, the first move would be to find the center of the keyway for the camshaft gear, as the probabilities are that the centers of the cams are laid out with reference to that center. Let us assume that we have our inlet cam shaped as shown in Figs. 1 and 2, and that the center of this cam coincides with the center line of the keyway; also that the opening and closing points are at the positions occupied by the cam rolls represented by the dotted circles *R* in Fig. 2. The actual opening and closing points are then one-half of 102 degrees, or 51 degrees in advance and 51 de-



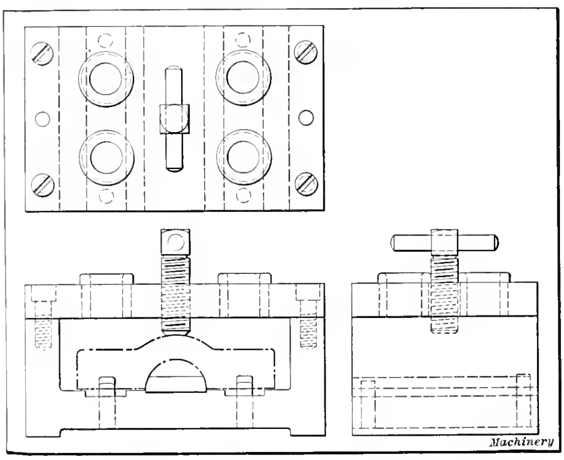
Figs. 1 and 2. Stand for the Dial Indicator and Diagram showing Method of Procedure

grees back of the starting point. With the indicator set on the dwell of the cam, allowing for a rise of 0.003 inch (the clearance under the valve stem) before zero, and with the indicator in the position shown, we index the camshaft around to the correct angle. If the work has been accurately done, the indicator needle should just begin to rise at that 51-degree angle; if not, it will rise either too soon or too late and the amount of error is read from the index circle. The relation of all the other cams to the keyway is checked in similar manner, taking all inlet points in their firing order and then all closing points. The amount of error found, in spite of very careful workmanship, is sometimes surprising, even when measurements with micrometers and a protractor show up well; but, thanks to that highly useful instrument, the indicator, many things in our line are being reduced to a degree of accuracy approaching perfection.

Hartford, Conn. ERNEST A. RUNGE

DESIGNING JIGS AND FIXTURES

The simple form of drill jig shown in the accompanying illustration, which is for a small bearing cap, illustrates a very good method of designing jigs and special fixtures. The part for which a jig is required is first laid out, and thus the



Drill Jig used to illustrate Method of designing Jigs and Fixtures

jig is designed by working around this lay-out. The part should preferably be drawn in red, green or some other light colored ink, and one or more views should be shown, as this will give a clearer idea of its shape and size and will be a help in determining the best and most accurate method of handling work. This method is particularly helpful in designing jigs for complicated parts. By drawing the work on the tracing with some light colored ink, then drawing the jig and dimension lines with black ink, the blueprint will show the distinction between the work and jig very plainly. The jig and dimension lines show on the print in bold, white lines while the work is in light, pale lines. This method is a great help to the patternmaker in working out the pattern for the jig or fixture because he can more readily understand the jig drawing. When the drawing is arranged in this way, it is also helpful to the toolmaker because he can not only understand the drawing better but also has a clearer idea of the parts which require the most accuracy. M. W. W.

[In the illustration, the work is indicated by dot-and-dash lines in the usual manner, as the pale lines on the original blueprint cannot be reproduced.—EDITOR.]

IDEAL DRAWER BOTTOM

Some time ago we had occasion to build several cabinets for filing tracings and pencil sketches. The drawers were 26½ by 38½ inches in size and were used without partitions for storing our largest size drawings which were 24 by 36 inches. Some of the drawers were divided up with partitions as shown in Fig. 2 to accommodate drawings 18 by 24, 12 by 18, 9 by 12 and 6 by 9 inches in size. The partitions were made of ½-inch stock. Upson wall board was found to constitute an ideal bottom for the drawers. This material is about 3/16 inch thick and can be bought in sheets large enough to make the entire bottom of the drawer from a single piece, thus eliminating cracks or joints. A further advantage is that the material has no tendency to shrink or warp out of shape. It is flat and stiff enough to require little reinforcement, and is considerably lighter than wood. In making the drawers, a groove was cut in each of the four sides to receive the edges of the wall board, and a small wood strip, ½ by 1 inch in size, was fastened across the center of the drawer on the under side of the wall board to act as a reinforcement. These cabinets have now been in use for nearly a year and are still in perfect condition.

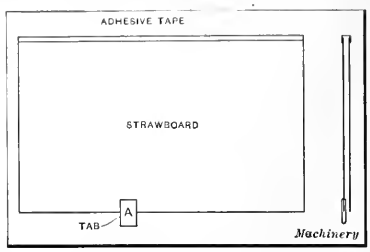


Fig. 1. Type of Binder used for filing Drawings

Pencil sketches are filed in these cabinets in alphabetical order, and owing to an insufficient number of drawers it was necessary to file the sketches coming under several index letters in the same drawer. In order to keep the drawings of different index letters separate, binders were made for each letter in all of the different sizes. These binders were made of two pieces of No. 50 strawboard, fastened together on the side which is placed toward the back of the drawer. Adhesive cloth tape is used for this purpose, the method being clearly shown in Fig. 1. It will also be seen from this illustration that a tab of this cloth tape is fastened to the front

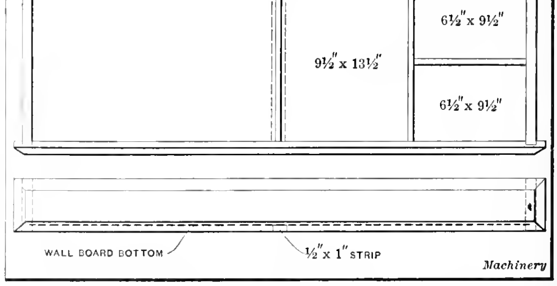


Fig. 2. Design of Drawer equipped with Upson Wall Board Bottom

of the top sheet of the binder, the proper index letter being marked on this tab. This arrangement makes it possible to locate any required binder promptly and the tab can also be used to lift the cover. These binders not only separate the drawings of different classes, but also prevent sketches from working out at the back of the drawers.

Aurora, Ill. E. J. G. PHILLIPS

SPRING STRIPPER PUNCH AND DIE

The punch and die illustrated in Fig. 2 was designed for punching five holes in the piece shown in Fig. 1. Owing to somewhat unusual conditions in gaging the work in this die, a spring stripper was found most satisfactory. Referring to the illustration, the stripper will be seen at *A*. It is operated by springs supported by the bolster *B*.

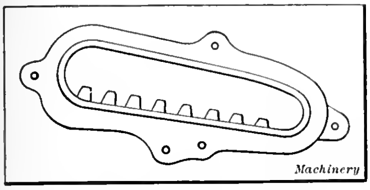


Fig. 1. The Work to be punched

The first step in designing the die was to determine the number of springs required to operate the stripper. The holes to be punched are ½ inch in diameter and the thickness of the work ⅜ inch, the material being malleable iron. A test was conducted by forcing a ½-inch punch through a ⅜-inch malleable iron plate, stopping the press at the bottom of the stroke and releasing the punch so that it could be removed with the plate. The plate and punch were then taken to a Riehle testing machine and it was found that a force of 1200 pounds was necessary to pull the punch out. It was obvious, then, that a force of 6000 pounds was necessary to strip the work off five punches.

It was decided to use springs coiled from wire 5/16 inch in diameter, the diameter of the coils being 1¼ inch. Referring to the table in MACHINERY'S Handbook, giving the maximum load in pounds which different sizes of helical springs will carry, it is found that the load that can be supported by springs of this size is 1220 pounds. Allowing a factor of safety of 1½—as the springs are not subjected to severe vibration—the total load used in calculating is $1.5 \times 6000 = 9000$ pounds. The number of springs required is then found to be $9000 \div 1220 = 7.35$. Using the next higher number, we find that eight springs are necessary. Four of the springs are held between the stripper *A* and bolster *B* by means of bolts *C* and the other four springs are secured by pins entering into the ends of the springs. One of these pins is shown at *D* in Fig. 2. Two 1¼-inch guide pins line up the die.

Each coil of a spring of the size used for the stripper may be compressed 0.138 inch. Allowing 5 inches between the stripper and the bolster, there will be sufficient room for springs with eight coils. The total allowable compression of these springs will be $8 \times 0.138 = 1.104$ inch. The stroke of the press is 2 inches and allowing the stripper to act through the last 1 1/16 inch of the stroke, the required pressure will be secured to strip the work from the punches.

Hamilton, Canada J. M. HARRISON

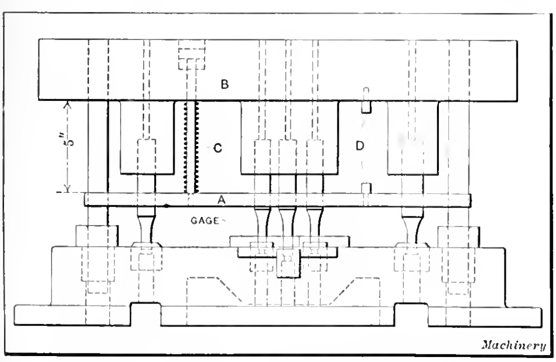
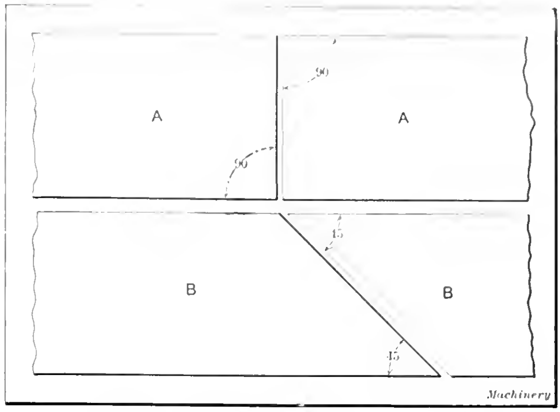


Fig. 2. Punch and Die for which the Spring Stripper was designed



Leather Belts laced at Angles of 45 and 90 Degrees

LACING LEATHER BELTING

It is a time-honored custom in splicing leather belting to cut the ends of the belt which are to be laced together so that the splice makes an angle of 90 degrees with the edge of the belt. This method is shown at *A* in the accompanying illustration. Anyone who has had much to do with the maintenance of belting knows that the rawhide laces wear and pull out long before the belt is worn out. The use of steel lacing does not eliminate the difficulty, because the holes in the belt finally become so large that the splice pulls apart.

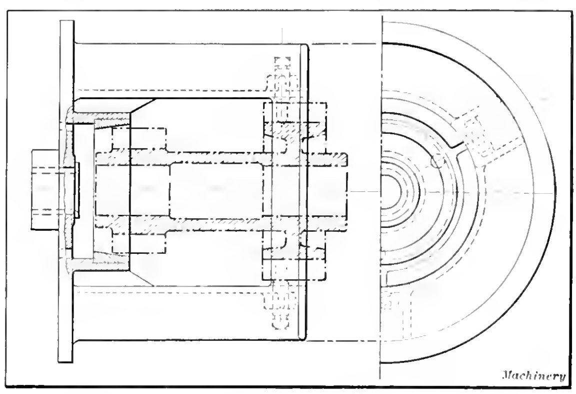
If the belt is spliced at an angle of 45 degrees, as shown at *B*, and laced in the usual manner, it will be found that the lacing will last fully as long as the belt. This is due to the fact that with the belt cut at a 45-degree angle, there are more strands of the lacing for a given width of belt, and the strain of the lacing in the holes is distributed over a greater distance than when the belt is cut in the usual manner.

East Orange, N. J. GEORGE GARRISON

[Mr. Garrison has used this method of splicing belts in certain classes of work, and finds the results entirely satisfactory. We have never seen this method used before and it appears that the practice of making the splice on an angle might have a tendency to cause the belt to run off the pulley. If other readers of MACHINERY have used this method, we should be pleased to hear of their experience.—EDITOR.]

CHUCK FOR TWIN SPUR GEARS

The chuck illustrated herewith was designed to produce more gears on a large turret lathe than were being produced



Special Chuck for holding Twin Spur Gears while boring Hub

on the same lathe equipped with a regular chuck having special jaws and clamps. This new chuck was also designed to insure greater accuracy. The dot-and-dash lines show the twin spur gears in place in the chuck. These gears are of cast steel and have one long hub, the bore of which must be accurate in relation to the teeth. The chuck has a finished boss that fits into the faceplate of the lathe and this boss is provided with a bushing for guiding the pilot of the turret

boring-bars, thus making the chuck and bars accurate in relation to each other.

The back of the chuck contains a taper ring of casehardened steel, which forms an accurate centering device for the smallest of the two gears, the gear being centered by the outside of the teeth. The larger gear, which has a number of teeth divisible by 3, is set centrally in the chuck by adjusting three screws that engage the bottoms of the teeth. These screws provide a means for locating the gears centrally, and also act as drivers. The chuck is of light construction and is well ribbed. The projecting ring and ribs not only strengthen the chuck but serve as guards to prevent the screw heads from injuring the lathe operator. As the guard ring is only a trifle larger than the gear, it is of value to the operator in judging the position of the gear when centering it.

M. W. W.

DESIGN OF SHEAR FOR CUTTING ANGLE IRONS

I was particularly interested in reading the answers to J. D. Y.'s inquiry in regard to the design of shear blades for cutting angle irons, which have been published in MACHINERY. I have had quite a little experience along this line and would like to add a suggestion in regard to the best method of handling this class of work. Three or four years ago I received orders to make a shear for cutting angle irons, the chief requirement being that it would be capable of cutting the pieces off square and free from burrs. I made a shear

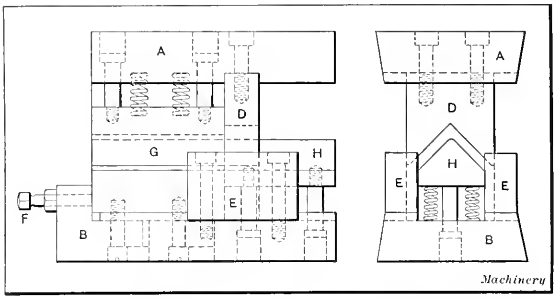


Fig. 1. Side and End Views of Shear for cutting Angle Irons

somewhat similar to the one described by J. M. Henry and tried it out. The first lot of angle irons was cut fairly well and I thought that the problem had been solved very satisfactorily, but the next lot of stock that came in was much softer and when we started to cut it up our troubles began. I tried all sorts of remedies but found it impossible to get satisfactory results until I finally hit upon the scheme of making a pair of shear blades equipped with spring pads. An equipment of this kind is illustrated in Figs. 1 and 2, from which the design will be readily understood.

Referring to Fig. 1, the upper and lower blocks upon which the shear blades are mounted are shown at *A* and *B*, respectively. The lower blade *C* is made of tool steel and formed to the shape of the inside of the angle iron. The upper blade *D* which is also made of tool steel is machined to the same angle as the outside of the angle iron. The lower block *B*, which is shown in Fig. 2, has a longitudinal slot cut in it to receive the blade *C* and a transverse slot to receive the backing up pieces *E* which support the upper blade. The block *B* also has holes machined in it to receive the screws for holding the shear blade in place, these holes being elongated so that the blade may be adjusted by means of the screw *F* to compensate for the effect of grinding.

The backing up pieces *E* fit snugly against the upper blade and are fastened to the block *B* by two fillister-head screws and a dowel pin. The spring pad for the upper blade is marked *G*, and *H* is the spring pad carried by the lower blade. These pads are held by two shoulder screws and each pad has four springs under it. The function of the pads is to hold the stock so that it cannot move lengthwise while being cut. The pad *G* extends 1/4 inch below the edge of the upper blade so that when the ram descends, the pad grips the angle iron before the blade comes into action. As the ram continues its downward stroke, the blade slides into the grooves in the side blocks *E* which makes it impossible for the upper and lower blades to separate.

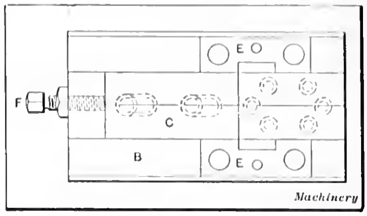


Fig. 2. Plan View of the Lower Shear

A shear of this kind may be made to cut all sizes of angle iron from 1/2 up to 2 inches. This shear is used in a punch press and has been in operation for about three years. Aside from replacing the blades when they become worn out, it has given practically no trouble. Of course the first cost of this shear will be higher than that of an ordinary shear of the type described in previous contributions, but where it is absolutely necessary to cut angle irons without leaving any burrs, it will soon pay for itself.

Chicago, Ill. A. H. WILSON

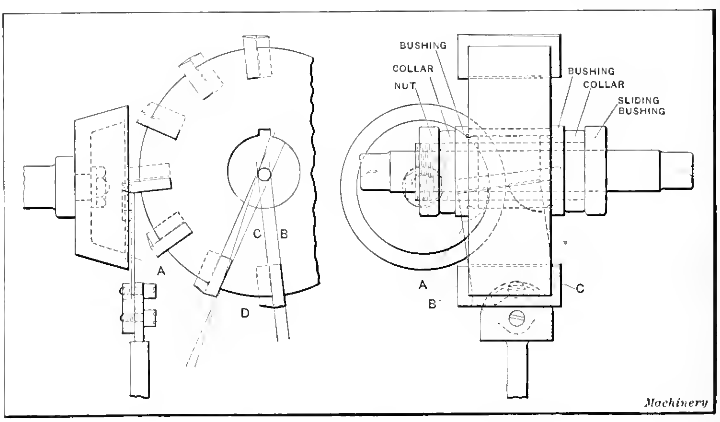
METHOD OF CUTTING PLATE GLASS

Among the numerous odd jobs met with in the general machine shop, there are few so "ticklish" as that of cutting plate glass where it is required to have the edges perfectly smooth and straight. If this work is attempted with the aid of a diamond glass cutter and rule, the glass will break with a ragged edge. The best method of overcoming this difficulty is described in the following: I have used it in cutting plate glass as thick as 1/2 inch and obtained excellent results. First obtain a good diamond glass cutter, and with this tool scratch the glass along the line on which it is to be cut, using any good straightedge to guide the diamond. In this connection it may be mentioned that the deeper the cut the more uniform the surfaces of the cut edge will be. After laying the glass on a cold surface with the cut side up, for which purpose the surface plate is very satisfactory, an iron or steel rod about 1/4 inch in diameter is heated to a dull red. This rod is then laid along the line scratched by the diamond point and pressed lightly against the glass. When held in position for from one to four minutes—depending on the thickness of the glass—it will be found that the glass will crack along the line, leaving a perfectly uniform surface.

JULIUS R. HANSEN

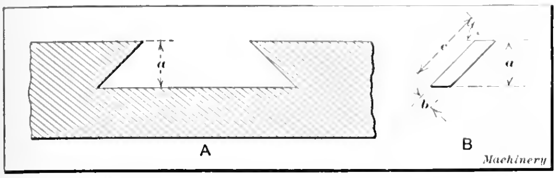
FIXTURE FOR GRINDING INSERTED-TOOTH CUTTERS

The accompanying illustration shows a fixture that has proved itself a great time-saver in grinding milling cutters



Tool Grinder Fixture for sharpening Angular Inserted-tooth Cutters

with inserted angular blades. The cutter to be ground is held on a sliding bushing which is carried on a straight mandrel mounted between centers on the grinding machine. This arrangement has been used for years in grinding spiral and straight milling cutters, but it is not suitable for grinding cutters with angular inserted blades without the use of the rest *A*. This rest holds the cutting edge of the blade at exactly the same height at both ends and gives excellent results on both angular and straight inserted-blade cutters.



Dimensions of Slide and Gib that should be given

The rest may be set to the desired angle for holding different cutters.

It will be noticed that the line *B* of the face of the blade has "drag" because it points ahead of the center, and that line *C* at the opposite side of the cutter has "rake" because it points back of the center. If it were attempted to grind an angular cutter with the blade supported on an ordinary rest at *D*, it will be seen that the blade would be at different heights on the emery wheel as it slides across the rest.

Franklin, Pa. FRED R. IRWIN

PROPER DIMENSIONS FOR A GIB

In the April number of MACHINERY, W. Butz invites a discussion in regard to the proper method of dimensioning a gib. As it seems to be a question of the necessary dimensions for both the required size of the stock and the gib to be machined from it, the writer believes that none of the three methods shown by Mr. Butz is entirely satisfactory. In dimensioning the slide *A*, one would naturally give the dimension *a*. The same dimension *a* should be given on the gib *B*. This dimension *a*, together with the proportions *b* and *c* and the angle *a*, should be given. Where the gib is proportioned in this way, and the required length of the gib is specified, the machinist has complete information and can proceed with the machining operations.

Whitinsville, Mass. S. H. HELLAND

DRILLED AND PUNCHED HOLES FOR A. S. M. E. STANDARD SCREWS

The accompanying table is taken from my note-book and gives the sizes of tap drills which have been found to give satisfactory results when drilling for A. S. M. E. standard tapped holes in various metals. In cases when it is desired to punch the hole, either for tapping size or for the body size—as in the case of sheet metal work—this table also gives the diameter to which it has been found the punches should be made in order to give satisfactory results. Designers who may have jigs to lay out or punch press tools to design where these sizes are called into play will find that the data presented in this table gives excellent results without involving much expenditure for the replacement of taps which break if too much stock is left for tapping.

Hartford, Conn. C. F. SCRIBNER

SIZES OF DRILLED AND PUNCHED HOLES FOR A S. M. E STANDARD SCREWS

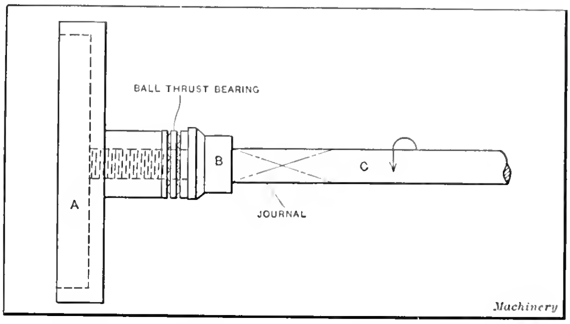
Number	Threads per Inch	Outside Diameter		Pitch Diameter		Root Diameter		Tap Drill Sizes				Body Drill, No.	Diameter of Punches	
		Maximum, Inches	Minimum, Inches	Maximum, Inches	Minimum, Inches	Maximum, Inches	Minimum, Inches	Steel, No.	Brass, No.	Cast Iron, No.	White Metal, No.		Tap, Inches	Body, Inches
0	80	0.060	0.057	0.0519	0.0505	0.0438	0.0410	..	..	..	..	52	.....	0.063
1	72	0.073	0.070	0.064	0.0625	0.0550	0.0520	..	..	..	..	48	.....	0.075
2	64	0.086	0.083	0.0759	0.0743	0.0657	0.0624	49	49	49	49	43	0.069	0.088
3	56	0.099	0.096	0.0874	0.0857	0.0758	0.0721	44	45	45	45	38	0.085	0.101
4	48	0.112	0.108	0.0985	0.0966	0.0849	0.0807	40	42	42	42	33	0.097	0.112
5	40	0.125	0.121	0.1102	0.1082	0.0955	0.0910	36	38	38	38	30	0.110	0.127
6	36	0.138	0.134	0.1218	0.1197	0.1055	0.1007	32	34	34	34	28	0.115	0.139
8	36	0.164	0.160	0.146	0.1438	0.1279	0.1227	28	29	29	29	19	0.139	0.164
10	32	0.190	0.185	0.1684	0.166	0.1467	0.1407	20	22	22	22	11	0.161	0.191
12	28	0 216	0.211	0.1928	0.1904	0.1696	0.1633	13	15	15	15	2	0.185	0.219

Machinery

A BALL BEARING APPLICATION

Part of a certain special machine is shown in the accompanying illustration. The mandrel shaft *C* carries the collar *B*, which is shrunk on against a shoulder. A left-hand threaded stem extends beyond the collar, and on this threaded stem there is a cast-iron flange *A*. Formerly this flange screwed up to the collar, and the nature of the work tightened the flange against the collar, which, in addition to the close fit of the long thread, made removal difficult. Sometimes the flange had to be removed after running two hours, and sometimes it was left on for a week; but it was always difficult to unscrew. The mandrel would have to be blocked and a pipe wrench applied to the hub of the flange in order to unscrew it; this usually required two men.

The writer was asked to remedy the trouble. An entirely different construction seemed to be the best remedy, but this was not feasible at the time. Naturally, knock-off arbors were thought of, but were rejected as being too complicated and too delicate for the rough unskilled labor which operated the machine. We had in our stock-room different sizes of standard ball thrust collar bearings. One of these was secured between the flange hub and the collar on the mandrel, as the illustration shows. With this bearing in place, the flange unscrewed as easily as it went on, and twirling it on with a "bang," made no difference; neither would a week's service, as it always came off readily. And curious to relate, there was no tendency for the flange to unscrew of itself, even though it was screwed on lightly and the machine run "light."



Flange screwed against Ball Thrust Bearing to facilitate Removal

Middletown, N. Y. DONALD A. HAMPSON

RELIEVING TAPS BY HAND

Having had an experience of some forty years in making and using taps, it seems to me that a tap relieved by hand with a file will work easier and last longer than a machine-relieved tap. A tap must be beveled at the end for several threads so that it will start into a hole, and, of course, it must be relieved on top of the beveled part. The first tooth to cut in starting cuts the whole width of the bottom of a V-thread; the next following tooth a little deeper, the next still deeper and so on until the full depth is attained, and all the cutting is done by the beveled or leading part of the tap.

My way of relieving a tap is to use a three-cornered file, the teeth of which are ground off on one side so they will not cut at all. I file the front side of the thread or tooth so it will be thinner at the back or away from the cutting side of the tooth. The front side is filed nearly up to the cutting edge, the smooth side of the file being held against the back of the tooth. When a tap is relieved in this way the front side of the thread will do all the cutting and the back will be smooth, just as the lathe tool left it, and the tap will cut freely and easily.

Of course I am aware that nearly all shops buy their taps now, but I have seldom seen taps that would work so freely and last so long as those relieved as described in the foregoing. Relieving both sides of the thread or tooth is not only unnecessary, but harmful, as the tap is more likely to chatter and cut a poor thread. It would probably be difficult to machine-relieve the thread on only one side, but I am convinced that taps relieved in that way are much more satisfactory.

Cleveland, Ohio S. S. Jennison

MAKING TUBING FROM HEAVY STOCK

The illustrations presented in this connection show two dies used for making a tube out of heavy stock. The method of using these dies is as follows: A ¼-inch plate of cold-rolled steel is placed in position on the die shown in Fig. 1, and

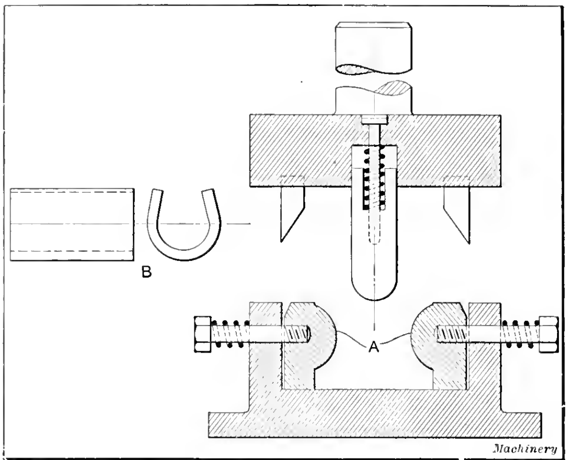


Fig. 1. Novel Punch and Die for performing the First Operation

when the punch descends it forces this plate to the bottom of the die, bending it between the surfaces *A*. The punch-holder and cams continue their downward movement, and the cams force the two surfaces *A* in, thus bending the work to the form shown at *B*. The work is next transferred to the die shown in Fig. 2, which closes it up to form a tube.

Milwaukee, Wis. W. Butzlaff

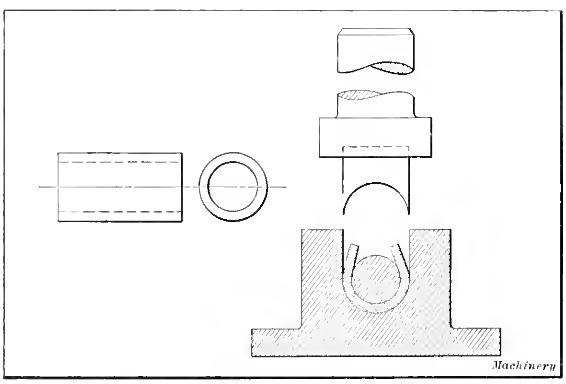


Fig. 2. Punch and Die for closing up the Tube

TWO LATHE TOOLS

Two useful forms of lathe tools are shown in the accompanying illustrations. The tool illustrated in Fig. 1 is either used in the tailstock of the lathe or placed in position against the work and supported by the tail-center at *A*. When using a lathe with badly worn spindle bearings, the use of this tool does away with the tendency toward vibration and at the same time takes up end play. For the purpose of description, let us suppose that a large casting or forging is held in the chuck of such a lathe in order to be turned and faced. The face *B* is brought up against the work, upon which it secures

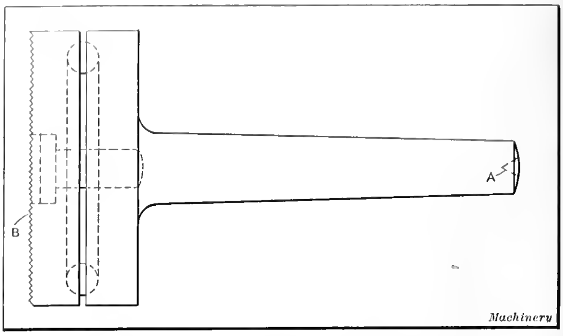


Fig. 1. Auxiliary Tailstock for supporting Work in a Lathe with Worn Spindle Bearings

a firm grip by means of the knurled surface. The support provided in this way prevents the lathe tool from digging into the work and thus produces a much better finish than would otherwise be obtained. It will be seen that the tool consists of two revolving disks which have races machined in them to carry ball bearings. The right-hand disk has a taper shank which fits the tailstock. The knurled disk which engages with the work is hardened and held in position by means of a fillister head screw.

The tool shown in Fig. 2 is a micrometer stop that is used to eliminate all guesswork when boring a recess in a piece held in the lathe chuck. For instance, suppose it is desired to bore out a hole three inches deep. After roughing out the hole to approximately the required depth, the stop is placed in position on the lathe bed near the headstock and the carriage brought up to it. The stop is clamped to the lathe bed by means of a C-clamp. The next step is to take a light cut on the bottom of the hole or recess in the work, after which an accurate measurement of the depth is made. By subtracting

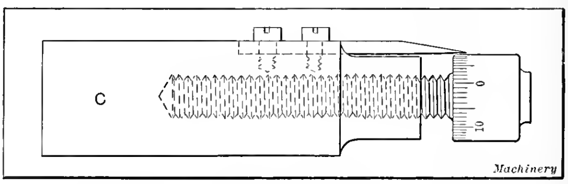


Fig. 2. Micrometer Stop for regulating Depth of Final Cut

this measurement from the required depth, the number of thousandths of an inch that must still be bored out is determined. The micrometer screw is then used to set the stop for the required depth, after which the tool can be fed into the work until the carriage engages the stop. This does away with all cut-and-try methods and increases the accuracy and rapidity with which the operation can be performed.

Brooklyn, N. Y. Edward Rantsch

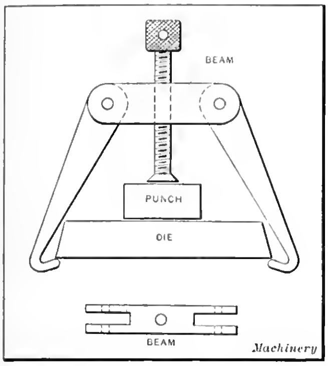
* * *

The imports of machinery to Germany during 1913 exceeded the imports during 1912 by 10 per cent. The exports during 1913 also exceeded the exports during 1912 by about 10 per cent. The total imports during 1913 amounted to 87,902 tons and the total exports to 593,969 tons. Of the imports, 40 per cent came from the United States, and 34 per cent from Great Britain. The exports were mainly to Russia, Austria-Hungary, France and Great Britain.

SHOP AND DRAFTING ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

DIEMAKERS' CLAMP



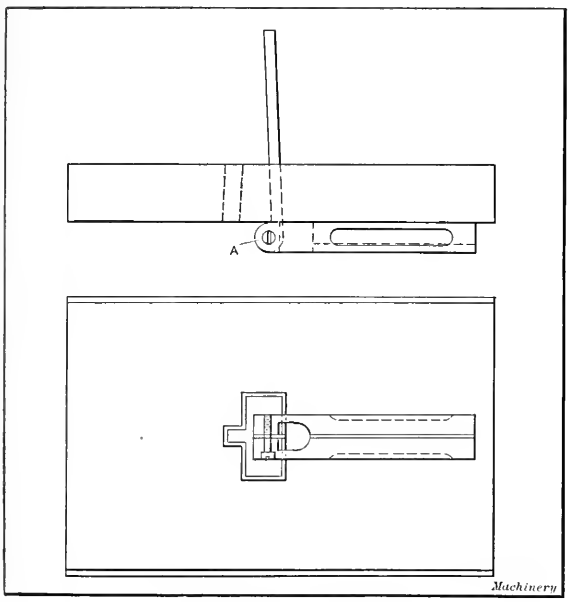
A Useful Form of Clamp for the Diemaker

The accompanying illustration shows a convenient form of diemaker's clamp. This tool is especially useful in transferring the shape of the hole in a blanking die onto the piece of steel from which the punch is to be made. The use of this device practically eliminates the chance of the punch slipping, when scribing its outline on the die, which would result in an inaccurate layout.

Upper Hamilton, Ontario, Canada. H. GROVES

ADJUSTABLE ANGLE GAGE

The accompanying illustration shows a useful form of adjustable angle gage which has several advantages over any other design that I have seen. The only drawback is that this form of tool takes longer to make than other types which are in general use. It will be seen from the illustration that the stock has a slot machined in it which is deep enough to enable the blade to lie flush with the upper surface when the tool is folded up. The hole in the stock must be made large enough and the sides thin enough to enable the screw to



Toolmaker's Adjustable Angle Gage

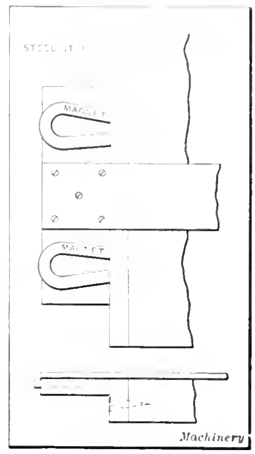
tighten up the blade in any required position. The blade is made of spring steel. After the stock had been hardened and tempered, the blade was put in place and folded into the slot. The stock was then ground on all sides, a magnetic chuck being used for this purpose.

It will be found convenient to have the end of the stock graduated at *A* and to have an index mark on the blade so that any required angular setting may be obtained. The chief features of the design are that the gage is adjustable and that the hole through the stock enables a toolmaker to see right along the blade when he is using the gage in small holes. The blade is also held square with the stock so that the gage may be used with the blade edgewise in narrow holes. The making of this gage will naturally depend upon the ability of the toolmaker and the appliances which are at his disposal.

Meriden, Conn. JAMES GALLIMORE

MAKING THE T-SQUARE STICK

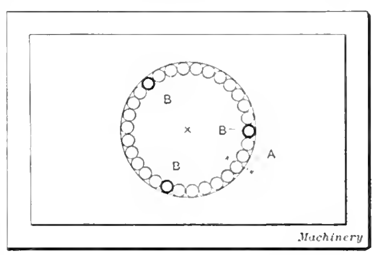
The article "Adjustable Clamps for T-square" by Murray Fahnestock, in the March number of MACHINERY, brings to mind an arrangement used in the drafting-room of the Stockbridge Machine Co., Worcester, Mass. The illustration explains the device, which is a magnetic arrangement for keeping the T-square in place against the edge of the drawing-board. This is especially to be desired when the T-square is to be used in one position for a considerable length of time. The head is mortised so that two ordinary horseshoe magnets can be securely held in it. On the edge of the drawing-board is screwed a steel strip against which the T-square bears. Thus the magnets, and consequently the T-square members, always have an attraction for the end of the drawing-board. While this device is very simple, it has worked out effectively. C. L. L.



A Magnetic T-square

LOCATING A HOLE TO BE BORED

It is sometimes more convenient to drill out the core of a large hole in a die or other piece of work than it is to drill and bore the hole in a lathe. When the core is removed by drilling, it may be conveniently relocated in the hole prior to setting up the work for finish-machining the hole. When this method is to be followed, a center punch mark is made at the center of the core, and a "witness line" *A* is scribed on the work, as shown in the accompanying illustration. After the core has been separated from the block, three drill rod pins of the same size as the drill used for making the holes are driven between the block and the core, as shown at *B*. The block is next mounted on parallels a little higher than the thickness of the block and fastened to the lathe faceplate, where it is accurately located with a center test indicator. The core is then driven out of the block from the front—the space between the work and the faceplate provided by the parallels making this possible—or when a lathe with a hollow spindle is used, the work can be fastened directly to the faceplate and the core driven out from the back. The same method can be used to advantage on pieces with irregular shaped holes that can be finished in a lathe, provided, of course, that the hole is large enough to enable the tool to clear all surfaces except the curve being bored.



Use of Core in locating a Hole to be bored

New Britain, Conn. W. C. BETZ

* * *

The Westinghouse strike at East Pittsburg, Pa., was called off by the workmen July 9, and the day set for return to work was July 13, but a large number of the men reported on the Friday and Saturday preceding. The works are now running full time.

TAPER BORING ATTACHMENT FOR THE TURRET LATHE

The cream separator bowl is full of headaches—for the producer. On account of the weight and thickness of the stock it is very hard to draw up, and as it must run very truly, it must be machined all over carefully.

At the plant of the King Sewing Machine Co., Buffalo, N. Y., which makes cream separators, as well as sewing machines, the bowls are finished very carefully, so that they will run at high speed and still be in balance. This requires that the inside of the bowl be machined perfectly concentric with the outside at all points, and for the purpose of finishing the inside of the tapered part of the bowl, as well as the straight part, the Warner & Swasey turret lathe is used, as shown

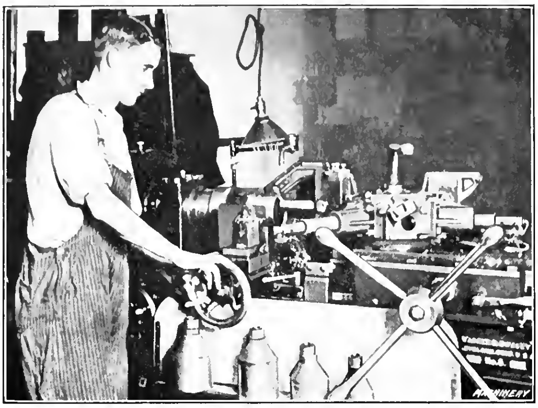


Fig. 1. Taper-boring Operation on Cream Separator Bowls

in the illustration Fig. 1. Fig. 2 shows the details of the taper-turning attachment, and Fig. 3 shows the cream separator bowl itself; in this illustration the surfaces that this taper-turning attachment machines on the inside of the bowl are indicated. It will be seen that the work done by this attachment consists of boring the straight section and then dropping to do the taper section with the same tool.

Referring now to the detail photograph, Fig. 2, the operation of the device may be seen. The tool itself is shown at *A*, being held on toolpost *B* that is made fast in the vertical tool-slide *C*. The tool-slide is fitted into a vertical bracket which is held on the face of the turret in the same manner as the other turret tools. At the upper part of vertical slide *C* is a roller mounted on stud *D*. This roller travels in a groove in the fixed bracket *E* at the rear of the machine. This groove is parallel with the line of turret travel for a short distance and then deflects downward on a taper of 36 degrees, to produce the required taper of the cream separator bowl. When the turret is brought forward for this operation, the cut continues parallel with the ways until the deflection in the slot on bracket *E* is reached. At this point the roll on stud *D* is

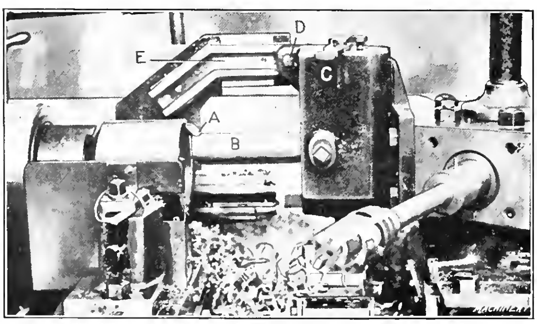


Fig. 2. Taper-boring Attachment

caused to travel downward as well as forward and carries with it the vertically moving slide *C* and also the toolpost *B* and the tool *A*. It should be noticed that tool *A* is sharpened at an angle which will be correct for cutting on the straight section as well as the inclined section. C. L. L.

HEAT-TREATING CASEHARDENED CARBON STEEL

The following practice for heat-treating casehardened carbon steel was recommended and adopted at the Atlantic City meeting of the American Society for Testing Materials, and referred to the members for letter ballot.

1. When hardness of case only is desired and lack of toughness or even brittleness is unimportant, the carburized objects may be quenched from the carburizing temperature, as for instance, by emptying the contents of the boxes into cold water or oil. Both the core and the case are then coarsely crystalline.

2. In order to reduce the hardening stresses and to decrease the danger of distortion and cracking in the quenching bath, the objects may be removed from the box and allowed to cool before quenching to a temperature slightly exceeding the critical range of the case, namely, 800 to 825 degrees C. Both the core and case remain coarsely crystalline.

3. To refine the case and increase its toughness, the carburized objects should be allowed to cool slowly in the carburizing box within the furnace or outside to 650 degrees C., or below, and should then be reheated to a temperature slightly exceeding the lower critical point of the case (in the majority of instances a temperature varying in accordance with the carbon content and thickness of the case between 775 and 825 degrees C., will be suitable), and quenched in water, or, for greater toughness but less hardness, in oil. The objects should be removed from the quenching bath before their temperature has fallen below 100 degrees C. This treatment is more especially to be recommended when the carburizing temperature has not exceeded 900 degrees C. It refines the case but not the core.

4. To refine both the core and the case and to increase their toughness, the objects should be allowed to cool slowly from the carburizing temperature to 650 degrees C. or below and should then be (*a*) reheated to a temperature exceeding the critical point of the core, which will generally be from 900 to 950 degrees C., followed by quenching in water or in oil; and (*b*) before they have cooled below 100 degrees C., they should be reheated to a temperature slightly exceeding

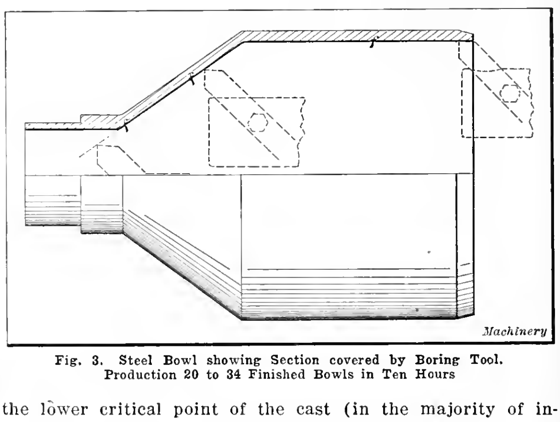


Fig. 3. Steel Bowl showing Section covered by Boring Tool. Production 20 to 34 Finished Bowls in Ten Hours

the lower critical point of the cast (in the majority of instances a temperature varying in accordance with the carbon content and thickness of the case between 775 and 825 degrees C. will be suitable), and again quenched in water or oil.

The objects should be removed from the quenching bath before they have cooled below 100 degrees C., in order to lessen the danger of cracking, and they should be placed in the reheating furnace while still at a temperature of at least 100 degrees C., likewise to lessen the danger of cracking, it being inadvisable (*a*) to allow steel to cool completely in the quenching bath and (*b*) to place hardened steel in a hot furnace. Obviously, if the furnace is cold the hardened steel may likewise be cold when placed in it for reheating.

5. In order to reduce the hardening stresses created by quenching, the objects, as a final treatment, may be tempered by re-heating them to a temperature not exceeding 200 degrees C.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

VAN NORMAN AUTOMATIC RADIAL GRINDER

The Van Norman Machine Tool Co., Waltham Ave., Springfield, Mass., is now building a No. 3½ automatic radial grinder for grinding raceways in cups, cones, or end-thrust rings for ball bearings. After the machine has been properly adjusted and the work set up in the work holder, the wheel is brought in cutting contact with the raceway, after which the operation is entirely automatic. Two important advantages are obtained in this way: first, one operator is able to look after a group of machines, so that the production cost is materially reduced; second, the precision of the machine rather than the skill of the operator is responsible for the accuracy of the work, so that it is possible to employ less highly trained help for grinding the raceways of the highest grades of ball bearings. This, of course, means a further reduction of production costs. Where a considerable amount of stock is to be removed, it has been found desirable to rough- and finish-grind in two operations. One machine or group of machines is arranged for the roughing cut, using a coarse wheel and operating with a fast feed. The finishing cut is done with a fine wheel and slower feed. These machines are built in two styles. Fig. 1 illustrates the machine for grinding single-row ball-bearing races, while the machine for grinding double-row races is shown in Fig. 2. The general design of these machines is the same and the description applies to both except that a detailed description is given of the means for shifting the work-head in grinding double-row bearings on the machine shown in Fig. 2.

Fig. 1. Van Norman No. 3½ Automatic Radial Grinder for grinding Single-row Ball Bearings

The most obvious features of these machines are their compact and rigid construction, and the provision of handy appliances which facilitate setting up the work and operating the machine. The extreme nicety which is required in the making of high-grade ball bearings to insure accuracy and interchangeability of parts is so well known that it requires no comment. This high degree of accuracy makes it necessary for grinders used in finishing ball bearing parts to be so constructed that there is practically no vibration. Particular attention has been paid to this point in designing these new Van Norman grinders. Referring to the illustrations, it will be seen that the slides upon which the work-head and wheel-head are mounted are located directly over the main frame of the machine. The slides are of unusually massive construction, which, together with the way in which they are supported, reduces vibration to a minimum. The work which different manufacturers grind on these machines varies considerably in shape and size. For this reason no standard style of work-holding equipment is sent out with the machines. The work-holding head oscillates about a vertical pivotal center, in order to obtain the required curvature of the race, and the necessary depth is obtained by the cross-feed of the wheel-head.

In preparing one of these machines for operation, there are three settings to be made: First, the work-head must be positioned by adjusting the upper head slide so that a line through the center of the path of the raceway to be ground will be exactly over the vertical pivotal center. Second, the work-head is positioned by means of the cross-slide of the head so that the radial center of the raceway is exactly over the vertical pivotal center. Third, the grinding wheel must be brought to the correct grinding position over the pivotal center. These settings of the work-head and grinding wheel are accomplished by means of a series of stops used in conjunction with plugs or distance gages of the required lengths which are placed between the stops. This will be better understood by the following description, which explains the method of procedure for each case.

Fig. 2. Van Norman No. 3½ Automatic Radial Grinder for grinding Double-row Ball Bearings

As a typical example of making the transverse setting, suppose it is required to grind a race in which the diameter of the ball center circle is 1.5 inch. It will be necessary to locate the head 0.750 inch off center, and this is done by means of a plug or gage, the length of which is exactly 0.750 inch. When in contact, the stops shown at *A* in Figs. 1 and 2 locate the central axial line of the work-holding spindle exactly over the vertical pivotal center of the oscillating head, while the stops shown at *B* in Fig. 3 locate the shoulder on the spindle exactly over the pivotal center when these stops are in contact. The 0.750-inch plug or gage is placed between the stops shown at *A* in Figs. 1 and 2, and the slide brought up so that both stops engage the ends of the plug. The cross-slide of the work-head is then locked in this position. The next step is to move the work-head back the required distance so that the radial center of the race held in the work-holder is exactly over the axis about which the head swings. For this purpose the shoulder near the front end of the spindle is made the reference point, and this shoulder is exactly over the axis about which the work-head swings when the stops *B* are in contact. Suppose that a work-holding fixture of the form shown in Fig. 4 is used, in which the distance from the reference point on the spindle to the face of the work-holding fixture against which the race is held is 1.250 inch. Further, assume that the race is 0.750 inch wide. Under these conditions it will obviously be necessary to have the reference point on the spindle 1.625 inch from the axis about which the work-head oscillates. This is done by means of a second plug or gage 1.625 inch in length placed between the stops *B* on the longitudinal slide of the work-head, which is shown in Fig. 3.

The next step is to locate the grinding wheel over the center line of the work, as indicated at the left-hand side of Fig. 4. The wheel-head is mounted on a slide which is moved back and forth by means of a hand-operated rack and pinion. When the wheel is in the working position, the adjustable stop shown at *C* in Figs. 1 and 2 is in contact with its bearing on the frame of the machine. In order to true the wheel, the work-head is moved around to its central position, where a plunger *D* enters a hole in the swivel slide support and holds the truing device securely in place. In this position the post *E* upon which the diamond holder is mounted is properly located. The distance between the axis about which the work-head oscillates and the center of the stud upon which the truing device is mounted is approxi-

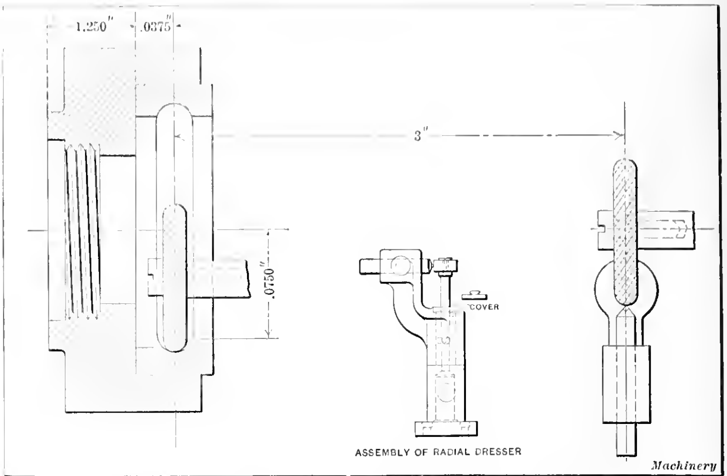


Fig. 4. Diagram showing Method of setting up the Work and truing the Wheel

mately 3 inches. In order to true the wheel, it is obviously necessary to move it back to the diamond point, and this is accomplished by means of the distance plug shown at *F* in Figs. 1 and 2, the length of this plug corresponding to the distance between the vertical pivotal center and the center of the stud *E*. In starting to true the wheel, the wheel-slide is released and moved back rather more than 3 inches; after which the 3-inch distance plug is swung into place and the slide moved forward to bring the stop *C* into contact with it. This locates the wheel in the correct position for truing.

With this preliminary statement, the method of procedure in setting up a new wheel in correct relation to the work may be explained. With the stop *C* in contact with the distance plug *F*, the wheel is brought into contact with the diamond point, which may be swung back and forth about its stud. The first step is to locate the wheel in such a position that the diamond point is centrally located in regard to the wheel. If it is found that the wheel is not located centrally on the diamond point, the adjustable stop *C* is regulated until the wheel is brought into the required position. This also locates the wheel in the correct relation to the work, because when the wheel has been trued, the distance plug *F* is removed and the wheel-slide brought forward to bring the stop *C* up against its bearing on the frame of the machine, causing the slide to be advanced exactly 3 inches. This brings the wheel central in regard to the work. After the wheel has been used for such a length of time that it requires truing, it is merely necessary to move the wheel-slide back and engage the stop *C* with the distance plug *F*, as previously described, and then swing the diamond point back and forth across the periphery of the wheel.

Fig. 4 also shows a detailed view of the device for truing the wheel. The stud upon which the wheel-truing device is mounted is secured to the base of the oscillating head; and the method by which the wheel truing device is located in line with the spindle of the wheel-head has already been described. Referring to the assembly view shown in Fig. 4, it will be seen that the bracket in which the diamond holder is mounted is slipped over the stud and held in place by a binding screw. It is obviously necessary to have the diamond holder located in different positions in the bracket when tru-

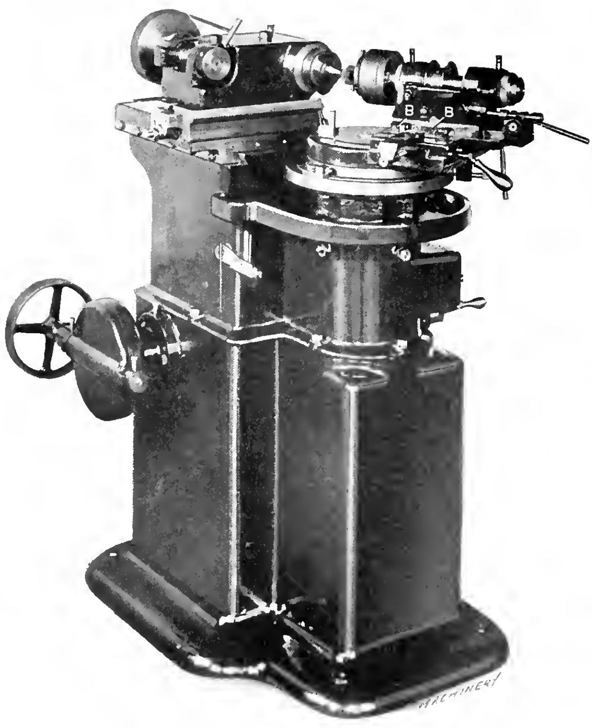


Fig. 3. Rear View of the Van Norman No. $3\frac{1}{2}$ Automatic Radial Grinder

ing wheels for grinding races of different radii. This is conveniently accomplished by having a small disk, the diameter of which is the same as the radius of the raceway to be ground, set up on a pin which slips into a hole in the bracket, as shown in the illustration. With the proper sized disk in place, the diamond point is brought into contact with the disk, after which the binding screw is tightened to secure the diamond holder in place. With this device any operator is competent to adjust the diamond point for truing the wheel to the correct radius, provided he has been given a disk of the proper diameter. The bracket and diamond holder which it carries are swung back and forth on the stud to true the wheel.

The wheel-head is arranged for both automatic and hand cross-feed. Power for the automatic feed is provided by the lower pulley shown at the right-hand side of the machine in Figs. 1 and 2, the power being transmitted through gearing to a vertical shaft inside the column of the machine, which is shown at *H* in Fig. 5. At the top of this shaft there is an edge cam *I*, on the upper side of which the face cam *J* is located. Each revolution of the shaft *H* brings the face cam *J* into contact with the plunger *K*, causing this plunger to be raised. The motion is transmitted by the plate *G* to the plunger *L* which actuates the pawl *M*, this pawl being adjustably set to pick the required number of teeth on the feed ratchet wheel. Each tooth of the ratchet wheel gives a cross-feed of 0.000025 inch to the wheel-head. The ratchet wheel is provided with a shoe which may be set to disengage the automatic feed at any point. When the pawl has moved the ratchet wheel around to the limit of the required motion, the shoe comes under the pawl, disengaging the feed. When so desired, the pawl *M* may be swung back out of engagement with the ratchet wheel and the small lever *N* used to feed the wheel-head by hand. Pushing down this lever causes the ratchet wheel to be turned by the second pawl shown in the illustration. Manufacturers using this grinding machine have found that the amount of wear developed in the grinding wheel in grinding each race can be accurately determined. For instance, one manufacturer has found that for the wheels and stock which he uses, the wheel is worn 0.00025 inch for each race. This wear is easily compensated for by setting the shoe on the feed ratchet after grinding each race, so that the wheel-head is fed in the necessary additional distance to compensate for the wear of the wheel.

Power for oscillating the work-head is also taken from the shaft *H*. The edge cam *I* mounted at the top of this shaft engages with a roller carried by the lever *O*. As the cam *I* rotates, the lever *O* moves to the left and transmits motion through the connecting-rod *P*. This rod is secured to the double disk *Q* which is loosely mounted on a pivot that rotates the work-head. It will be seen that the disk *Q* is made in two parts, which are secured together by two bolts, the heads of which fit in T-slots in the lower disk. By loosening these bolts, the two sections of the disk *Q* may be adjusted in relation to each other in order to regulate the field of oscillation of the work-head. The angle through which the work-head oscillates may also be adjusted by regulating the position of the crankpin which secures the connecting-rod *P* to the lever *O*. Below the double disk *Q* there is a block splined to the pivot that rotates the work-head. This block carries a tapered pin which enters a hole in the disk *Q* when it is desired to have the work-head oscillated by power.

When it is required to have the work-head free so that it may be oscillated by hand, the lever *S* is swung over to the left. This draws the tapered plunger down out of the disk *Q*, leaving the disk free to oscillate about the pivot without causing the work-head to move. The head may then be swung back and forth by hand. When it is again desired to

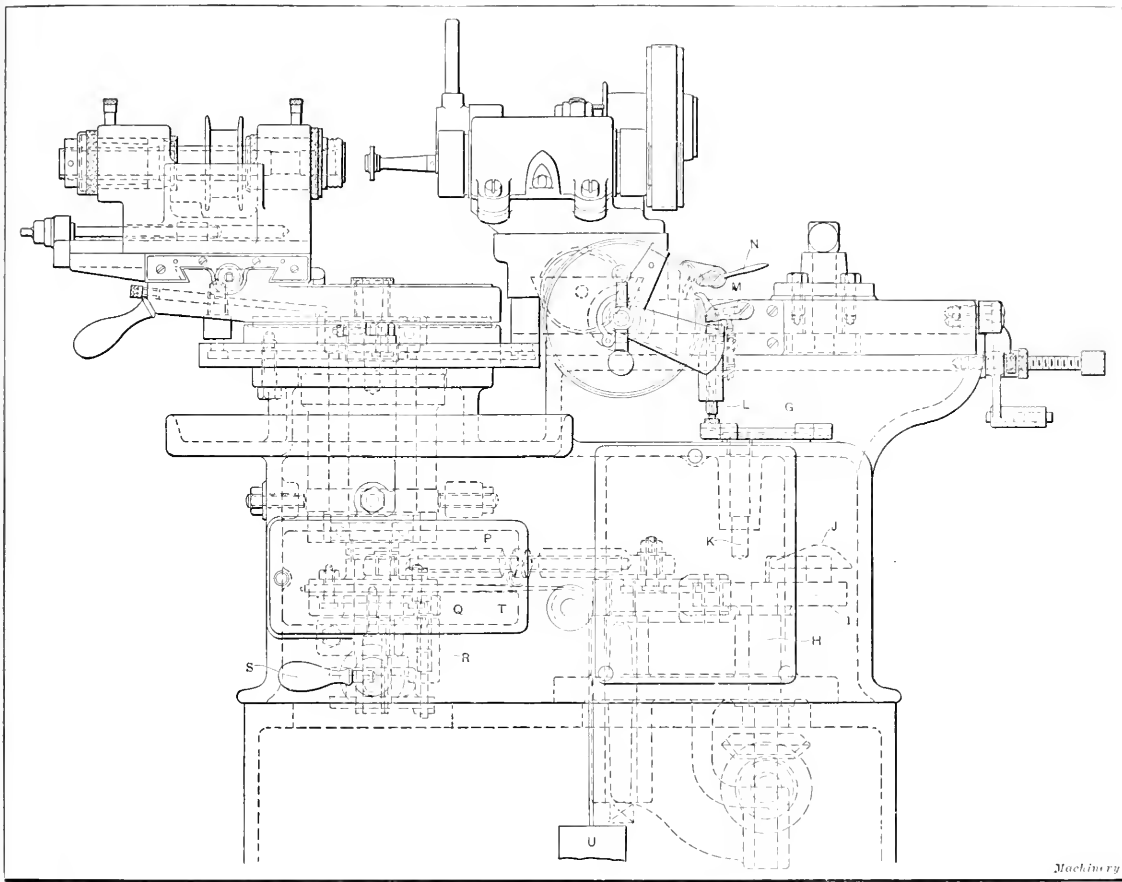


Fig. 5. Front Elevation of the Van Norman No. 3½ Automatic Radial Grinder

bring the power oscillation into action, the handle S is moved to the right. This releases the plunger which is pushed up against the bottom of the disk Q by a compression spring, and when the hole in this disk comes over the plunger, the latter is pushed up, thus connecting the disk with the pivot and bringing the power oscillation into action. The forward oscillation of the work-head is controlled by the cam I, as previously described, and when the high point of this cam has been passed, the work-head is returned through the action of the chain T and counterweight U, the movement being controlled by the contour of the cam. A very smooth motion is secured in this way, as the cam and roller which govern the oscillation of the head are always held in contact with each other and there is no lost motion.

Fig. 1 shows the machine for grinding the races of single-row ball bearings, while a machine for grinding the races of double-row bearings is illustrated in Fig. 2. These two machines are identical except that the one shown in Fig. 2 is provided with means for shifting the work after the first race has been ground, to bring it into position for grinding the second race. Referring to the illustration, it will be seen that there are two straight levers at the extreme left. In shifting the work, the operator swings the first of these levers over with his right hand. The lever turns a pinion which meshes with a rack on the cross-slide in the work-head, and by turning the handle the work is moved back away from the wheel. He then takes the second lever in his left hand and swings it over. This lever turns a second pinion meshing with a rack which actuates a longitudinal slide in the work-head. This slide causes the work to be moved over to bring it into the proper position for grinding the second race. An adjustable stop is provided on the longitudinal slide which can be set to enable the work-head to be brought into position for grinding the second race. The first lever is then swung back to return the work-head into position to start grinding.

Machines of this type are built either with or without a pump and water equipment for wet grinding. The regular equipment does not include chucking devices, as the great variety of work handled by different manufacturers makes it desirable for each to make his own work-holding fixtures. The radial diamond holder for truing the wheel is part of the regular equipment but the diamond is not supplied with the holder. The work-holding head swings 9 inches, and although this machine is especially adapted for grinding raceways from the smallest diameters up to 4 inches, larger sizes can easily be ground. The vital features of these grinders are protected by patents issued and pending. The net weight of the machine is 1600 pounds.

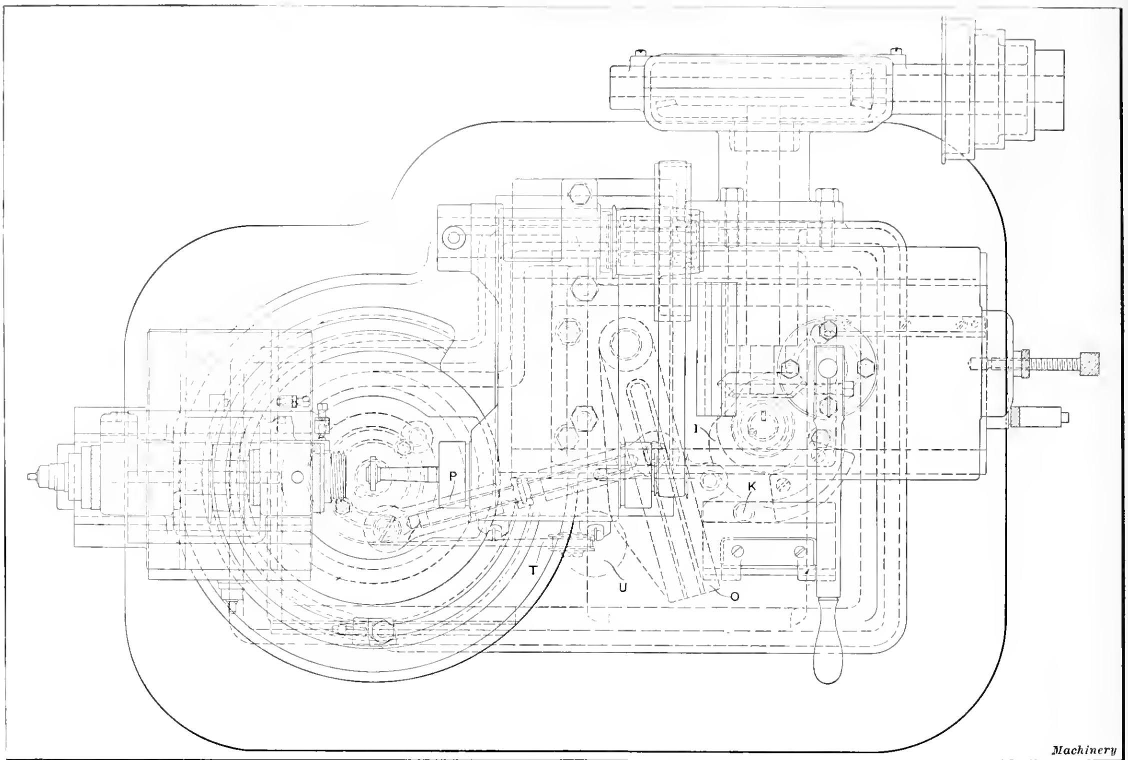


Fig. 6. Plan View of the Van Norman No. 3½ Radial Grinder

"UNIDRAFT" DRAFTING FABRIC

The Universal Drafting Machine Co., Cleveland, Ohio, is about to place a new drafting fabric upon the market which provides for making drawings and blueprints by an entirely new process. This fabric is somewhat similar to ordinary tracing cloth but it is covered with an opaque surface. In making a drawing on this material, the draftsman works with a pointed steel tool instead of a pencil; this tool is used exactly as a pencil would be and scrapes away the opaque surface along the lines which make up the drawing. This exposes the transparent fabric to permit the passage of light. In making blueprints from such drawings, the method of procedure is exactly the same as where ordinary tracings are used, but as the lines are transparent and the remainder of the drawing opaque, it will be evident that the resulting blueprint has blue lines on a white background instead of white lines on a blue background.

The use of this material eliminates the necessity of making a tracing either for the purpose of producing blueprints or for providing a clear and durable drawing for future reference. The lines are clean cut and drawings may be made on this material just as rapidly as it is possible to make them on paper with an ordinary drawing pencil. The surface of the "Unidraft" fabric is a dull brown which reflects very little light into the draftsman's eyes, thus reducing eye-strain and troubles resulting from this cause. The elimination of the necessity of making tracings is the means of effecting a considerable saving on each drawing, and where there are a great many drawings to be made on a single job, there is also a great reduction of the time required to get out

a complete set of drawings. Another advantage is that all errors due to tracing are eliminated and the checking and correcting of drawings is materially simplified, because the lines stand out far more distinctly than the lines of an ordinary pencil drawing.

It will be evident from the preceding description that it is possible to make a blueprint at any time before the drawing is completed and this is often a very valuable feature in the case of drawings showing general layouts. As the surface of "Unidraft" is a dull brown, it does not show dirt, which is another point that will be appreciated by those who have had experience in the making of drawings which are worked on for a considerable length of time, or with drawings which are allowed to lie about in places where there is

Fig. 3. Enlarged View of Tool used to Draw on "Unidraft"

covered with an opaque brown surface which is cut through by a steel pointed instrument. This exposes a white line which stands out in strong contrast to the dark background. An idea of how strongly the drawing stands out will be

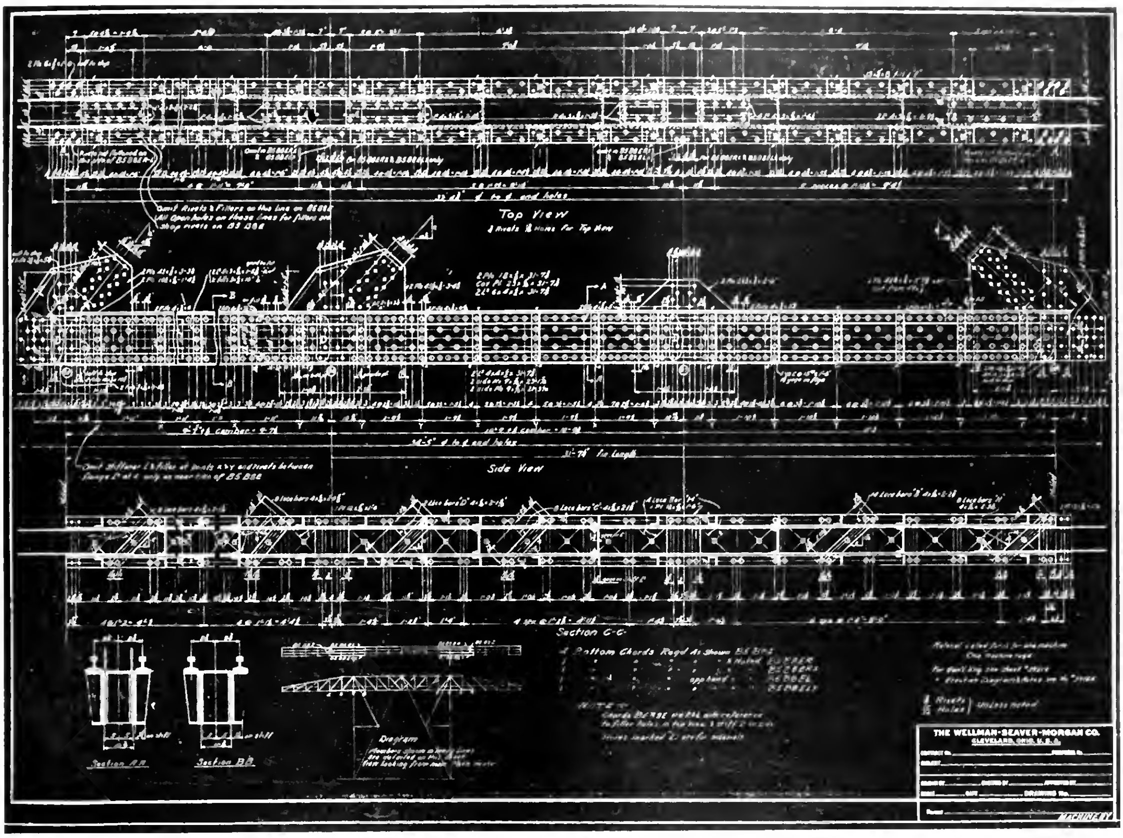


Fig. 1. Example of a Complicated Structural Drawing made on "Unidraft"

a lot of dust and dirt. Another point in favor of "Unidraft" is that the necessity for sharpening pencils is eliminated because the draftsman works with a steel tool which does not change its shape.

It has already been mentioned that "Unidraft" fabric is gathered from the illustrations which show reproductions of several drawings made on this material. Fig. 1 shows quite a complex structural drawing, while Fig. 2 illustrates a relatively simple design. It must be clearly understood that this material is applicable for use in making the most complicated mechanical and structural drawings and for all other classes of drawings which can be made with pencil and then traced. It is just as easy to erase a mistake made on "Unidraft" as it is to erase a line from a pencil drawing, and considerably easier than it is to erase an ink line. The erasing is done with an ordinary writing pen which inks in the line that it is desired to erase; erasing on "Unidraft" is merely a matter of replacing the opaque surface where it has been taken off by mistake. Either straight or curved lines can be erased in this way and after the erasure has been made, it is possible to redraw any part of the line with the steel tool. In the event of it being desired to change a full line into a dotted line, this is very easily done by simply dotting in the spaces with ink.

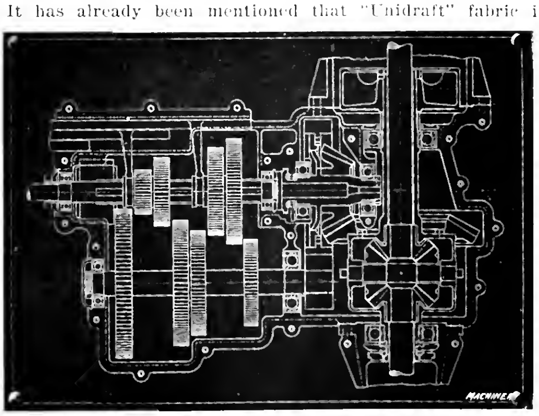


Fig. 2. Simpler Drawing—Note how the Lines stand out

It has already been stated that the blueprints of these drawings have blue lines on a white background, but where so desired, the blueprints may be reversed. The width of the line may be varied by varying the pressure on the point

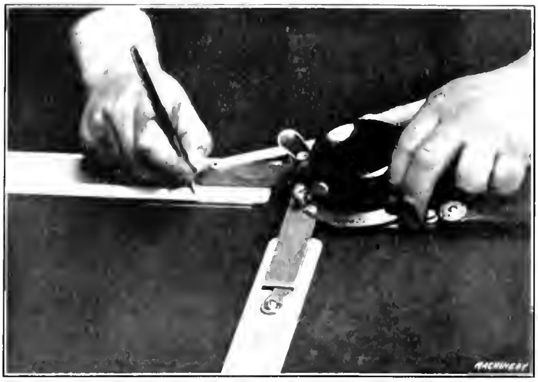


Fig. 4. Method of drawing Straight Lines on "Unidraft"

of the tool in the same way that the width of a pencil line can be varied by varying the pressure. The fabric may be worked on with a drafting machine and with the usual drafting instruments without scratching its surface except at those points where it is desired to draw the lines. Blueprints of drawings on "Unidraft" are made at about the same speed as blueprints of ordinary tracings.

Fig. 5. How Free-hand Lettering is done

It is stated that it is easier to learn to draw on "Unidraft" fabric than to learn to make a good tracing. The cost of making drawings is reduced because the original drawing can be used to make blueprints without requiring a tracing to be made. This saves the cost of tracing cloth, pencils and ink, and also the expense of a tracer's time. The elimination

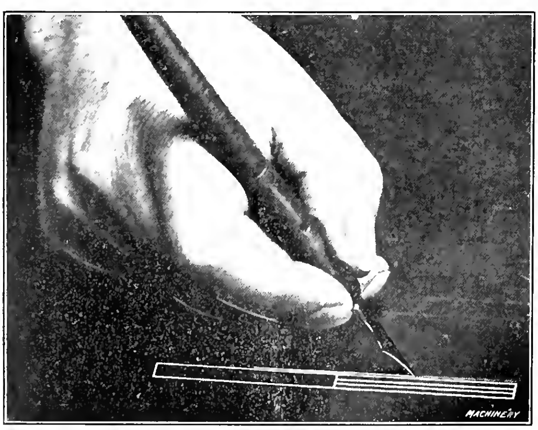


Fig. 6. The Use of an Ordinary Pen to erase a Line

of errors produced in tracing is an important feature, and as the drawing stands out exceptionally clear on the dark background, it is easier to check than it is to check a pencil drawing which often becomes somewhat indistinct before it is completed.

Figs. 1 and 2 show reproductions of drawings made on "Unidraft," and these illustrations give a good idea of the clearness with which the lines stand out. Fig. 3 is an enlarged view of the instrument used for drawing the lines. It will be seen that the point of this instrument is rounded and fine limit lines for lettering may be made by using the tool

Fig. 7. A Bow-pencil provided with a Steel Drawing Point

edgewise. Fig. 4 shows the method of procedure in drawing straight lines and emphasizes the point that the lines come up clearly and distinctly as they are drawn. In Fig. 5, free-hand lettering on "Unidraft" is being done and Fig. 7 shows the use of a bow-pencil provided with a steel point for drawing circles and arcs on this material. In Fig. 6 the drafts-

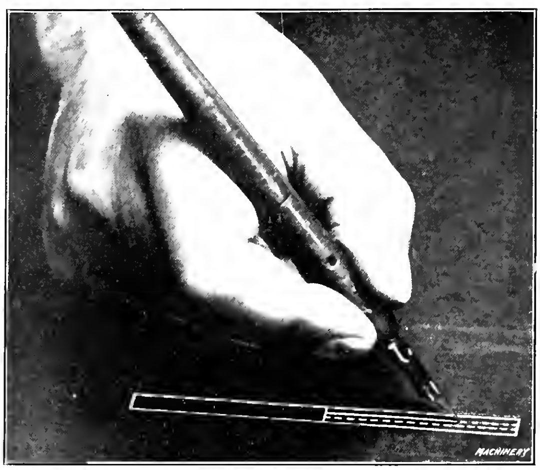
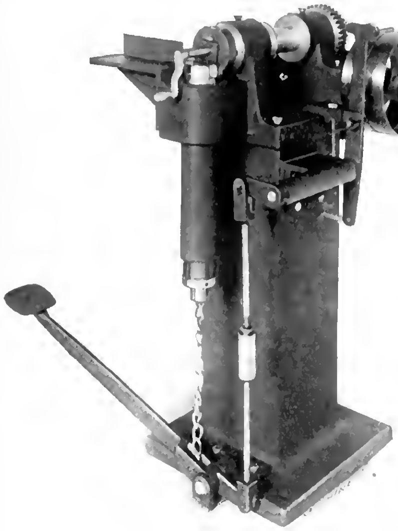


Fig. 8. A Full Line is easily converted into a Dotted Line

man is using an ordinary pen and ink to erase a line and it will be seen that the portion of the line already erased is to the right of the pen-point. Fig. 8 shows how a full line is easily converted into a dotted line by simply inking in intermediate spaces.

GARVIN COPPER COIL FORMING MACHINE

The machine shown in this illustration was designed to coil copper field coils for automobile lighting systems, taking the copper in strips and coiling it together with a strip of insulation on a rectangular arbor. The copper strip is not only cut to length, but has a right-angle bend at one end, which is used for dogging purposes. A powerful spring keeps the work against the arbor and is controlled by a foot treadle. The machine trips automatically on the completion of three revolutions of the spindle. The coils are stripped off the arbor by turning the crank handle shown in the



Garvin Copper Coil Forming Machine

center of the spindle. The next strip is put in place and the machine will start immediately on removing the foot from the treadle. Other metals can be used in place of copper, and the number of coils and their shape can be changed to suit the work. The machine is manufactured by the Garvin Machine Co., Spring and Varick Sts., New York City, and weighs 665 pounds.

CRESCENT WOOD SURFACER

To meet the requirements of shops that have work which is too heavy for the 24-inch Crescent planer, the Crescent Machine Co., 56 Main St., Leetonia, Ohio, has recently placed on the market a 26-inch machine, two views of which are shown in Figs. 1 and 2. The design is heavy and compact, requiring little floor space, but providing a capacity for handling lumber of large dimensions. There are four feed rolls, all of which are driven by flanged pulleys on each end of the machine. The feed is of the Crescent variable friction

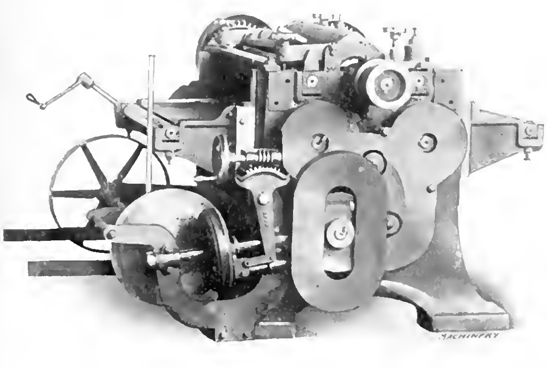


Fig. 1. Crescent 26 by 8-inch Wood Surfacer

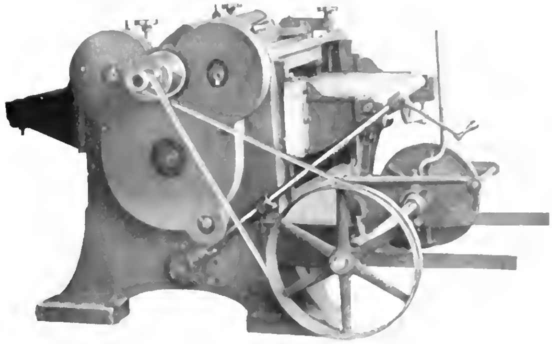


Fig. 2. Opposite Side of Crescent Surfacer shown in Fig. 1

type which has found successful application on other styles of planers built by this company. The range of feed is from 15 to 60 feet per minute, and a pointer and scale are provided for setting the machine for the proper feed.

The pressure of the upper feed rolls is obtained by springs, which some shops have found to be undesirable owing to the fact that the springs are not easily adjusted for different pressures, and because a foot treadle cannot be used to provide additional pressure when it is necessary. These difficulties have been overcome by providing a small handwheel at the top of the machine which may be turned until the desired amount of pressure is obtained. The pressure is quickly adjusted in this way and any pressure up to 600 pounds may be readily obtained. Additional pressure may be secured by operating either of a pair of foot levers. The springs which control the pressure of the rolls are flexible, and they act quickly and uniformly so that the machine is not subjected to uneven strains. The head is usually furnished with two knives, but a four-sided head may be obtained on special order. The countershaft for driving the machine is ordinarily mounted on the ceiling or it may be set on the floor back of the machine where such an arrangement is found more convenient.

"LITTLE DAVID" RIVET SET RETAINER

To provide for the safety of the operators of the "Little David" riveter of its manufacture, the Ingersoll-Rand Co., 11 Broadway, New York City, has recently provided a rivet set retainer for use on this tool. This attachment consists of but a single piece of heavy spring steel, closely wound into a spiral form. One end of this spring fits over the outside of

"Little David" Riveter equipped with an Improved Rivet Set Retainer

the hammer nozzle and hooks over a projection integral with the nozzle. The other end is wound to a smaller diameter. Sets for rivets over 7/8 inch diameter are formed with a coarse thread and are simply screwed into place. Sets for rivets 7/8 inch diameter and smaller are formed with a shoulder and are slipped into the retainer while it is detached from the hammer, the shoulder holding it in place. The device positively prevents the rivet set or piston from being driven out, even when the hammer is run free.

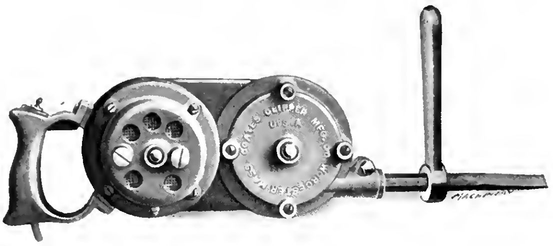
Other important improvements have been embodied in the "Little David" riveter. There is but a single ground joint between handle and barrel, and these parts are securely held together by two bolts, one on each side of the barrel. This construction eliminates the need of a vise in taking the tool apart for inspection, a feature of value to the structural worker, as well as to others who are not usually equipped with

special facilities for repair work. There are no threaded joints on the barrel. The valve chamber is placed beside and parallel to, instead of in line with the cylinder, obviating any possibility of injury to the valve by the piston. This construction gives a very much shorter tool, adding to its usefulness, as it can be used in closer quarters.

"Little David" riveters are made with either outside or inside types of triggers, in five regular sizes adapted for all kinds of riveting work. In addition, there are two sizes of jam riveters which have an exceptionally short over-all length, making them peculiarly well adapted for riveting in very cramped quarters.

COATES CENTRIFUGAL CHIPPING HAMMER

One of the recent products of the Coates Clipper Mfg. Co., Worcester, Mass., is an electrically driven centrifugal chipping hammer. This tool has found successful application in chipping castings, cleaning the bottoms of ships while in drydock, making bolt holes in concrete and a variety of similar classes of work. Power is supplied by a 1/5 horsepower electric motor which is connected to the centrifugal hammer by spur gears. There is a spur gear on the armature spindle and



Coates electrically driven Centrifugal Chipping Hammer

a spur gear on the spindle of the centrifugal hammer, these gears being connected by an intermediate gear. The "ducking" or centrifugal hammer consists of a disk which has the hammers pivoted at its periphery. The disk rotates at high speed, and centrifugal force causes the hammers to fly out and strike the end of the chipping tool, after which they "duck" back to permit the disk to continue its rotation. The hammer delivers two thousand blows per minute on the chipping tool.

STANDARD ROLL GRINDING MACHINE

The Standard Engineering Co., Ellwood City, Pa., is now building a roll grinding machine equipped with two heads, both of which are located on the same side of the roll and arranged for grinding both the necks and bodies. The whole machine is of very massive construction so that a large amount of work can be produced without sacrificing quality. The roll is carried on dead centers and driven by a 10 horsepower variable speed motor mounted on the headstock. The motion is transmitted to the roll by two sets of worm gears entirely enclosed in an oil-tight case, and provided with ball thrust bearings. The headstock is fixed at one end of the machine while the tailstock is movable longitudinally by means of a rack and pinion. In addition to the longitudinal movement, the tailstock has also a transverse adjustment for lining up and grinding tapers. Each of the grinding heads is provided with a 26-inch wheel driven by a 15 horsepower motor mounted on the grinding wheel carriage. This motor is of the variable speed type in order that the peripheral speed of the wheel may be kept uniform as the diameter is reduced through wear. Each wheel is protected by a heavy steel guard, that can be easily removed when changing wheels.

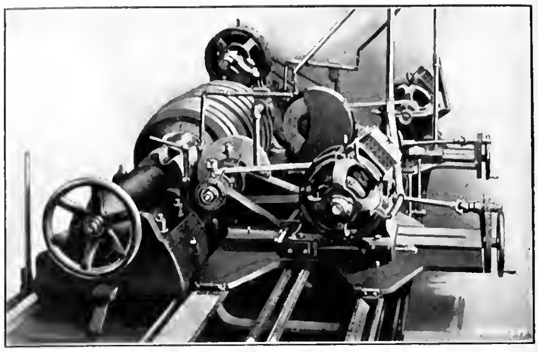


Fig. 2. Partial Plan View of Standard Roll Grinder

The longitudinal travel of each head is obtained by a screw driven by gearing and a belt from the headstock motor. This gearing has clutches for controlling the motion of the grinding head, operated by a handle which may be set at any convenient position on the front of the bed. In addition to the handle, the clutches may be operated by a stop on the carriage so as to obtain a continuous motion in both directions. This motion of the carriage may also be obtained by means of a handwheel which revolves the screw when the clutches are disconnected. The transverse travel of each grinding head is accomplished by means of a screw having a handwheel mounted on its end. In addition, another handwheel is provided which is geared to the screw for the adjustments. This last handwheel and the one for operating the carriage longitudinally are placed in positions which are convenient for the operator while watching his work. The machine is provided with devices for truing the grinding wheels, so arranged that the wheels may have their edges rounded to suit fillets in the roll necks. In addition to carrying the roll on centers, the machine is provided with housings for carrying the roll by its necks in case this method is desired when grinding bodies. These housings are adjustable so that rolls may be "crossed" or various kinds of tapered work accomplished. The machine swings 50 inches and when provided with a bed 30 feet in length, which is the size required to accommodate rolls having a length of 21 feet, it has a weight of about 80,000 pounds.

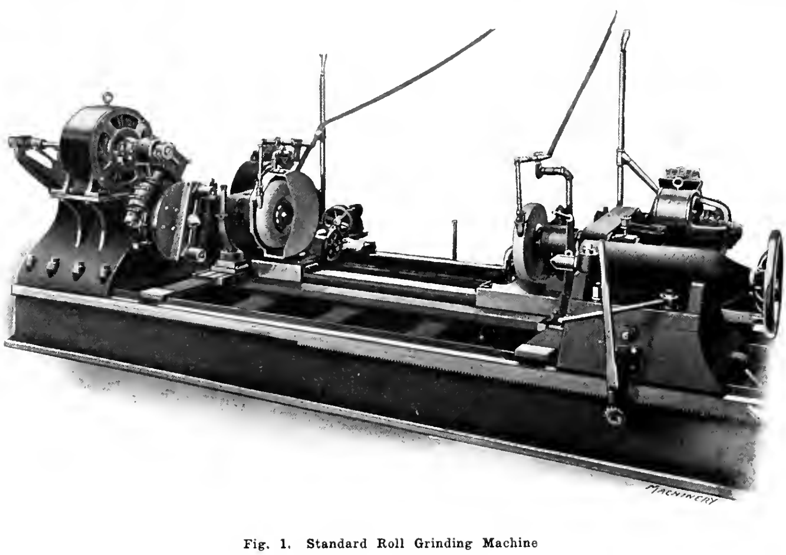


Fig. 1. Standard Roll Grinding Machine

MONARCH GEARED HEAD LATHES

To meet the demand for a lathe equipped with individual motor drive or single pulley drive, the Monarch Machine Co., Sidney, Ohio, has added to its line the 16-inch by 6-foot and the 14-inch by 6-foot machines which are illustrated in Figs. 1 and 2. Fig. 1 shows the application of motor drive, and Fig. 2 shows a machine equipped with the single pulley for taking power direct from the line-shaft. It must be understood, however, that either machine may be provided with single pulley drive or motor drive according to the requirements of the shop in which it is to be installed. The geared headstock provides eight mechanical changes of spindle speed, any of which may be instantly obtained by operating two levers at the front of the headstock. With the driving shaft running at 300 revolutions per minute, spindle speeds of 25, 40, 58, 83, 116, 182, 262 and 375 revolutions per minute are obtainable. This is a wide enough range for most classes of work, but for exceptional cases a two-speed countershaft or a variable-speed motor may be employed to extend the range.

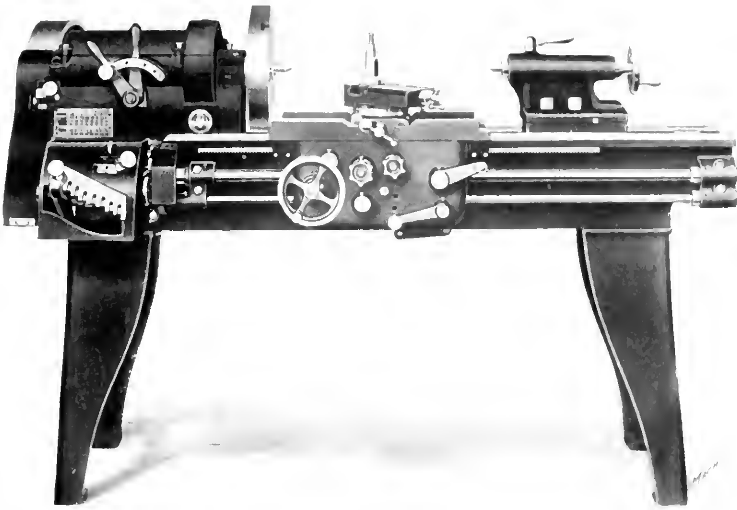


Fig. 2. Monarch 14-inch Lathe equipped with Single Pulley Drive

The geared headstock applied on these lathes is the automobile sliding gear type of transmission with positive clutches. There are twelve gears, eight of which are constantly in mesh. All of the gears have cut teeth; they are 8 pitch and $1\frac{1}{4}$ or $1\frac{1}{2}$ inch face width. All bearings are bushed with phosphor-bronze and the changes are obtained by two levers operating over segments on the front of the headstock. The gears run in oil and the bearings are thoroughly lubricated by the splash system. The headstock is oil-tight and a drain is provided so that the oil may be run out for cleaning. Provision is made for instantly stopping

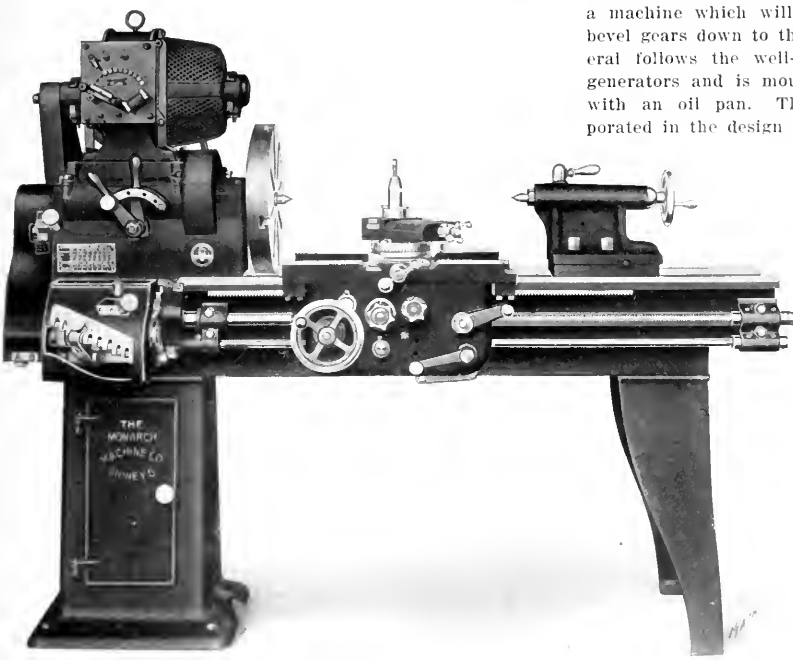


Fig. 1. Monarch 16-inch Lathe equipped with Electric Motor Drive

the spindle and then starting it again at the same speed. This is a particularly useful feature when it is required to stop the work for measuring.

For machines equipped with single pulley drive, the pulley is provided with a friction clutch which is operated by a shipper rod at the back of the lathe. Where individual motor drive is employed, a $1\frac{1}{2}$ or 2 horsepower motor is used. The motor should run at from 1000 to 1100 revolutions per minute. Where the motor is mounted on the headstock, the drive is through a silent chain, which is completely enclosed to provide for the safety of the operator. An ordinary starter such as a manufacturer would recommend for use with a constant-speed motor can be used. This starter is usually mounted as shown in Fig. 1.

GLEASON THREE-INCH BEVEL GEAR GENERATOR

The accompanying illustrations, Figs. 1 and 2, show a small size, generating bevel gear planer developed by the Gleason Works, Rochester, New York, to meet the demand for a machine which will accurately and rapidly handle small bevel gears down to the finest pitches. The machine in general follows the well-known lines of the Gleason two-tool generators and is mounted on a pedestal which is integral with an oil pan. There are several new features incorporated in the design which facilitate rapid changing of the work. Shifting the head is accomplished by means of a rack and pinion operated by a lever, and a micrometer stop is supplied for readily setting the head to any desired distance from the cone center of the machine. The distance from the apex of a gear to the back of the hub being known, to set the head in position all that is necessary is to set the micrometer stop to this distance and then bring the head up to the stop. The locking of the head is effected by means of a single locking lever.

The use of the tool gages is also simplified by supplying a limit gage 0.0005 inch over and under for length, with a separate gage for the pressure angle. The machine can be arranged for either belt or individual motor drive, and Fig. 2 shows the method of attaching the motor. This generator will handle any bevel gear not over $2\frac{1}{8}$ inches cone distance and $\frac{3}{4}$ inch face. The largest pitch recommended is 8 diametral pitch and the smallest pitch for which tools are made as standard is 32 diametral pitch. Smaller pitches can be cut, but this is limited by the tool, which must be of sufficient thickness at the point to stand up to the cut.

Fig. 1. The New Gleason 3-inch Bevel Gear Generator

The machine will generate a tooth in four seconds as the fastest, and forty seconds as the slowest speed. The extremes of tool speed are 400 strokes per minute and 120 per minute, and a slip gear arrangement is provided for throwing the tools out of gear while making changes. The indexing mechanism is positive and runs in an oil bath; and the feed mechanism is similarly provided for. All the wearing surfaces on the machine are square gibbed and the shaft bearings are bronze lined. All gears are pack-hardened, and an oil pump is part of the regular equipment. The machine weighs 1250 pounds and takes 44 by 32 inches floor space.

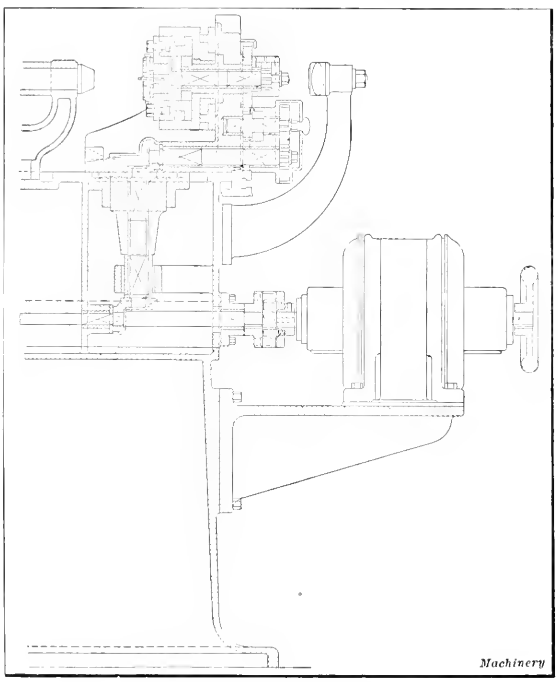
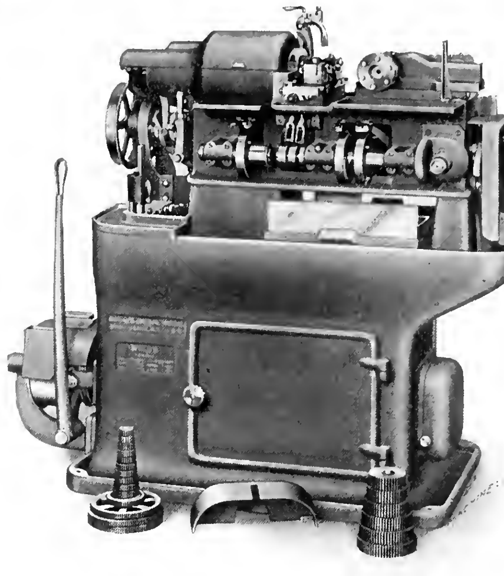


Fig. 2. Partial Cross-sectional View showing Application of Electric Motor Drive

BROWN & SHARPE NO. OG AUTOMATIC SCREW MACHINE

A recent addition to the line of automatic screw machines manufactured by the Brown & Sharpe Mfg. Co., Providence, R. I., is shown in the accompanying illustration. A notable feature of this machine is the method of driving it, only one belt being used. The main driving pulley runs in one direction at a constant speed and is equipped with a friction clutch for starting and stopping, allowing the machine to be belted directly to the lineshaft, with all overhead works eliminated. Not only does this permit the belt-driven machines to be placed to much better advantage on the shop floor, but it makes the arrangement for individual motor drive comparatively simple. A constant-speed motor is employed, it being attached to the rear of the cabinet base. The main driving shaft runs through the base of the machine. Power is transmitted from this shaft to the spindle by a pair of belts, one for driving forward and one backward, an automatically operated friction clutch controlling the change.



Brown & Sharpe No. 0G Automatic Screw Machine

Speed changes are made by means of a pair of change gears located outside of the base at the right-hand end, under the hinged cover. An automatic speed change is incorporated in the driving mechanism and operated by the machine feed shaft. This serves to slow down the spindle in the ratio of 1 to 2¼ for threading and similar operations. This machine handles bar stock up to ½ inch in diameter and turns work to 1¾ inch in length. It is known as the No. OG automatic screw machine. The details of construction and operation of the driving mechanism on this machine are similar in general to those on the No. OOG automatic screw machine, which was fully illustrated and described in the April, 1913, number of MACHINERY.

"CAPITAL" GRINDER

A small rapid production internal grinder has recently been placed on the market by the Lansing Stamping & Tool Co., Lansing, Mich. This machine is rigidly built and is an accurate and economical producer. The grinding spindle is rigidly mounted and driven by two belts, which overcomes vibration or any tendency for the spindle to run out of truth. The machine is designed to finish holes from ⅝ inch to 2 inches in diameter and up to 2 inches in length. Power feed for the table is not provided, because it has been found that for a short hole more satisfactory results are obtained by using hand feed. The feed is accomplished by means of a handwheel which operates a rack and pinion. The table is of heavy construction and the ways are automatically oiled

with rolls set in the bed; this gives a particularly smooth action and makes it possible to produce work with a very high finish. Chatter marks are also entirely eliminated by this construction.

One of the principal features of this machine is the means provided for stopping the work chuck in order to gage the hole. This is accomplished by the mechanism shown in Fig. 2 which consists of a roll carried by a bracket at the back of the table which, through a tripping device, operates a clutch on the countershaft when the table is moved to the extreme of its travel. This clutch is of the conical type and furnished with cork inserts. A spring on the countershaft throws the clutch back into engagement when it is desired to start the machine. The clutch is operated by a fork at the end of a bellcrank lever which receives its motion from a tie-rod operated by a tripping dog. This dog is engaged by the roll carried on a bracket fastened to the table of the machine. As the table is thrown back out of the operating position, this roll comes into contact with the tripping dog, throws the clutch out of engagement and operates the brake, thus stopping the rotation of the work instantly. The clutch can also be thrown out by a foot lever shown in Fig. 2. The provision of this means for stopping work is of such importance that one automobile manufacturer who is using these machines for certain grinding operations has found it possible to increase his rate of production 50 per cent. Also, many parts which were formerly finished by lapping are now ground on this machine.

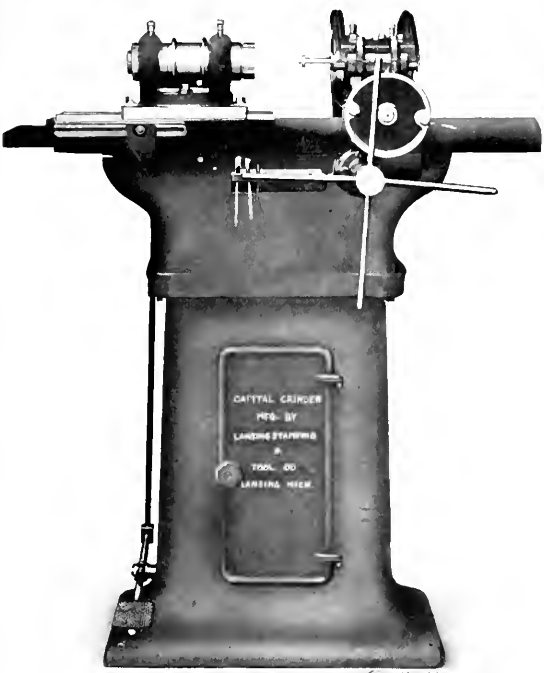


Fig. 1. "Capital" Internal Grinder

Fig. 3 shows a cross-sectional view of the headstock which is very rigid in design and provided with phosphor-bronze tapered bearings that enable adjustment to be made to compensate for wear. The spindle is fitted for carrying spring chucks but jaw chucks can also be used. The spindle is made from 50 point carbon crucible steel; it has a $1\frac{1}{4}$-inch hole through its center to provide for handling collet work and is large enough to accommodate a dust collecting pipe used in connection with the machine when dry grinding operations are being performed. The table upon which the headstock is mounted is made of cast iron; it is 36 inches long with wide V and flat ways and has oiling rollers set in the bed.

The internal grinding spindle is made of hardened and ground tool steel and runs in Hess-Bright ball bearings

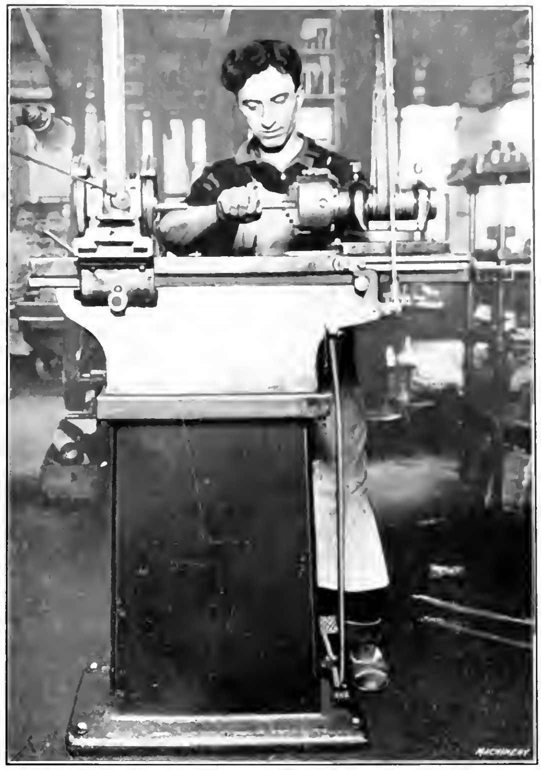


Fig. 2. Rear View of "Capital" Internal Grinder, showing how the Work Chuck is stopped automatically

which have a four-point bearing at the front and a three-point bearing at the rear. This spindle is provided with felt washers to prevent dust getting into the bearings and is capable of running at a speed of 22,000 revolutions per minute. It is driven by two belts which not only afford a steady drive but also eliminate any binding of the spindle in its bearing. This tends to equalize the belt pull and insures a true running spindle. The grinding head is set by a handwheel and dial which has two hundred graduations and can be set to 0.001 inch.

The following will give an idea of the productive capacity of this machine. On cams for automobile cam-shafts the holes in which are $\frac{7}{8}$ inch in diameter by $\frac{7}{8}$ inch long, and from which 0.008 inch has to be removed from the inside diameter, a production of 60 cams per hour is secured. The cams are heat-treated steel. Another job handled on this machine consists of grinding a hole $\frac{3}{4}$ inch in diameter by $1\frac{3}{4}$ inch long in spindle bushings, and this work is produced at the rate of sixty pieces per hour, the same amount of metal being removed from this hole as in the preceding case.

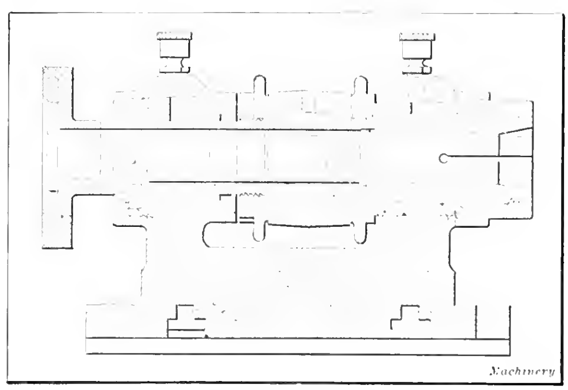


Fig. 3. Cross-sectional View of Headstock of "Capital" Internal Grinder

Bushings for roller bearings which are 1¼ inch in diameter by 2 inches long, and which are required to have an extremely high finish and to be perfectly accurate as regards the concentricity of the bore from end to end, are finished on this machine in a very satisfactory way.

As previously mentioned, the feature of this machine which makes possible such high rates of production is the fact that the work chuck can be instantly stopped for gaging the work. The machine has only one belt shifter which is operated by moving the table back. The workman can caliper the work very rapidly, and in addition to allowing him to turn out work more quickly, the machine is also capable of the highest possible accuracy. The following gives the principal dimensions of these grinders: traverse of table, 10 inches; greatest distance from wheel spindle to work spindle,

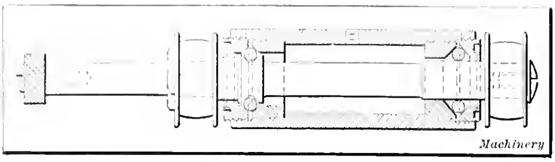


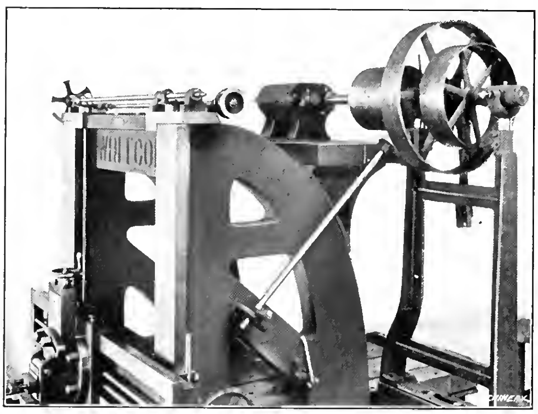
Fig. 4. Special Head for Use in grinding Valve Seats

12 inches; swing of work-head over table, 8 inches; swivel of work-head, 60 degrees; size of nose on work spindle, 2 inches in diameter with eight left-hand threads per inch; and length of cross-slide, 15 inches.

WHITCOMB-BLAISDELL PLANER WITH GEARED SPEED BOX

The accompanying illustration shows a planer recently built by the Whitcomb-Blaisdell Machine Tool Co., 134 Gold St., Worcester, Mass., which is equipped with a geared speed-box. This is nothing more than the sliding gear automobile transmission applied to a planer.

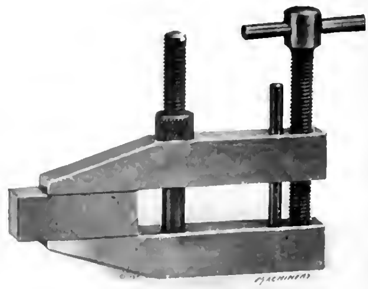
It will be seen from the illustration that the gear-box is mounted on a bracket secured to the housings of the planer. At the side of the machine there is a dial with four stations in which a spring plunger can be entered by operating a suitable hand lever. By locating the plunger in any of these holes, the corresponding pair of gears in the change gear box are engaged to give the required forward speed. The forward speed shaft telescopes inside the return speed shaft. Four cutting speeds of 25, 35, 45 and 60 feet per minute are available, and the return speed is constant at 100 feet. The illustration shows the machine equipped for belt drive, but it is a very easy matter to mount a motor on the bracket and provide the necessary gearing for individual motor drive.



Sliding Gear Speed Box for Whitcomb-Blaisdell Planer

M. B. HILL CLAMP

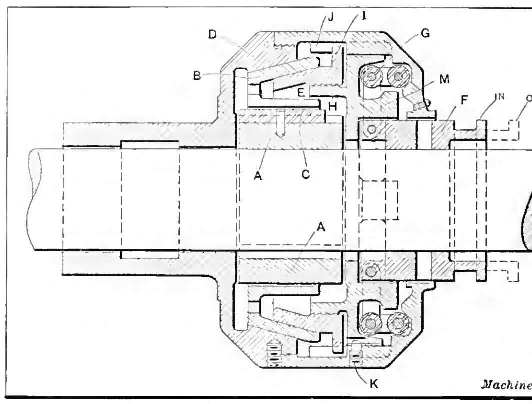
The accompanying illustration shows a clamp made by the M. B. Hill Mfg. Co., Worcester, Mass., which is so designed that one side is prevented from dropping down by means of a pin placed in front of the rear screw. This clamp can be operated with one hand, leaving the other hand free to handle the work. It is claimed that the work can be held more securely and with less strain on the screws than is possible with the old style of clamp, as the pin causes the jaws to have a more even contact on the work. These clamps are made in three sizes to meet the requirements of different classes of work.



M. B. Hill Clamp

AKRON MULTI-CONE CLUTCH

The accompanying illustration shows a cross-sectional view of the "Ideal" multi-cone clutch which is a recent product of the Akron Gear & Engineering Co., Akron, Ohio. This is what might be called a multiple-disk cone clutch and its design represents a departure from the usual types of friction clutches. In order to avoid too sudden engagement of the cones, the face angles are greater than those of the ordinary two-cone clutch, and the clutching force and pulling power lost in this way is compensated for by the addition of a third cone which practically doubles the pulling power. The cones run in oil and have oil films between them which permit the clutch to slip before the films are broken down by the contact pressure. In this way the too sudden engagement of the clutch is avoided.



Cross-sectional View of Akron Multi-cone Clutch

The design of the cones, together with the application of the oil bath, permits immediate disengagement of the clutch when it is thrown out. Very little force is required to throw in the clutch and the movement of the shifter is relatively small so that the clutch is suitable for foot control or for use in places where long levers cannot be employed. The horizontal pressure exerted by the throw-in mechanism is equally distributed over the complete surface so that there is no tendency to distort the cones. When the clutch is thrown out of engagement, the throw-in mechanism is at rest and there is no danger of centrifugal force engaging the clutch.

Referring to the illustration, the driving ring *A* is keyed to the shaft and the middle or driving cone *B* is driven from the ring *A* by means of two feather keys. Both friction surfaces of the cone *B* are provided with oil grooves. The driven cones *D* and *E* are brought into contact with the middle cone *B* when the shifter sleeve *F* is pushed in. When this lever is pushed in the rollers *G* are thrown outward and

forward against the ring *H*, carrying the cone *E* forward into contact with the middle cone *B*, and then carrying the middle cone into contact with the outer cone *D*. Having these cones come into contact singly prevents the clutch from engaging too suddenly. The inner cone *E* is made to revolve with the outer cone *D* by means of lugs *I* which project outward from the ends of the cone *E* and ride between lugs *J* located on the inside of the casing. The faces of these lugs *J* are turned true and serve to hold the ring *H* centrally. The casing screws onto the outer cone *D* and is locked in place by set-screws.

The inner end of the locking screw *K* enters one of the slots in the outside of the ring *H*, causing this ring to revolve with the casing. The adjustment of the clutch is made by inserting this screw into one of the slots. The rollers *G* and the pivots on which they are supported are of large diameter and bearing area to afford long life and easy operation. In throwing the clutch out the rollers *G* strike the lugs *M* and pull the cone *E* forward to give the required clearance for the oil films between the surfaces of the cones. The face angle of the cones is large enough to enable them to disengage instantly. The throw-in mechanism is very powerful, the multiplication between the horizontal force on the shifter sleeve *F* and the pressure on the cone faces being approximately 100 to 1 for all sizes of clutches.

"NATCO" HIGH-SPEED MULTIPLE DRILLS

The National Automatic Tool Co., Richmond, Ind., has recently added to its line two high-speed multiple drills which embody many features of high productive value. These meet the demand for powerful machines capable of drilling up to 7/8-inch holes in cast iron at heavy feeds. The "Natco" No. 18 drill shown in Fig. 1 is of the table feeding type, the head being tongue grooved and bolted solidly to the column. It is designed to drive eight 1/2-, twelve 3/8- or twelve 5/16-inch drills in cast iron at a feed of 5 inches per minute with the drills running at a peripheral velocity of 75 feet per minute. Under a test it carried a much heavier complement of drills than the above with ease under the heaviest feeds. The "Natco" multiple drill embodies weight, proper distribution of metal to insure maximum rigidity, proper speeds and feeds for high-speed drills and, above all, a machine with all its parts designed to deliver the power necessary to obtain the above results.

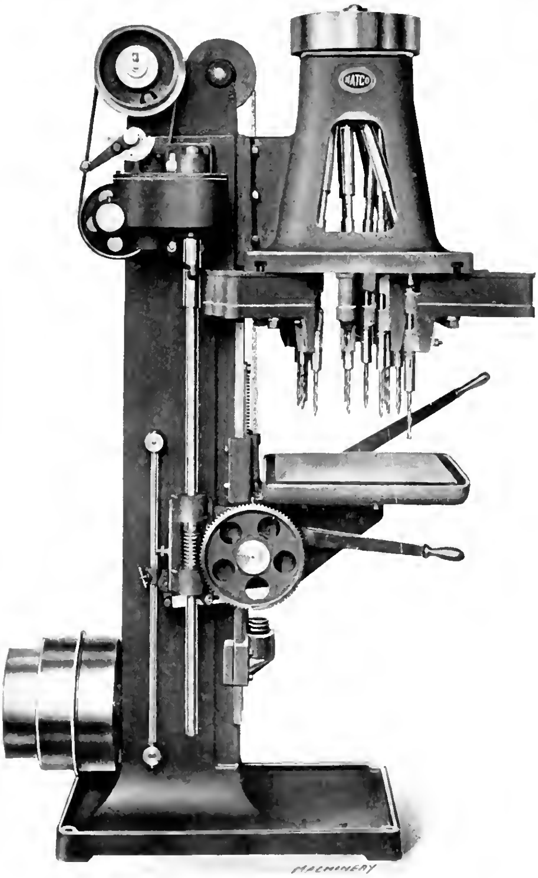


Fig. 1. No. 18 "Natco" High-speed Multiple Drill

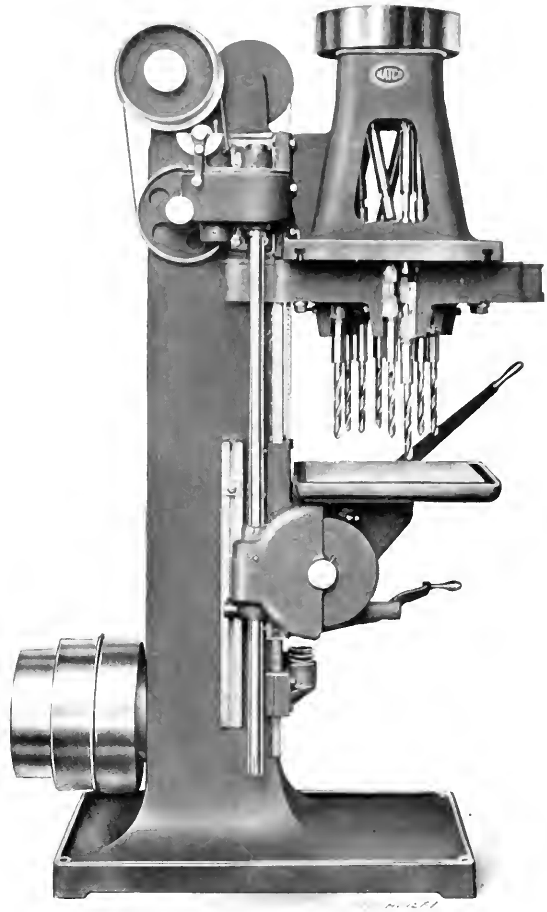


Fig. 2. No. 20 "Natco" High-speed Multiple Drill

The column is of heavy box section, the metal being so distributed as to insure a maximum of strength and rigidity. It has a wide face to which a steel rack is securely fastened. The drive is by means of a two-step cone and continuous belt. The idler pulleys are of large diameter and are mounted on Hyatt high-duty roller bearings. The cone pulley on the base is also mounted on Hyatt high-duty roller bearings. This insures a high transmission efficiency. The knee has an extended top providing a support where it is needed most and the main part is of box section which insures a very stiff support for the work to be drilled. It is counterbalanced with sectional weights which may be added to or removed to suit the work being drilled. The table is made with a large oil channel around the outer edge to catch the overflow of lubricant, and a screen oil pocket in this channel prevents chips from choking up the pipe. The feed box is located near the top of the column on the side, which provides three changes of feed that may be made while the machine is running. The feed gears are hardened and run at moderate speeds in a bath of oil. All the bearings are bronze bushed. The feed worm-gear is made of bronze, the worm being provided with an extra heavy ball thrust, and the bearings at this point are bronze bushed. A guard is provided which completely covers these parts.

The rack pinion shaft is made of crucible steel and the pinion is cut from the solid. This construction insures great strength. The right-hand end of this shaft is provided with an adjustable hand lever or a four-arm pilot for rapid, easy advance and return of the table. The power feed which is of the worm knockout construction may be tripped by hand or automatically at any point. The table returns automatically to its "home" position after being tripped. Pressing down on the feed lever releases, and pulling up engages the feed. This machine is provided with a 9 by 15-inch rectangular head which can be equipped with from two to sixteen adjustable spindles. All gears in the head are hardened and ground and run in oil. All bearings are bronze bushed. The head may be equipped with various combinations of arms or cluster boxes. The drill spindles are made of special steel hardened and ground and provided with ball thrust bearings at the lower end and lock-nuts at the upper end to take up any end wear that may develop. The spindles are made to carry either straight shank or Morse taper shank drills, as required, and the machine may be provided with a reservoir to carry lubricant to the point of the drills.

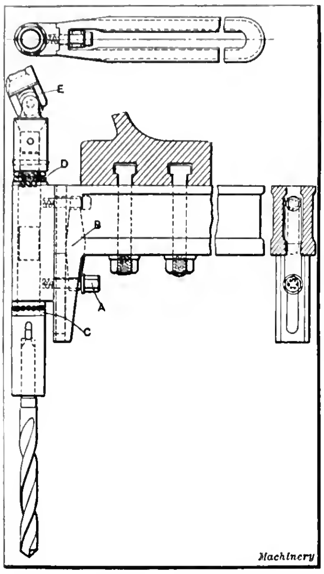


Fig. 3. "Natco" Spindle Adjustment

The bronze bearings which carry the drill spindles are provided with vertical adjustment to compensate for variation in the drill collets. This adjustment is quickly and easily secured by simply loosening one nut which is always accessible, regardless of how close the spindles may be clustered together. This spindle adjustment—which is a patented construction—holds the bearing rigidly to the end of the arm, and the arm may be moved to cover any layout within the range of the head. The construction is illustrated in Fig. 3. In making the adjustment, it is only necessary to loosen the nut *A*, as mentioned. This allows the steel beam *B* to rock on its fulcrum and loosen the bearing to provide for making the adjustment. The ball thrust bearing on this spindle is shown at *C* and the lock-nuts and washer for taking up end wear are illustrated at *D*. It will be seen that an oil chamber is provided in the bronze bearings in order to insure adequate lubrication of the spindles. The universal joints used on the "Natco" multiple spindle drills are milled from the solid and carefully hardened. One of these joints is shown at *E* in Fig. 3. This is composed of only five pieces and does not depend upon a cross-pin that may be broken, or upon screws that may work loose. The weight of this No. 18 drill is 1400 pounds without the adjustable arms.

The "Natco" No. 20 drill shown in Fig. 2 is a heavier machine equipped with larger sizes of heads and a greater number of spindles. It is an extremely powerful machine capable of driving up to 7/8 inch high-speed drills in cast iron. The table feeds the work up to the drills, the head being tongue grooved and bolted securely to the column. It was designed to drive from six to eight 3/4-inch drills or their equivalent in cast iron, at a feed of 5 inches per minute with the drills running at a peripheral velocity of 75 feet per minute. The No. 20 drill embodies all the essentials for high-speed drilling results, namely, weight, proper distribution of metal to insure rigidity, proper speeds and feeds for high-speed drills.

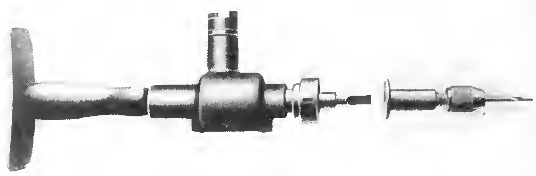
The column is of heavy box section, and has a wide face to which the steel rack is securely fastened. The drive is by means of a two-step cone and continuous belt, the two-step cone being mounted on Hyatt roller bearings. The idler pulleys are of large diameter and also mounted on Hyatt roller bearings. The knee has an extended top, providing a support where it is most needed, and the main part is of box section. It is counterbalanced and is provided with a new friction power feed which is an entirely new principle applied to multiple spindle drills. The advantage of the friction power feed is that the drills can be brought up against the work before throwing in the feed, thereby saving time in bringing the work to the point of the drills. It also eliminates any danger of breakage to the power feed mechanism, because should anything become caught, the friction would slip when the pressure reaches a certain point. The friction is adjustable to compensate for the different loads that are being drilled. The rack pinion shaft is made of crucible steel and the pinion is cut from the solid, insuring great strength. The right-hand end of this shaft is provided with either an adjustable lever or four-arm pilot for rapid, easy advance or return of table. The power feed may be tripped by hand or automatically at any point, the table returning automatically to its "home" position. The table is made with a large oil channel to catch the overflow of cutting lubricant and a screen pocket prevents chips from choking up the oil pipe.

The feed box is located on the side of the column near the top. It provides three changes of feeds. The feed gears are hardened and run at moderate speeds in a bath of oil. All the bearings are bronze bushed. Several sizes of heads are provided, all of which may be equipped with various combinations of adjustable arms or cluster boxes. Some of the heads are equipped with the "Natco" independent drill speed feature which gives two independent changes of speed in the head for each step on the cone, thereby making possible the drilling of large and small holes in the same operation at correct cutting speeds. All gears in the head are hardened and ground and run in oil. All bearings are phosphor-bronze bushed. The smaller sized heads are arranged with from two to sixteen adjustable spindles and the larger sizes have from two to twenty-four adjustable spindles. The adjustable arm, drill spindles and universal joints are of the same construction as illustrated in Fig. 3 for the description of the No. 18 drill. The main points of advantage of the No. 20 drill over the No. 18 is greater capacity, the independent drill speed feature, larger sizes of heads, greater number of spindles and the new friction power feed. The weight of the No. 20 drill is 2300 pounds without the adjustable arms.

COATES FLEXI-SHAFT SCREW-DRIVER

The power-driven screw-driver which forms the subject of this article is a recent product of the Coates Clipper Mfg. Co., Worcester, Mass. This tool is driven by one of the flexible shafts manufactured by this company, which transmits power to the screw-driver through a worm and worm-wheel. The thrust of the worm is taken by a ball bearing so that the tool runs very smoothly at all times.

The blade of the screw-driver remains stationary until


Coates Flexi-shaft Screw-driver

pressure is applied to the breast-plate. This pressure engages a friction clutch and starts the tool operating. The clutch may be adjusted so that it will release at different pressures according to the work which is being handled. This feature prevents marring the slots in the heads of the screws when they have been driven home. When the pressure on the breast-plate is released, the clutch is disengaged.

Different sizes of screw-driver blades may be mounted in the tool to adapt it for different classes of work. The tool may also be used for drilling operations. For this purpose, a drilling attachment is provided which has a slot at its

upper end into which the blade of the screw-driver fits. The arrangement will be readily understood from the illustration without requiring further description.

GREENFIELD NO. 1 PLAIN GRINDER WITH HYDRAULIC TABLE FEED

The Greenfield Machine Co., Greenfield, Mass., is now building a plain grinding machine for handling cylindrical work up to 12 inches in length and up to 4 inches in diameter. For those plants manufacturing small parts which can be finished by grinding, this machine has several features that commend it. The most noteworthy point in the design is the application of a hydraulically operated table. This method of driving does away with all gears, clutches, etc., usually employed for this purpose and it is claimed by the manufacturers that it is far superior in smoothness and evenness of operation. The machine is adapted for either straight or taper grinding and is essentially a manufacturing machine. Front, rear and plan views are shown in Figs. 1, 2 and 3; and Fig. 4 shows the way in which the hydraulic table mechanism operates.

The method by which the table operates is clearly shown

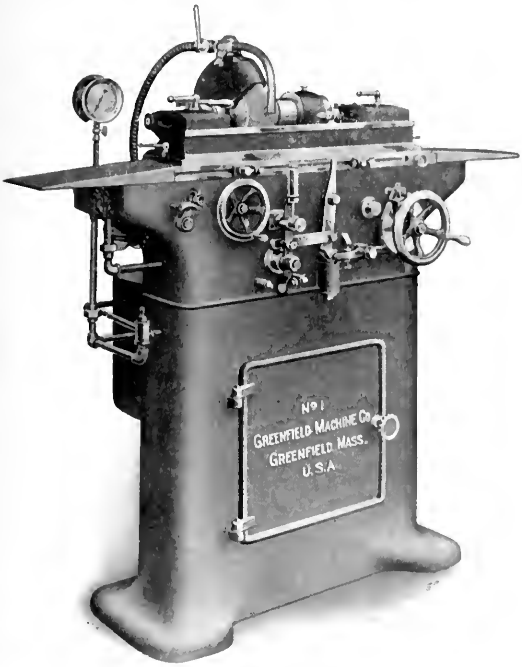


Fig. 1. Front View of Greenfield Grinder

in Fig. 4. In the base of the machine there is an oil supply tank, which supplies oil to the hydraulic cylinder. This oil is pumped by means of a rotary pump which will be seen at the rear of the machine in Fig. 2. Referring to this illustration it will be seen that the oil piping extends around the left-hand end of the machine to the relief valve. This valve is usually set to give about 75 pounds pressure which is indicated on the gage directly above. The oil held back under pressure by the relief valve goes to the operating valve, which is illustrated in Fig. 4. In one position the oil passes to the left of the piston within the cylinder, which is shown in Fig. 3, forcing the piston toward the right until the operating valve is shifted—either by hand or automatically—when it reverses by causing the oil to flow into the cylinder from the opposite end and thus moves the piston and table, to which it is attached, in the other direction. The speed with which the table is traversed is governed by a supply valve which controls the amount of oil passing to the cylinder, and any desired speed between 0 and 254 feet per minute may be obtained with a pressure of 75 pounds. It will be noted that all working parts of this mechanism are lubricated by a continuous bath of oil.

The mechanism for operating the automatic cross feed will be seen at the extreme right of the machine in Fig. 1. The pawl which operates the feed is moved by the horizontal lever, which, in turn, is actuated by the V bottom of the vertical shifting lever. Just beneath the horizontal lever there is an adjusting screw which governs the amount of motion of this lever. By turning this screw the action of

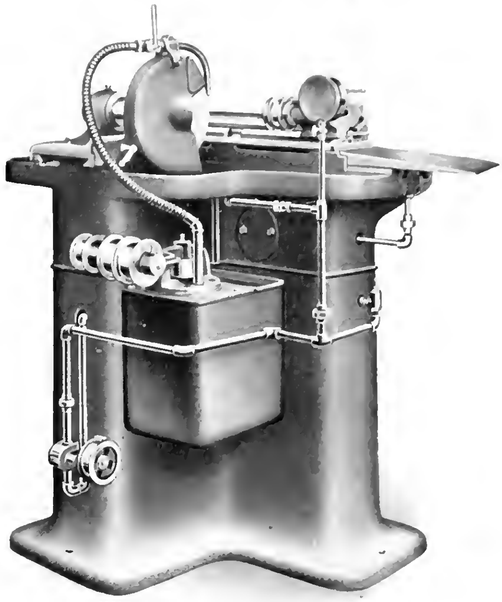


Fig. 2. Opposite Side of Machine shown in Fig. 1

the pawl may be regulated to enable it to pick up the required number of teeth on the ratchet wheel, each notch on which represents a movement of the head of 0.00025 inch. Revolving with the ratchet wheel there is a mechanism which is provided for the purpose of throwing out the pawl, thereby stopping the cross-feed when the work has been ground to the desired size. On the front of this mechanism there is a casehardened knob with a knurled edge, upon the face of which the figures "1" and "1/4" are stamped. A little lever or key projects from this mechanism, and when the figure "1" is turned so that it is in line with the key, the depression of the key moves the mechanism 0.001 inch or four notches

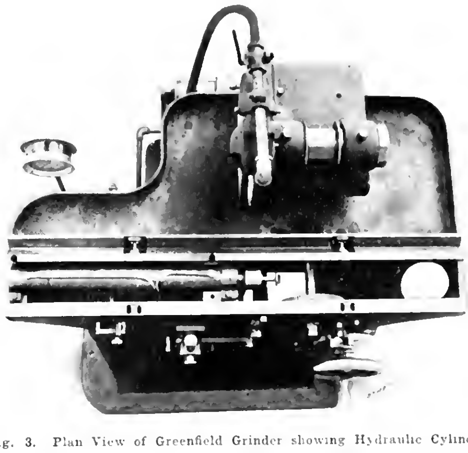


Fig. 3. Plan View of Greenfield Grinder showing Hydraulic Cylinder

of the ratchet wheel. When the knob is turned so that the figure "1/4" is in line with the key, the depression of the key moves the mechanism 0.00025 inch or one notch of the ratchet wheel.

In practice, this would be used as follows: after one or two cuts have been made across the work, it is calipered and the

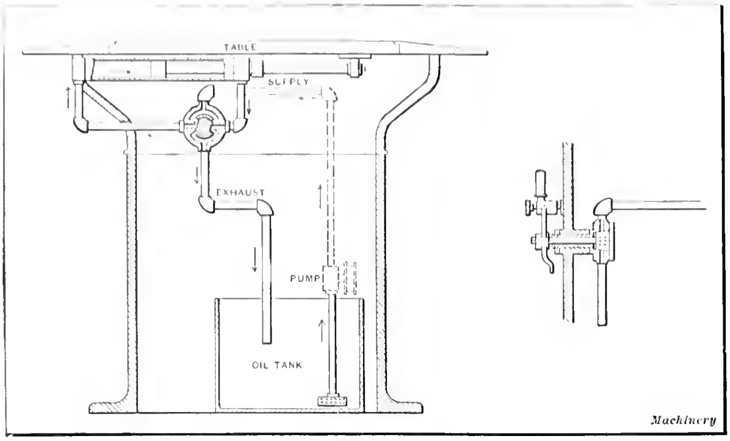


Fig. 4. Diagram showing how Oil circulates to operate the Table Traverse

amount of stock still to be removed to bring it to the desired size is determined. The mechanism is then brought around until the shield on the ratchet wheel touches the pawl; this shield is then set back the proper amount by depressing the key. For instance, suppose it is found that 0.0025 inch is still to be removed from the work. The shield mechanism is brought forward so that the shield just touches the pawl, after which the knurled knob is turned until the figure "1" is brought in line with the key. The key is then depressed twice, which will move the mechanism back 0.002 inch. The knurled knob is then turned until the figure "¼" is in line with the key and depressed twice more which will move the shield back 0.0005 inch. When this has been done the machine is again started and when the necessary 0.0025 inch has been removed from the work, the cross-feed will be automatically disengaged. In producing duplicate work, this device will have to be set only once and will then throw out on each piece at the same point so the required dimension is obtained. An occasional depression of the key in the "¼" position will take care of the wear on the wheel. A feature of this grinder is that all handles and levers for controlling the mechanism are within easy reach of the operator. Provision is made for delivering an ample supply of water for cooling the work, and the design has been worked out in such a way that the tendency of the water to be fanned away from the wheel is overcome. The principal dimensions of the machine are as follows: Extreme distance between centers, 12 inches; swing, 4 inches; maximum travel of table, 14 inches; diameter of grinding wheel, 10 inches; face of grinding wheel, ¾ inch; speed of wheel, 2100 revolutions per minute; number of work speeds, 3; floor space occupied, 70 by 29 inches; net weight of machine, 1335 pounds.

WARNER & SWASEY NO. 4 TURRET SCREW MACHINE

The Warner & Swasey Co., Cleveland, Ohio, has recently added to its line a No. 4 universal turret screw machine. The improvements incorporated are: the power longitudinal feed for the carriage, the arrangement on the carriage for chasing threads, and the fact that the carriage and turret are

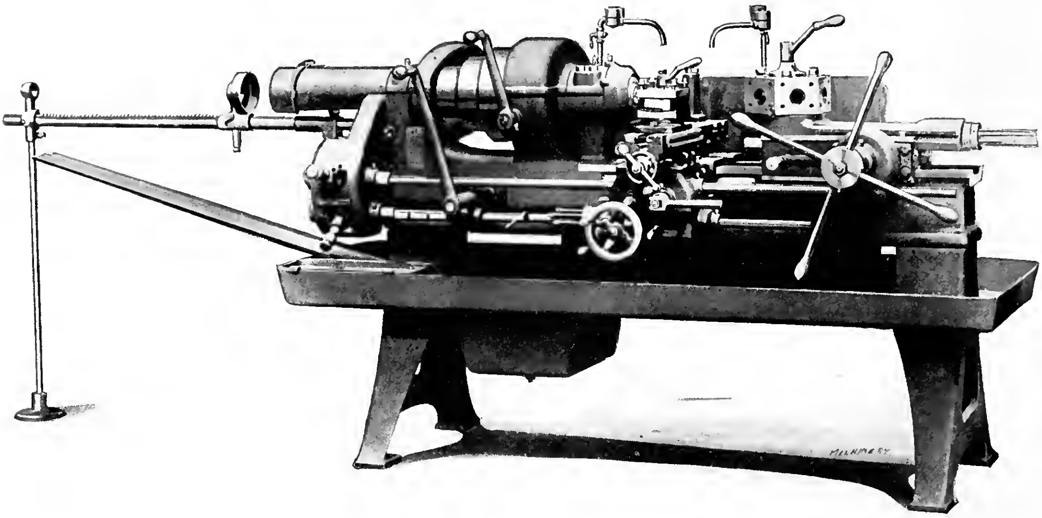


Fig. 1. Warner & Swasey No. 4 Universal Turret Screw Machine with Bar Equipment and Cone Pulley Drive

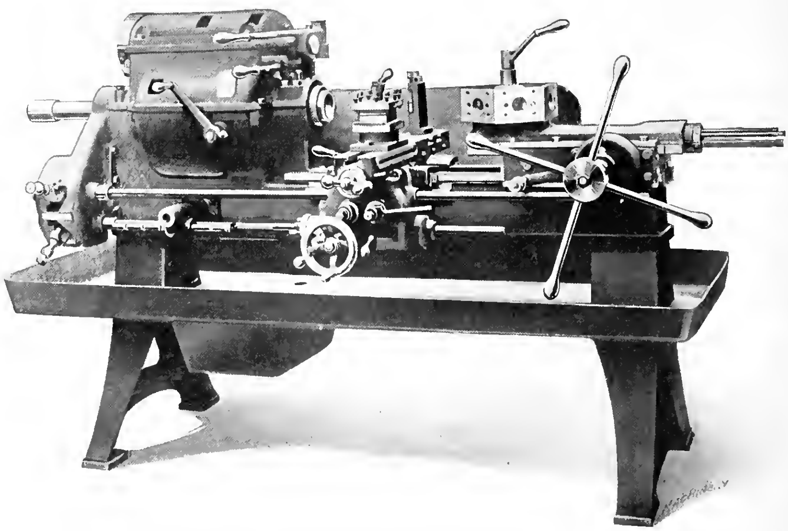


Fig. 2. Warner & Swasey No. 4 Universal Turret Screw Machine with Single Pulley and Geared Head

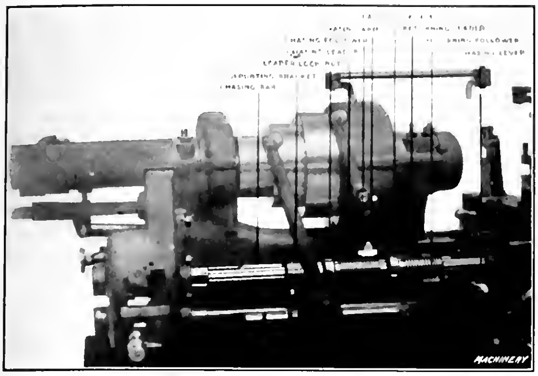


Fig. 3. Chasing Attachment

driven by separate shafts. These features add greatly to the efficiency of the machine and have been developed as the result of this company's wide experience in building turret screw machines.

For a long time screw machines have been built with power cross feed on the carriage, but this is the first machine to be fitted with power longitudinal feed. In order to add greatly to the possibility of working with the carriage, it is driven by a separate feed shaft. Another important feature is the fact that the feeds of this carriage can be reversed entirely independently of the feeds of the turret; thus, the turret can be fed toward the chuck while the carriage feeds away from the chuck if necessary. In this way, two diameters can be turned at once, or the outside of a piece may be turned with the carriage while the hole is being bored from the turret. The longitudinal feed to the carriage has six independent adjustable stops for gaging the length turned. These stops trip the power feed and act also as dead stops.

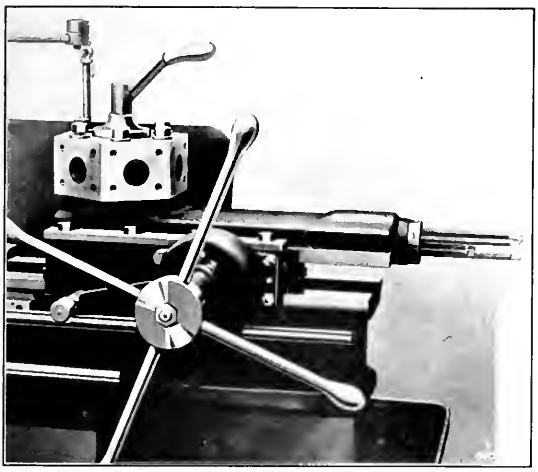


Fig. 4. Turret, Turret Saddle and Adjustable Stops

To return to the chasing attachment: This is well shown by Fig. 3. By placing the chasing lever in its horizontal position, the chasing follower is brought into engagement with the chasing leader. When the thread has been chased the chasing lever is lifted, thus bringing the returning follower into engagement with the returning leader and throwing the chasing follower out of engagement with its leader. As the returning leader and follower are threaded in a direction opposite to that of the chasing leader and follower, the carriage is thus returned to its starting point. It is not necessary to reverse the countershaft nor spindle for returning the chasing tool to its starting point. Each leader and follower cuts threads in multiples of 1 and 4 of its own pitch.

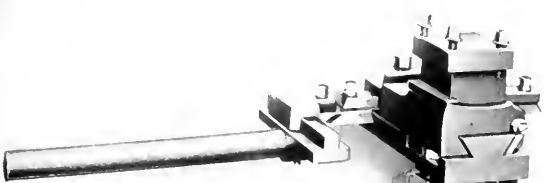


Fig. 5. Taper Attachment

The turret slide, shown in Fig. 4, has a length of feed of 10 inches, which is an extremely long travel for this size machine. It has also a very long bearing in its saddle. The saddle is provided with a supplementary taper base, and the slide is fitted with taper gibs on each side, these being fitted

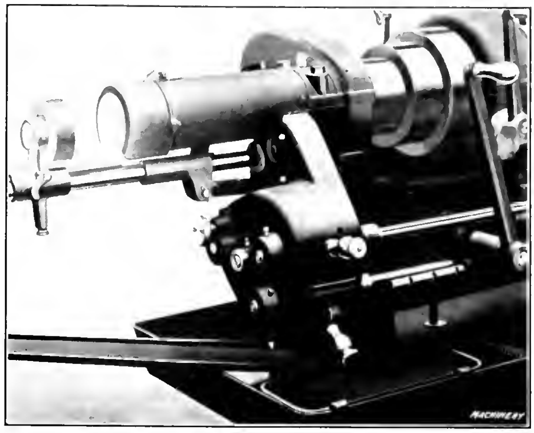


Fig. 6. Head—showing Cone Pulley and Feed Box

for realignment of the turret after it has worn slightly, although in the ordinary course of events it will not be necessary to adjust any of these parts for a very long time. The power feed to the turret is through a taper friction instead of the ordinary worm and worm gear.

Fig. 5 illustrates the taper attachment. The cylindrical arm of this attachment fits into a corresponding boss on the back of the bed. At the other end of the arm is the T-block, and the base of the attachment bolts into the T-slots at the

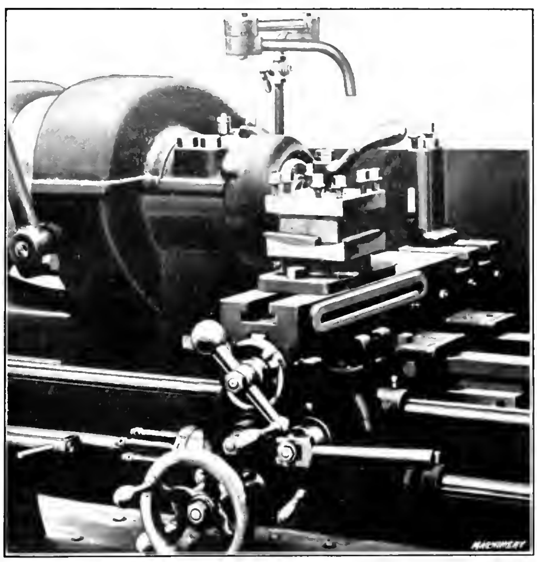


Fig. 7. Carriage with Cross-slide and Square Turret

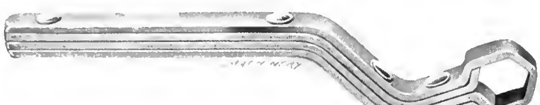
rear of the cut-off slide. To this base is fitted the tool-block itself, this being, in turn, operated by the taper bar at the back, this taper bar being adjustable for tapers up to 3 inches to the foot. In doing taper work it is not necessary to disconnect the cross feed screw, inasmuch as the taper is not obtained from the cut-off slide itself, but from the tool-block of the attachment. This tool-block is arranged for either

inside or outside tapers. The taper attachment does not interfere with the operation of the turret or the square turret. Both cylindrical and taper work can be done on the same piece with the carriage, without removing the taper attachment.

The machine can be fitted with geared head, driven by single pulley as shown in Fig. 2 or with the three-step cone head shown in Fig. 6, the latter being the standard. The automatic chuck and wire feed handle bar stock up to $1\frac{1}{2}$ inch capacity. The machine swings 16 inches over the bed and $8\frac{1}{2}$ inches over the carriage cross-slide; the total longitudinal travel of the carriage is 17 inches and the cross travel, 8 inches; and the longitudinal travel of the turret is 10 inches.

WALDEN WRENCH

A recent product of the Walden Mfg. Co., Worcester, Mass., is a wrench for adjusting the reverse and brake pedal bands of the Ford automobile. This wrench is of exceptionally simple construction, being made of three pieces of steel which are secured together by four rivets. The head of the wrench is formed by a single piece of steel which is bent to the



Simple Form of Walden Wrench

required shape with the ends extended to form a handle. Two center pieces are held between the ends which form the outsides of the handle. The forward ends of these center pieces are bent so that they form one angle of the "hex." The peculiar shape of the handle is for the purpose of providing the necessary clearance, and the Walden Mfg. Co. is prepared to make wrenches of this type of a form which will give the necessary clearance around the nuts of other machines.

"SATCO" DRILL HOLDER

The Steel-Art Tool Co., Machinery Hall, Chicago, Ill., is now manufacturing the "Satco" safety drill and tool-holder

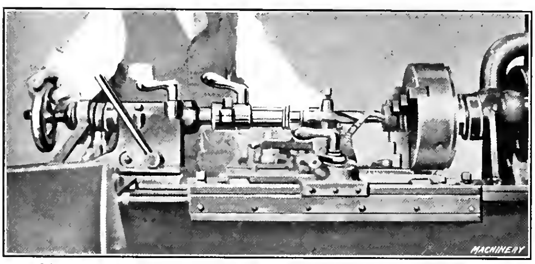


Fig. 1. "Satco" Drill Holder performing a Drilling Operation

for lathes, four applications of which are shown in the accompanying illustrations. This tool will hold taper, square and straight shank drills, taps, reamers, boring-bars, and various other lathe tools. It is quickly attached to or detached from the machine, and the tool can be instantly re-

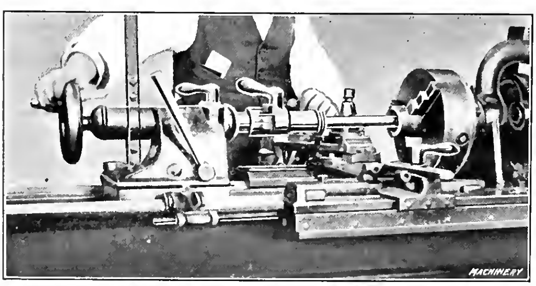


Fig. 2. Boring-bar held in the "Satco" Drill Holder

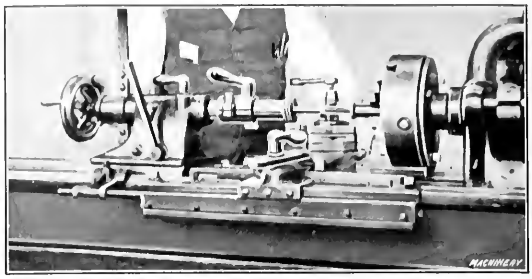


Fig. 3. The "Satco" Drill Holder is well suited for Reaming Operations

leased from the holder without requiring the use of a hammer and drift.

Referring to the illustrations, it will be seen that the holder is provided with a split bushing which fits over the tailstock spindle. With the tool-holder in place on the spindle, the cap-screw is tightened to bind this bushing in place. The tool fits in a socket at the opposite end of the holder and when it is required to remove it, it is merely necessary to turn the small lever on the holder. This draws a wedge up against the end of the tool shank and forces it out of the socket in the holder. This arrangement forms a substitute for the

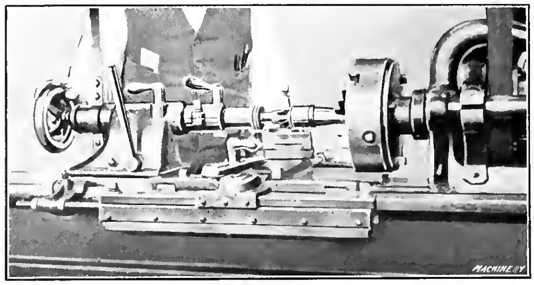
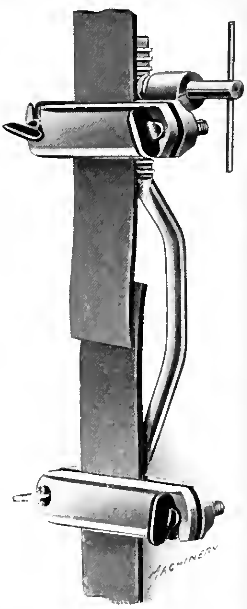


Fig. 4. Taper Reamer mounted in the "Satco" Drill Holder

use of a drift and hammer and eliminates the possibility of accidents which occasionally occur in removing tools in this manner.

SOUTHWICK "LITTLE GIANT" BELT TIGHTENER

The George W. Southwick Co., 35 Warren St., New York City, has recently brought out the "Little Giant" belt tightener which forms the subject of this article. The most noteworthy feature of this device is that the belt can be brought to the proper tension and the ends fastened while they are held in position over the pulleys. This eliminates all guesswork in regard to the amount to be cut out of the belt to take up the slack. Another feature is that the pull exerted by this device comes centrally so that the tension is uniform and draws the ends of the belt squarely together.



Southwick Belt Tightener

Referring to the illustration, it will be seen that this belt tightener consists of two clamps which are secured in place on the belt by means of thumb-screws, one of these clamps being stationary while the other may be adjusted by means of a rack and pinion. The gear is turned by a worm which is operated by the handle at the top of the tightener. By this means the required tension of the belt is obtained. These belt tighteners are made in four sizes

with capacities for belts up to 4, 6, 10 and 14 inches in width.

The location of a belt does not affect the efficiency with which a fastening can be made, and it is claimed by the manufacturers that this tightener can be adjusted to the belt and the belt drawn to the required tension and made ready for the fastening in less than three minutes. An important feature of this device is the offset in the draw-bar which permits of the use of a block for hooks and a clamp for cemented joints. The manufacturers of this tightener believe it will be greatly appreciated by those who use the wire hinge joint for fastening the ends of their belts, from the fact that before the belt is removed from the pulley the proper amount to be removed can be determined and when the belt is replaced on the pulley the ends can be drawn together and the rawhide fastening pin can be quickly inserted through the interlocking wire loops.

MILLERS FALLS POWER HACKSAW

The Millers Falls Co., Millers Falls, Mass., is now building the No. 90 "Star" power hacksaw which is illustrated herewith. This machine is equipped with a geared drive which gives an exceptionally uniform cutting stroke and a quick return stroke. The saw is returned at twice the cutting speed. The usual provision is made for lifting the saw clear of the work on the return stroke and an attachment

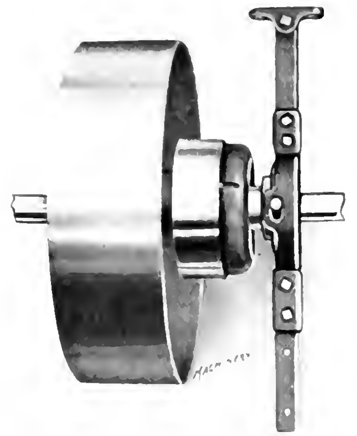
Millers Falls No. 90 Power Hacksaw

is provided which enables the saw to be suspended above the work when it is necessary to make measurements or to adjust the position of the work in the vise. By simply turning a small lever, the operator is able to lift the saw out of engagement with the work for the purpose of making such measurements or adjustments. Another feature of this machine is a support on the cut-off side which prevents the material from dropping when the cut is nearly finished. An adjusting screw in the head provides for taking up wear on the arm and the vise nut in the bed is removable so that it may be replaced when necessary. The working parts of the machine are located under the bed where they are protected from dust and dirt. The machine stops automatically when the cut is completed.

The principal dimensions of this power hacksaw are as follows: ratio of back gears, 3 to 1; height from floor to top of bed, 28 inches; floor space occupied, 20 by 16 inches; suitable speed, 60 strokes per minute; size of driving pulley, 6 inches in diameter by 2 inches face width; cutting capacity of machine, 5 by 5 inches; length of blade, 12 inches, net weight of machine, 215 pounds.

EDGEMONT FRICTION CLUTCH

In the December, 1912, number of MACHINERY, the plate type friction clutch manufactured by the Edgemont Machine Co., 2700 National Ave., Dayton, Ohio, was illustrated and described. Since that time this company has brought out an enclosed friction clutch which forms the subject of the present description. This clutch was designed to meet the demand for a powerful friction clutch of simple design that could be adjusted without removing the cover and still have none of the parts exposed in a way which would make them likely to catch belts or the clothing of men employed to look after the shafting.

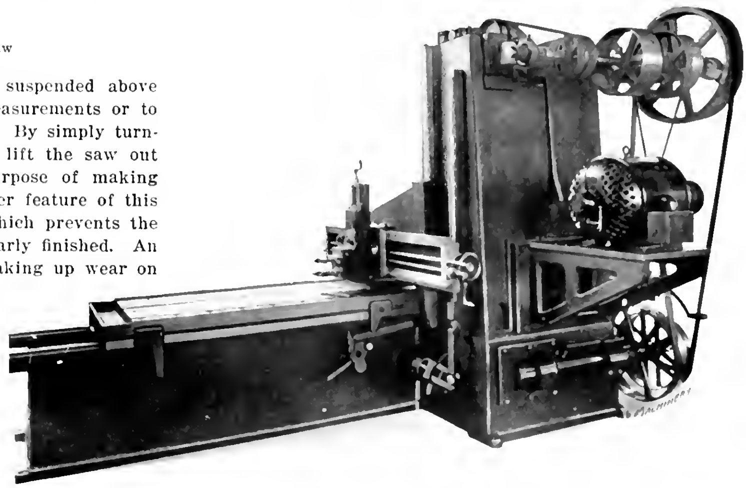


Edgemont Friction Clutch

This new Edgemont clutch is equipped with an improved expanding type of friction with metal-to-metal contact. Ample provision is made to adjust for wear and the sleeves are made in sizes to provide for using them in connection with standard wood or steel pulleys, rope sheaves, sprocket wheels or gears. These clutches are made in fourteen different sizes which have a range for transmitting from 2 to 25 horsepower.

CLEVELAND OPEN-SIDE PLANER

The Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, Ohio, has recently built a special open-side planer for use on the United States Government torpedo boat destroyer, tender No. 2, *Melville*. The installation of this planer between decks made it necessary for the over-all height not to exceed 8 feet 5 inches, which is 16 inches lower than the height of the regular 36-inch machine of this type. The design was finally worked out in such a way that the



Cleveland Open-side Planer built for the U. S. Government

machine was built to meet the requirements and still have the full planing capacity of the standard machine.

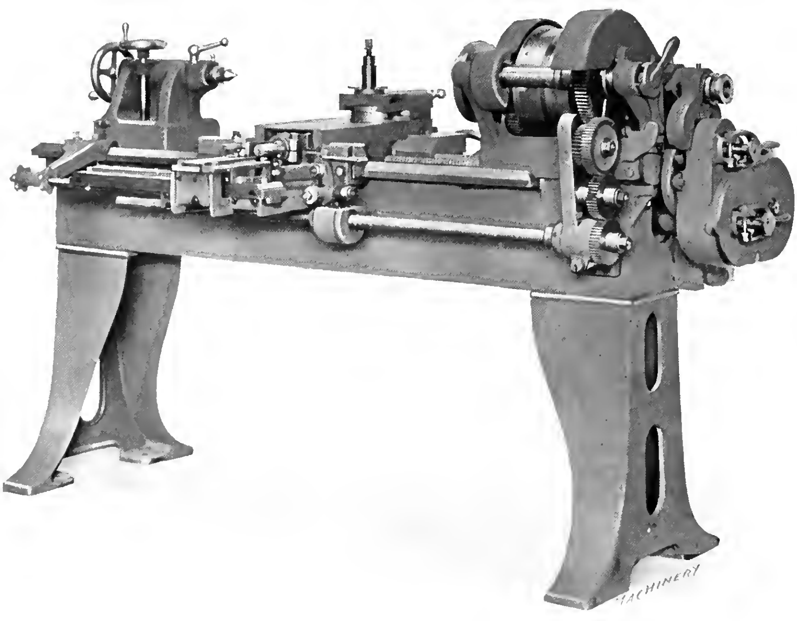
Owing to the weight of the Cleveland open-side planers, no provision is necessary for bolting them to the foundation when set up under normal conditions. In the present case, however, it was necessary to provide for anchoring the planer owing to the roll of the ship. Referring to the illustration, it will be seen that power is provided by an individual electric motor which was built by the Reliance Electric & Engineering Co. under government specifications.

WHITCOMB-BLAISDELL RELIEVING ATTACHMENT

The Whitcomb-Blaisdell Machine Tool Co., 134 Gold St., Worcester, Mass., is now equipping lathes of its manufacture with the relieving attachment shown in the accompanying illustration. The features of this equipment are that it is of simple design, that it can be used for relieving either spiral or straight fluted cutters, and that the full range of the compound rest is available in connection with the attachment.

Referring to the illustration, it will be seen that the relieving attachment is geared to the lathe head by a train of spur gears carried by a suitable bracket. Change gears are provided so that for each revolution of the lathe spindle the relieving attachment makes anywhere from three to twenty-seven strokes. By compounding the gearing, the tool may be made to lag sufficiently for relieving spiral fluted cutters.

The horizontal shaft carries a cam as shown, and as the shaft rotates, this cam rocks the bellcrank on the relieving attachment. This bellcrank, in turn, rocks a second crank which is carried on the end of the transverse shaft. The oscillation of this shaft is transmitted through a pair of bevel gears to a small vertical spindle, at the upper end of which there is a disk almost half of which has been milled away. The flat side of this disk contacts with a pin in the tool-slide, and as the shaft oscillates the disk causes the slide to be moved forward. The movement of the slide is against the tension of a spring and when the shaft oscillates back—thus releasing the pressure of the disk on the pin in the slide—the slide and tool are withdrawn from the work. As the power to the vertical spindle carrying the disk is through bevel gears, it is possible to set the compound rest to any required angle as previously mentioned. By adjusting the throw of the cranks which operate the relieving attachment, the amount of relief can be varied as required.



Relieving Attachment for Whitcomb-Blaisdell Lathes

BESLY NO. 41 DISK GRINDER

The accompanying illustration shows an improved direct-connected motor-driven disk grinder developed by Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., and designated as the No. 41 Besly grinder. Heretofore, disk grinder bearings have usually been grease lubricated, owing to difficulty in automatically lubricating the thrust bearings with liquid oil. In this new grinder, the Besly Co. has worked out a system of ring oiling for both the radial and thrust bearings. Owing to the extremely severe duty and accuracy required of the modern disk grinder, the design and construction of the spindle and its mountings is especially important. In the manufacture of the No. 41 Besly grinder the motor is equipped with special end castings carrying extra large bearings suitable for disk grinder service. All wearing parts are renewable. The rotor shaft is of hard crucible machine steel, the wheel collars are drop-forged from hard crucible steel, and the bearing bushings are cast iron, lined with high-grade bearing metal. These bushings are ground over the outside and carefully fitted into bored and reamed holes in the motor end casings, so that new bearings may be inserted when necessary, without affecting the alignment of the spindle.

Charles H. Besly No. 41 Disk Grinder

End thrust in both directions is taken on hardened and ground tool steel thrust collars of large area, running at each end of the right-hand bearing bushing. End play of the spindle is taken up on these thrust collars by means of adjusting collars which are threaded on the spindle. With this construction the heating of the bearings when running does not tend to tighten and bind them, because the longitudinal expansion from heat is greater in the spindle than in the bearing bushing. However, the expansion is so nearly uniform that the change in adjustment due to temperature changes is practically nil. Therefore this machine can be run safely with all end play

taken up, providing for the grinding of work within closer limits. The motor is 7½ horsepower, running fully enclosed for alternating current. When operating on 60 cycle current, this machine carries 20-inch disk wheels and runs 1200 R. P. M. When operating on 25 cycle current, the machine runs at 1400 R. P. M., and is equipped with 18-inch disk wheels to give the correct abrasive speed. The machine may be equipped with any type of work table. As illustrated, it carries on the right a geared lever feed table and on the left a plain tilting table. It is started and stopped by means of a single-throw switch located inside of the base casting. The floor space occupied is 28 by 28 inches and the weight of the machine with all equipment is 2000 pounds.

REED-PRENTICE AUTOMATIC LATHE FOR STRAIGHT TURNING AND FACING

An automatic lathe for straight turning and facing operations on forgings and castings, which was recently built by the Reed-Prentice Co., Worcester, Mass., for the Ford Motor Co., is shown in Fig. 1. These machines are of unusually rugged construction to insure an absolute absorption of vibration and to withstand the severest service which can be demanded of machines of this type. The power is in excess of any demand made upon the lathe. The wide double belt drives to a large diameter pulley, and then through a pair of herringbone gears running in oil, to the main head spindle. This arrangement gives a constant spindle speed, no mechanical changes being provided. A feature of these lathes is the one-feed and one-speed idea which guarantees a maximum production when the machine has been set at the proper feed and speed for a given operation. Change gears can be used if desired to vary the feed to suit the class of work, although when once set up the feed is rarely changed. In order to obtain the desired spindle speed the countershaft speed must be changed accordingly.

The object of this machine is to furnish a second operation machine that will produce a large quantity of work

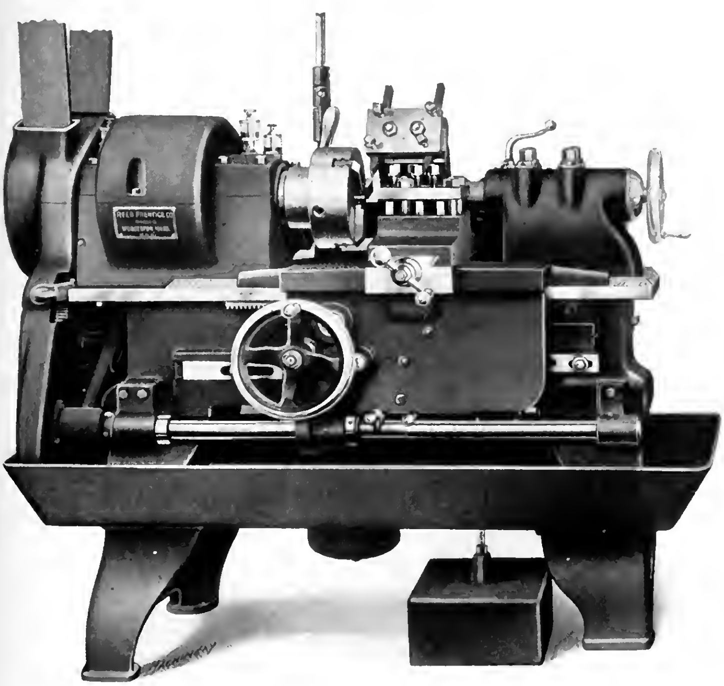


Fig. 1. Reed-Prentice Automatic Lathe for turning and facing Forgings and Castings

which will be equal in quality to that produced on the best types of engine lathes. In the construction of this machine careful consideration has been exercised in the distribution of material. The head spindles are made of heat-treated chrome-nickel steel, the bearings are hardened and run in phosphor-bronze journals, and sight-feed oilers are used for lubrication of all head bearings. The driving pulley which is mounted on a shaft at the rear of the head, and which arrangement entirely eliminates any belt tension on the main spindle, is well guarded to protect the operator, the same guard entirely covering all end works gearing.

The tailstock is extremely rigid, being of the four-bolt type. It is made in one piece in preference to the regulation two-piece tailstocks, as this prevents any chance of sideways shift of the tail spindle. The carriage and apron are also very

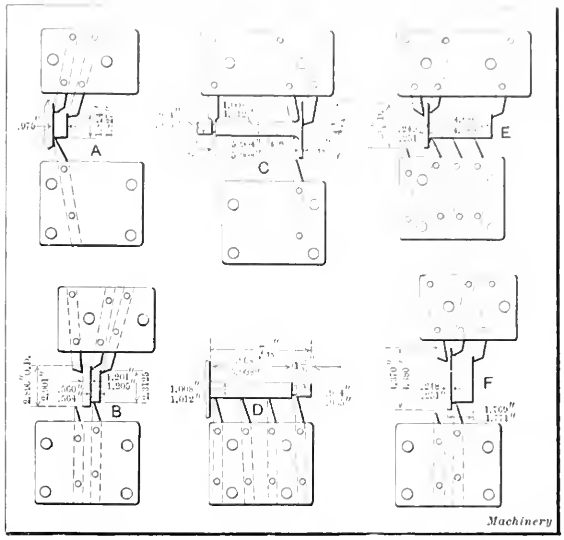


Fig. 2. Examples of Work done on the Reed-Prentice Lathe

heavily constructed, the rack pinion being made of hardened steel, engaging with a hardened rack on the bed. A cam feeding-in attachment is incorporated in the construction of the apron and carriage, which arrangement constitutes an adjustable bracket on the side of the bed carrying cam surfaces, and a link motion inside of the apron that transmits a cross-feed action to the front tool-block. The longitudinal travel of the carriage causes the link motion and cam surfaces to deliver this feed-in motion to the block, feeding the tools into the work to a predetermined diameter.

The back arm facing device is an attachment mounted on a large shaft or bar, which is supported in bearings cast integral with the head and tailstock, and bored in perfect alignment with the main spindles. A cam attached to the rear of the carriage actuates the bar by means of a roll carrier arm which projects from the bar, and is in contact with the cam surface. The longitudinal travel of the carriage which carries the rear cam causes a rotating motion to the bar, and this motion feeds the facing tools in toward the center of the spindle. It will be noted that the longitudinal travel of the carriage actuates both the feeding in of the front tools and the feeding in of the facing tools. When the work is completed the feed is automatically tripped, and the carriage and all tools almost instantly return to their starting position.

The complete cycle of operations on a piece is as follows: The work mounted on an arbor is placed between centers, the countershaft started, and the feed latch lifted into position. Both feeds are thus started, the work progressing until all diameters are turned and all shoulders and ends faced down, after which the feed is automatically tripped, and all tools return to their starting position. This completes the cycle of operations, and the machine is then ready to receive another piece

which has already been pressed on another arbor. Thus it will be seen that it is quite possible and practical to permit one operator to have charge of two or more machines. It will be noted from Fig. 1 that the entire machine is very compactly designed to eliminate any spring due to long arbors or excessive overhang of tail spindle. The floor space occupied is 5 feet by 3 feet 4 inches.

Figs. 2 and 3 illustrate the adaptability of the machine to the usual run of work. It happens that the pieces shown are all steel forgings and in most cases the production obtained on this new Reed-Prentice lathe has been practically double that previously obtained. Referring to Fig. 2, at *A* the hub and back of the bevel gear blank are finished, three tools being provided for this purpose—two tools for facing and one for turning. The actual time required to finish these pieces is ½ minute. The steel gear blank shown at *B* is turned and faced with three tools for facing and two tools for turning. The actual time required to finish these pieces is also ½ minute.

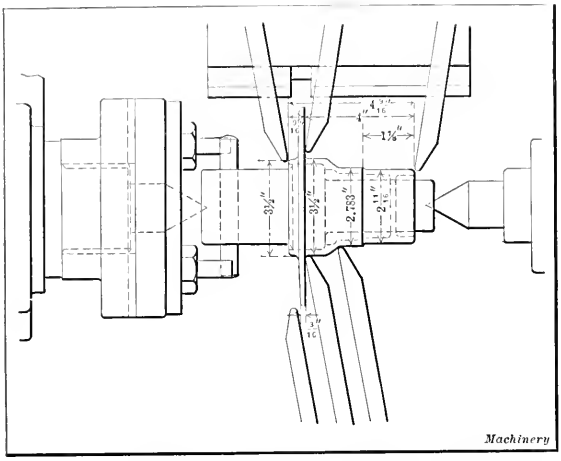


Fig. 3. Machining a Wheel Hub on the Reed-Prentice Lathe

The flange of the piece shown at *C* is turned and faced and the stem notched as shown, in 1½ minute. The stem is turned in a previous operation, while the flange is held in the chuck and the stem supported on centers. Four tools are used for this turning operation as shown at *D* and the time required is 45 seconds. Another example of turning and facing is shown at *E* where it will be seen that three turning and three facing tools are employed. This piece is finished in 1¼ minute. A somewhat similar operation is illustrated at *F*, in which three facing tools and two turning tools are employed. The time required to finish this piece is 1¼ minute. Fig. 3 shows the way in which a wheel hub is turned and faced on the Reed-Prentice automatic lathe, the actual time required to finish this hub being 2½ minutes. These are merely examples of work which tend to show that this type of lathe is adaptable for use in the production of small pieces in a great number of factories.

MARVIN & CASLER CENTER INDICATOR

A rotary center indicator particularly adapted for use on the Casler offset boring head has recently been placed on the market by the Marvin & Casler Co., Canastota, N. Y. This instrument is designed to indicate the center of any rotating spindle or shaft. It is small, compact and strongly built so that it is not likely to be injured by careless handling. When used in connection with the Casler offset boring head, it enables the operator to locate holes without removing the boring head from the spindle of the machine.

The indicator consists of a shank *A* which is gripped in the chuck of the boring head or a draw-in collet in the spindle. A pointer *B* is held against the faceplate *C* by means of a spring carried in the shank of the tool. The contact surfaces between the pointer and faceplate are hardened, ground and lapped to an accurate finish. The pointer is free to float in any direction over the surface of the faceplate and the head *D* is ground to a diameter of 0.250 inch. When used in the chuck of a boring head, the chuck is first

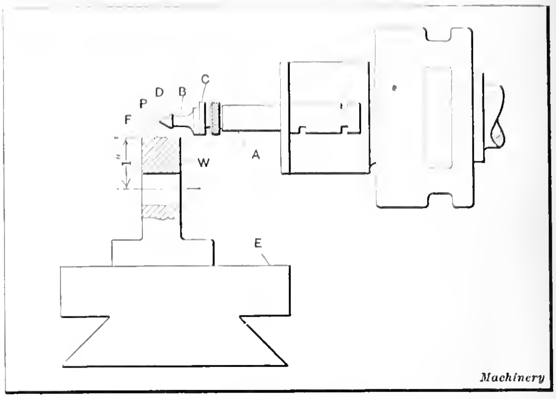


Fig. 1. Diagram showing how Marvin & Casler Center Indicator operates

brought concentric with the head. It is not necessary to have the shank of the indicator run true, as it is designed to operate satisfactorily without paying attention to this point. The pointer *B* is next brought in contact with a finished surface *F* near the center of the hole which is to be bored, after which the pointer *B* is moved to one side of the faceplate *C* so that it will describe a circle when the spindle is rotated. With the spindle rotating, the table *E* carrying the work *W* is slowly raised. Under these conditions, the head *D* of the pointer will strike the finished surface *F* of the work and be forced back toward the center of the faceplate *C*. The distance which the head is forced back at each revolution becomes less as the work is raised, until the pointer has finally been brought to the exact center of the faceplate *C*.

The operator continues to raise the table until the pointer runs true, *i. e.*, does not recede from the work. The graduated dial indicating vertical movement of the table can now be set to zero and as the diameter of the head *D* is exactly 0.250 inch, the table can be raised ⅛ inch, which will bring the center of the spindle in line with the finished surface of the work. For the case shown in the illustration, a further movement of 1 inch will bring the spindle on a horizontal line, passing through the center of the hole to be

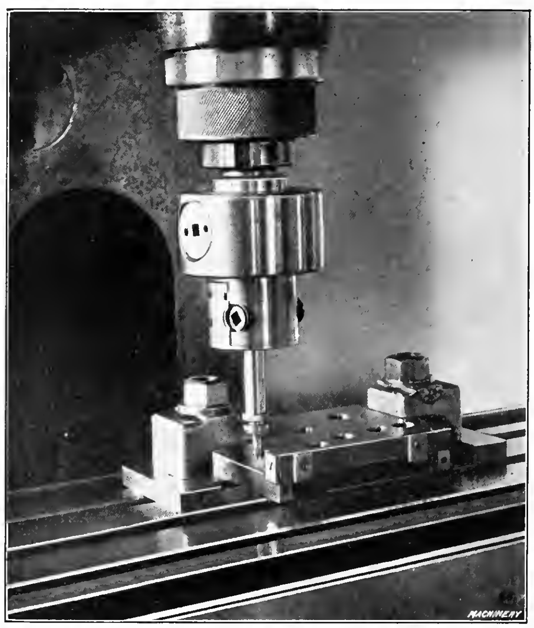


Fig. 2. Marvin & Casler Center Indicator in Place on the Machine

bored. It will be evident that lateral distances can be determined in a like manner by setting the pointer B to engage with any vertical finished surface on the work.

NEW MACHINERY AND TOOLS NOTES

Autogenous Welding Outfit: Tolman Mfg. Co., Boston, Mass. An equipment consisting of the usual pair of oxygen and acetylene cylinders connected to a cutting torch.

Pipe Cutter: Borden Co., Warren, Ohio. A pipe cutter in which the frame of the tool clamps onto the pipe. The cutters are carried in a ring and are fed in by spring pressure as the ring is revolved about the pipe.

Drop Hammer: Henderson Machine Co., 5032 Germantown Ave., Philadelphia, Pa. A steam- or air-lift drop hammer adapted for the rapid handling of work where it is necessary to raise the hammer a slight amount and drop it repeatedly.

Combination Vise and Drilling Machine: Diamond Expansion Bolt Co., 90 West St., New York City. A tool known as the "trident" combination drill press and vise which consists of a vise, anvil and a drilling machine mounted on a swivel base.

Rack-cutting Attachment: Kearney & Trecker Co., Milwaukee, Wis. A milling machine attachment adapted for milling racks, sawing off stock, milling slots which have to be accurately indexed, cross-milling operations and similar classes of work.

Graphite Lubricant: Lumen Bearing Co., Buffalo, N. Y. A semi-fluid graphite lubricant prepared in such a way that the graphite is held in suspension when mixed with lubricating oil or grease. This product has been given the trade name of "Lesoyl."

Offset Pliers: H. D. Smith & Co., Plantsville, Conn. Slip-joint offset pliers which are drop-forged and made with a serrated opening between the jaws. The gripping surfaces at the ends of the jaws are checkered and there is a wire cutter at the rear.

Bending Machine: Garrison Brass & Machine Works, New York City. A machine for cold-bending rods or tubes of steel or brass. The machine is also applicable for use in bending band iron into different forms for handles, coils, hooks and similar parts.

Punching Machine: Cleveland Punch & Shear Works Co., Cleveland, Ohio. An open-gap punching machine of unusually heavy construction which was built for the Cambria Steel Co. The machine will be used in the fabrication of splice bars and tie plates.

Die Cutting Machine: Alfred H. Schütte, New York City. In operating this machine a light sheet-metal templet the shape of the die to be cut is secured on top of the die blank. This serves as a guide for the cutting tool which is made with a single relieved cutting tooth.

Hydraulic Press Valve: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. A pilot-operated hydraulic press valve for use in operating high-pressure hydraulic presses where a very large volume of water is required. The valve is controlled by two small pilot valves.

Drilling and Boring Machine: Pawling & Harnischfeger Co., Milwaukee, Wis. A horizontal drilling and boring machine which has a working area of 60 square feet. The design follows the general lines of the No. 3 machine which has been built by this company for some time.

Washer Making Machine: Joseph M. Mason Machine Co., Philadelphia, Pa. A washer making machine provided with a carrier plate that removes the product after it has been stamped. In addition to cutting washers, the machine is suitable for making various small hardware specialties.

Motor-driven Planer: Niles-Bement-Pond Co., 111 Broadway, New York City. A 72-inch planer equipped with electric motors for operating the feed mechanism and power traverse of all the heads. This machine is equipped with the Niles-Bement-Pond Co.'s standard reversing motor drive.

Gear Testing Machine: Feicht-Bevington Mfg. Co., Cleveland, Ohio. A machine for testing the accuracy of gears. Readings can be made to 0.0005 inch and the dial graduations are large so that they are easily read. The multiplying levers of the indicators on this machine have a ratio of 250 to 1.

Boring Tool: Allen & Curtiss, South Bend, Ind. A boring tool intended for use on the lathe, milling machine or drill press, which is provided with simple means of adjustment. The body is slotted to receive the cutting tool which is adjusted by two set-screws tapped into the body at the ends of the slot.

Muffle Furnace: Eclipse Fuel Engineering Co., Rockford, Ill. A vertical muffle furnace for heating high-speed steel tools. The muffle is 5 inches inside diameter and 11¼ inches high. The furnace is heated by six burners which deliver the heat to the annular space between the muffle and the lining of the furnace.

Die-sinking Machine: Jackson Machine Tool Co., Jackson, Mich. A duplex die-sinking and cherrying machine which was formerly manufactured by the Melling-Northrup Co. and taken over by the present builders about six months ago. Numerous improvements have been made which add to the efficiency and durability of the machine.

Elevator Guide Planing Machine: Niles-Bement-Pond Co., 111 Broadway, New York City. A planer designed for machining elevator guides. It measures 52 inches between the housings and the maximum distance from the table to the cross-rail is 18 inches. The table is 20 feet long and material ranging from 2 to 6 inches in height can be accommodated.

Electric Annealing Furnace: Electric Furnace Co. of America, Alliance, Ohio. An electrically-heated furnace for use in annealing brass and German silver blanks. The framework is made of steel and is 15 feet long by 8 feet wide by 7 feet 6 inches high. Doors are provided at both ends of the furnace and a mechanical pusher actuated by compressed air operates the charging mechanism.

Multiple-spindle Chucking Machine: C. M. Conradson, Madison, Wis. A hydraulically-operated six-spindle automatic chucking machine for boring and turning operations. It is equipped with tools for cutting both vertically and horizontally, and has a wide range. Both the spindle speeds and feeds may be changed at any time while the machine is under cut, which is an especially valuable feature when operating on pieces of large diameter.

Manufacturing Lathe: Greaves-Klusman Tool Co., Cincinnati, Ohio. An automatic machine in which the use of cam drums or pins for moving the tool-slides has been eliminated. The feed movement is secured through large diameter screws of coarse pitch which work in long nuts set close to the guides. The shifting mechanism which controls the feeds, speeds and indexing is operated by dogs on a drum which shift levers connected to positive clutches.

Grinding Machine: Landis Tool Co., Waynesboro, Pa. A grinding machine designed with a stationary work-table and a traversing grinding wheel. Wherever possible, ball bearings have been used in preference to plain bearings, and forgings have been used in place of castings for those parts of the machine which are subjected to severe strains. The grinding spindle runs in bearings which are self-adjusting to compensate for expansion due to an increase of temperature. These bearings can also be adjusted to take up wear. These machines are built to swing 10 and 12 inches and to take from 18 to 96 inches between centers.

* * *

SWEDISH ENGINEERING CONVENTION IN THE UNITED STATES, 1915

Plans are being made for a meeting or convention of Swedish engineers visiting the United States in 1915 on account of the San Francisco Exposition and engineers of Swedish birth permanently residing in this country. The meeting will be held in early September in Chicago, where papers will be read by visiting engineers as well as by resident members of the organization. All engineers of Swedish birth are invited to enroll. The fee for enrollment is $5. The secretary of the Eastern Organization Committee is Erik Oberg, associate editor of MACHINERY; home address 185 Sixty-eighth St., Brooklyn, N. Y. The chairman of the committee is C. J. Mellin, consulting engineer, American Locomotive Works, Schenectady, N. Y.

* * *

The Marconi Telegraph-Cable Co. in connection with the Marconi Wireless Telegraph Co. of America, has announced that the Marconi high-power trans-oceanic stations now being constructed in the vicinity of New York are nearing completion, and that public messages for direct wireless transmission between the United States and Great Britain and Ireland will be accepted soon. The tariff for full rate marconigrams will be seventeen cents a word, and for the other classes of service the wireless rates will show a corresponding reduction from regular cable rates.

* * *

The forest departments of the states of Washington and Oregon intend to discontinue the use of barbed wire for fences. The claim is that barbed wire has no advantage over smooth wire, that it injures stock, and that it is more likely to be broken down by snow. Stockmen in Oregon, who recently constructed fences of smooth wire with some misgivings, now say that they will never use barbed wire again.

G. E. HIGH VOLTAGE OUTDOOR OIL SWITCHES

The general principles of operation of indoor and outdoor oil switches are the same, but some of the details of construction are obviously different. In addition to performing the usual duties, the outdoor switch must be so constructed that successful service will result while exposed to the effects of the severest weather; neither rain, snow nor sleet should be able to interfere with satisfactory operation. All moving and operating parts must be totally enclosed and fully protected. The Type F, Form K-22 oil switches illustrated herewith meet these conditions fully. They are built in single-pole elements and are operated by hand, solenoid or air. The mechanism for each element is self-contained and mounted on the top of a steel tank. The switches trip free from the operating mechanism, so that the automatic switches cannot be held closed on overload or short circuits; and all the switches, non-automatic or automatic, are always opened at the same quick rate of speed. The standard hand operating lever consists of a removable wooden handle attached directly to the switch mechanism. This handle is removable to guard against unauthorized operation. The solenoid mechanism is similar to the hand mechanism, except that a direct-current solenoid with a rod for connecting to the mechanism is used instead of the operating handle. The air-operated mechanism is rather special and needs individual consideration.

Since the insulating properties of oil are superior to those of air, the bushings are inserted through the cover at an angle converging at the lower end, which materially reduces the size of the oil tank necessary for any given voltage. The bushings extend below the oil level down to the stationary contacts of the switch, and an iron cap forms the top of the bushing. The bushings are supported by metal clamps bolted to the tank cover and may easily be removed for inspection or repair. The contacts are of the well-known "sliding-wedge" construction. Each phase contains two contacts in series. The stationary ones consist of widely flared fingers and extra long arcing tips of drop-forged copper. The movable element of the contact is a wedge-shaped copper blade.

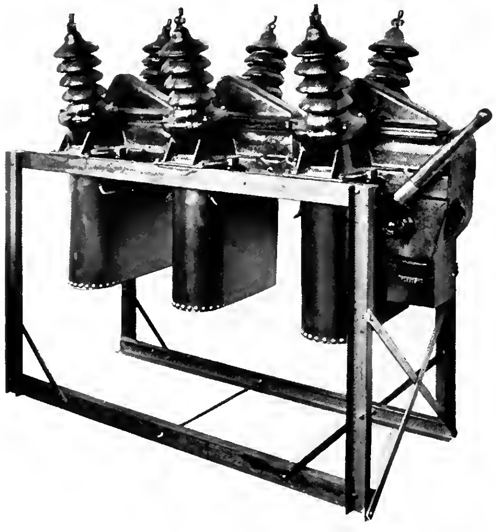


Fig. 1. Triple Pole Single Throw Oil Switch for 300 Amperes at 22,000 Volts

This blade moves in a vertical plane, being drawn up by the switch mechanism when the switch is closed and dropped by gravity assisted by springs when the switch opens. As the wedge-shaped movable contact enters the stationary flared contact, a steady and increasing pressure is exerted on the contact surfaces, which insures good contact, especially since these surfaces are kept clean and bright by a rubbing motion each time the switch operates. By the use of the sliding wedge contact, the arcing set up by opening the switch under load occurs between the extended portion of the stationary contact fingers and the upper extremity of the movable blade, which sections are not in contact when the switch is fully closed.

The switches are, as a rule, tripped on overload by trip coils acting directly on the switch toggle and operated by bushing type current transformers, although the other methods of tripping oil switches in general use can, of course, be

Fig. 2. Solenoid Operated Oil Switch for 100 Amperes at 130,000 Volts

applied. These transformers consist of the switch stud as the primary and a copper ribbon wound on an iron core around the bushing as the secondary. From one to six transformers with from one to three trip coils may be used on a three-phase circuit, depending on the protection required. The bushing transformer has been designed to furnish at a lost cost a series transformer for high tension systems. It may also be used to furnish current for ammeters where only approximate accuracy is required. These switches have been developed by the General Electric Co., Schenectady, N. Y., and are for use on lines from 22,000 volts upward.

* * *

When the additions and alterations to its huge grain elevator at Kansas City now under way are completed, the Missouri Pacific-Iron Mountain R. R. will have one of the largest plants of its kind in the world. As originally constructed, the elevator consisted of ten concrete circular storage tanks, with a capacity of 80,000 bushels each, or 800,000 bushels in all, and the elevator building proper, with a capacity of 200,000 bushels, a total plant capacity of 1,000,000 bushels. Forty additional concrete circular storage bins, 22 feet in diameter and 84 feet deep, with a capacity of 25,000 bushels each or 1,000,000 bushels all told, are under construction, besides nineteen smaller bins, with a capacity of 7000 bushels each or 133,000 bushels total. The latter are what is known as "interstice" storage bins, and they will occupy the space formerly left vacant between the circular bins of this style of elevator. The elevator will have a total of sixty-nine units of storage space, with a capacity of 2,133,000 bushels, which is more than double its present capacity.

* * *

Interesting sidelights are being thrown upon the results of the great national aeroplane subscriptions inaugurated two years ago, when, as the result of voluntary contributions by citizens, 208 aeroplanes were presented to the French army. It is alleged that certain manufacturers of aeroplanes seized on this opportunity to dispose of machines that were not of the most recent and improved types, and that many of the machines bought for the money collected by the national subscription were not new. The French army has acquired nearly one thousand aeroplanes since the beginning of 1911. The Blériot Works alone have built 181 military aeroplanes and Farman 105. This indicates why the aeroplane industry in France has developed to such an extent as compared with that in other countries.

WHAT TO PATENT

BY CON WISE

This is not an attempt to catalogue the numerous things for which the world is clamoring and which are sure to bring unlimited wealth to the patentee at a moment's notice. It is an attempt to start a discussion as to what inventions it is worth while to protect. The big values are in basic patents skillfully followed up by minor combination patents taken out at such intervals that they practically extend the life of the original patent. As F. W. Harris pointed out in the July number of MACHINERY, it is possible to obtain a patent that has no value except to the holder of the bottom patent or else which makes the bottom patent unworkable. If the holder of one patent won't buy, then the other is worthless, but there are a number of men who have made a comfortable living following up inventions in this way. Hardly any inventor is far-sighted enough to protect himself fully in his original patent and still fewer attorneys are shrewd enough to secure this protection, or it may be that they are just shrewd enough to see the possibility of getting another patent to take out if their client should happen to think of an improvement which he might also protect. For this very reason it is wise to file an application on as broad a ground as possible and then take advantage of the slow procedure of the patent office, to consult as many people as possible as to the working out of your idea.

Suppose, for example, you have invented a one-legged shop stool which maintains its balance by means of a gyroscope under the seat (any one that wishes to borrow this invention is welcome—I haven't money enough to pay the fees). You might as well write up a description, make a drawing yourself and mail the whole thing to the patent office, paying due regard to the rules which they publish, and which are clear enough so that you cannot go far wrong; then put the thing up to people who might buy your stools in some quantity. You will have to do this eventually, so you might as well begin that way. You may find that there is no market for a stool of any kind in a shop unless you create the market yourself. Will your capital hold out while you are making shop superintendents see the value of having men sit at their work? Possibly someone may object to your stool on the ground that their work requires that their men should have a back to lean against, and yours won't stand leaning against. Someone else may sit down and prove to you by mathematics that the seat of your stool will have to be four feet seven and a quarter inches in diameter to cover a gyroscope that will keep it steady, and that it will require a fifty horsepower motor to keep it running, and they won't believe to the contrary even if you bring around a sample to show them. After you have tried to play salesman for about a week you will get a totally different view of what you have invented—that is unless you were entirely crazy about it. You need not fear that anyone will take you up and actually order one of the things. No inventor ever sold anything he invented—he knows too much about it. Wait till you hear some professional salesman sell a hundred of your one-legged milking stools to some rich agriculturist, one for each cow. Then you will realize that inventing and selling are for two entirely different sets of consciences.

But to get back to the subject. It is hardly to be expected that anyone without abundant time and funds at his command will make fundamental inventions in the future with any great frequency. The field is pretty well covered and large concerns are spending large amounts of money trying to do just that. The field for the individual inventor has narrowed down to improvements on already existing devices, which may be sold to the holders of the fundamental patents or which may be worked with small capital. For example, one of my neighbors has recently made a fortune out of a labelling machine. There are and have been for years patents galore on such a machine, but there have been very few machines because those that would work were too expensive and those that were reasonable in price would not label. This man studied the situation and finally bobbed up with a simplification of the complicated machine. He had not really invented a new machine, but none of the old ones were worth anything at all, so he was able to gather in the previous patents for a song and then he came out with a patent that with the others, made a pretty strong combination. Mind one thing though, he knew the ins and outs of the machines that had been built before, because he had built a number of them. Don't try to invent something that you don't know anything about yourself. You may find that what you are trying so hard to invent has been invented before and used and forgotten. Of course it gives more play to your imagination to get up something about which you know nothing, but it also gives more play to the pocket-book. If your job is chucking pulleys invent a new chucking drill or a chuck or something that you are familiar with; don't start to invent a dish washer let your wife do that.

Just because you can get a patent allowed is no sign it is worth the paper it is written on. I do not doubt you could get a patent on a dining room chair with a bouquet holder on one side, and your next-door neighbor could probably get one on the same chair with a holder on each side, but what would they be worth, unless it was the fashion to wear flowers that way? And if you get a patent that is good for something it is worth nothing to you unless you can sell it. The place to sell it is where they are taking out patents as a regular thing. They have ten chances to one of anyone else, of being able to use it. It may be that they want to ward off an attack by some competitor, or it may just supplement some more important invention of their own, or it may point a way to them that is worth following up. In any of these cases they would much prefer to put the thing through the office in their own way and at their own expense.

* * *

DENATURED ELECTRICITY

An interesting method of preventing the improper use of electric current has been devised by an Italian engineer. The practice of making especially low rates for current to be used in electric power, heating and cooking devices is becoming more and more general, but with the ordinary constant potential current it is difficult to detect the use of lighting devices on circuits intended only for power and heating purposes. This engineer advocates the use of special circuits on which the current is subject to extreme fluctuation of voltage at rapidly recurring intervals, which would make it practically impossible to use lamps, because of the flicker in the lights. As the current is not entirely interrupted and the normal voltage is almost immediately restored the proper operation of power or heating apparatus is not interfered with and the rightful use of the circuits for their respective purposes is assured.

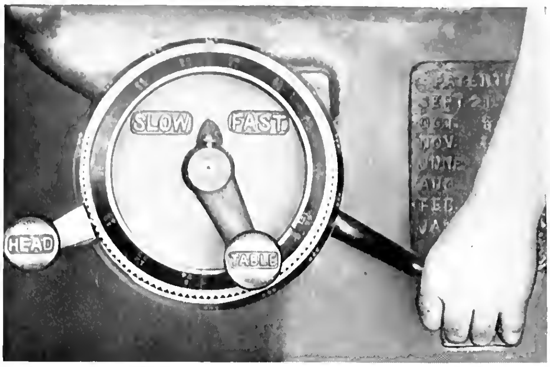
* * *

Henry J. Gaisman of New York City lately received a check for $300,000 for his invention of means for identifying photographic negatives at the time of exposure. Mr. Gaisman's invention was bought by the Eastman Kodak Co. of Rochester, N. Y. It comprises a window in the back of the camera which when opened exposes a red strip of paper on which a legend can be written with a stylus. The writing makes a break in a strip of chemically-prepared paper underneath, and sufficient light is admitted to print the writing on the negative. Hence when the negative is developed the writing develops also, and it appears on the prints made from the negative. The value of the invention will be apparent to all who have taken any photographs; oftentimes it is difficult to identify the various negatives even if careful memoranda are made of each at the time of making the exposure.

* * *

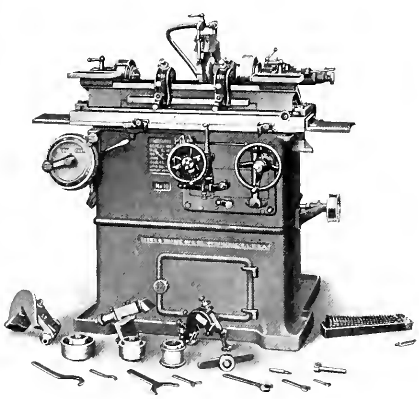
The three-hundredth anniversary of the invention of logarithms by John Napier is celebrated this year. Napier published in 1614 his work, "Description of the Admirable Canon of Logarithms," in which the statement appeared on the title page that he was the author and inventor, which was the fact, as he was the inventor of the method of logarithmic calculation and of the word logarithm itself. The debt owed to Napier by the scientific world can hardly be overestimated. The advent of logarithms marked an epoch in the history of science. Napier was born in 1550 at Merchiston Castle, near Edinburgh, and died in 1617.

Work Control in Four Motion[s]



1st—Starting the Table—The first piece is in position; take, for example, a $1\frac{1}{2}''$ diameter shaft. Pull up on the long lever and the mechanism for rotating the work and traversing the table starts. The grinding wheel is already running, for it is independent of the work, and does not stop when the work is stopped.

2nd—Speeding Up Rotation—The lever marked "Head" has previously been set to give a trial speed of rotation of 172 R. P. M., as indicated by figures on outer dial. This is too fast, so the lever is moved around the dial until the speed is right. The decrease is gradual and not by jumps.



No. 10 Plain Grinding Machine
Capacity: To 6″ diameter and 20″ length

This simple control system increases output by reducing setting-up time, by making correct speed and feed combinations quickly available, and by providing for rapid changes for different diameters on the same piece.

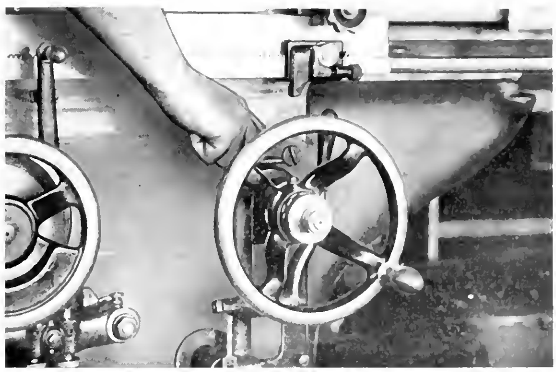
BROWN & SHARP[E]

PROVIDENCE

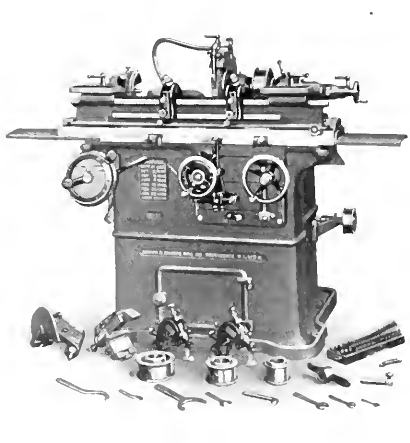
Makes Rapid Grinding Easy

3rd Regulating Table Traverse—The trial rate of table traverse of 80″ per minute is found too slow, so the lever marked "Table" is moved in the proper direction until the speed and feed are in the correct combination. The Head and Table Levers are independent so any desired combination can be obtained.

4th—Shifting to a Finish Feed—After the work is brought quickly to size with a rapid-table travel, the lever behind the hand wheel on the right is turned. This slows down the table in the ratio of 1 to 2½, so the work receives a smooth finish, without disturbing the lever for roughing table traverse.



There are many other interesting production features in addition to the above. Have you ever investigated our Universal Back Rests and Automatic Cross Feed? We should be glad to send descriptive matter.



No. 11 Plain Grinding Machine
Capacity: To 6″ diameter and 32″ length

MFG. COMPANY
RHODE ISLAND

Read page 71

EXHIBITS AT PANAMA-PACIFIC INTERNATIONAL EXPOSITION

More than sixty thousand exhibits have already been accepted by the division of exhibits of the Panama-Pacific International Exposition and there is every likelihood of this number being increased to eighty thousand before the last of the final allotments of space have been made. The first installation was started on May 27 in the palace of machinery when a 500 H. P. Diesel engine was placed in the center of the building. On the following day five thousand cases of exhibits arrived at the exposition and these are now being placed in their respective positions. It can be safely asserted that the finest collection of electrical and machinery exhibits ever assembled under one roof will be displayed in the palace of machinery. About five thousand exhibits will be shown there. Although the building is 967 feet long and 367 feet wide, the space has been over-applied for.

A feature of the palace's display will be the fact that every operating exhibit—and practically all of them will be in operation—will be equipped with "safety-first" appliances. The exhibitors have also cooperated with the officials in so associating their exhibits with others that complete operation will be possible, and the merits of the various exhibits will be well displayed. Machines will be shown in parts, with cross-sections, and the various workings of the different parts of the interior construction open to the view. The products of the machines shown in the various stages of manufacture, from the raw material to the finished article, will call particular attention to the machine.

Electric current for any use desired will be available to exhibitors in all of the buildings. The charge will be small, based on the actual cost. Steam will be supplied in the palace of machinery from the Gas and Fuel Building which is adjacent. When the product of the machines is turned over to the exposition, the air, steam and electricity will be supplied free. This applies to boilers, engines, compressors, ice machines, gas producers, machine tools, etc., which may be placed as exhibits in the service of the exposition.

Fuel oil will be supplied in part from stills in a model oil exhibit, which will be located in a building east of the palace of machinery and operated by the United States Government. Engine tests will be made on the different grades of refined oil coming from this interesting exhibit which will be open to the public. A large number of manufacturers are arranging to send their expert shop men with the exhibits so that the public may gain a clear idea of the efficient methods by which the finished products are made. The latest types of conveying machinery will be so arranged and the construction and operation so clearly shown that the carrying of small packages, as well as large and bulky boxes on the same conveyor to any height or distance will be as well demonstrated as it would be in a modern and up-to-date factory. Working exhibits of the latest type of hydraulic motors, such as impulse wheels and turbines, with the necessary regulating and control apparatus will be shown connected with pumps and electric generators with the working parts of the wheels and turbines exposed through glass plates.

In the palace of mines and metallurgy will be intensely interesting exhibits of all phases and features of the mining and metallurgical industries. The United States Steel corporation and its subsidiary companies intend having a comprehensive exhibit of its operations and will begin with the ore fields and carry on an educative picture of its operations in ore mining, rail and water transportation, dock operations, coal, coke and pig-iron production, steel manufacturing in its various lines, and will also present the processes of manufacturing of many of its subsidiary companies' products; also how it utilizes its by-products and the display of many of the uses in which its general products are employed, typifying the advancement in uses of this country's resources.

Two hundred and thirty-six national and international organizations have already accepted the invitation of the exposition to hold their 1915 conventions in San Francisco, and many thousand visitors will thus attend as delegates and representatives of these organizations.

VANADIUM STEEL FOR BLOW-PIPE HEADS

An interesting characteristic of chrome-vanadium steel has been demonstrated by tests made on blow-pipes used in glass factories by glass blowers. The pipes used by incandescent lamp manufacturers have been soft steel or Norway iron, inasmuch as they are easy to weld and do not oxidize rapidly. But blow-pipes made of common steel or iron must be frequently repaired, because the hot glass clings to them so tightly that they have to be hammered to remove it, but not so with chrome-vanadium steel. The glass cracks off freely and consequently the repairs on the chrome-vanadium steel pipes are less than on pipes made of iron or machinery steel.

* * *

PERSONALS

Jesse W. Reno of New York was awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute, for his escalator.

E. K. Morgan has been promoted from the position of foreman to superintendent of the Rockford Drilling Machine Co., Rockford, Ill. Mr. Morgan takes the position of John S. Langwill, lately deceased.

F. C. Kent, formerly general superintendent of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., is now connected with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, in the capacity of works manager.

Dudley A. Johnson has been made manager of the Chicago branch of the Joseph Dixon Crucible Co., succeeding the late Sam Mayer. Mr. Johnson was assistant to Mr. Mayer for a number of years and has had extensive experience in the lead pencil and stationery business with other concerns.

Adolph Spielman, inventor of an electrically-driven portable machine for cutting cloth up to 150 thicknesses to any desired pattern at one time, was awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute.

Charles Eisler, for the past two years employed as designer of general tools and special machinery by the United Incandescent Lamp & Electrical Co., Ujpest, Austria-Hungary, and previously as general tool-room foreman with the Metzger Motor Car Co., Detroit, Mich., has taken a position as special machine designer with the Westinghouse Lamp Co., Bloomfield, N. J.

Thomas H. Mirkel, Jr., formerly general manager of the Southwark Foundry & Machine Co., Philadelphia, Pa., and for the past four years vice-president and general manager of the Poole Engineering & Machine Co., Baltimore, Md., joined the Treadwell Engineering Co., Easton, Pa., July 1. Mr. Mirkel will represent the company in Philadelphia and vicinity, and will have offices in the Mutual Life Bldg., Tenth and Chestnut Sts., Philadelphia.

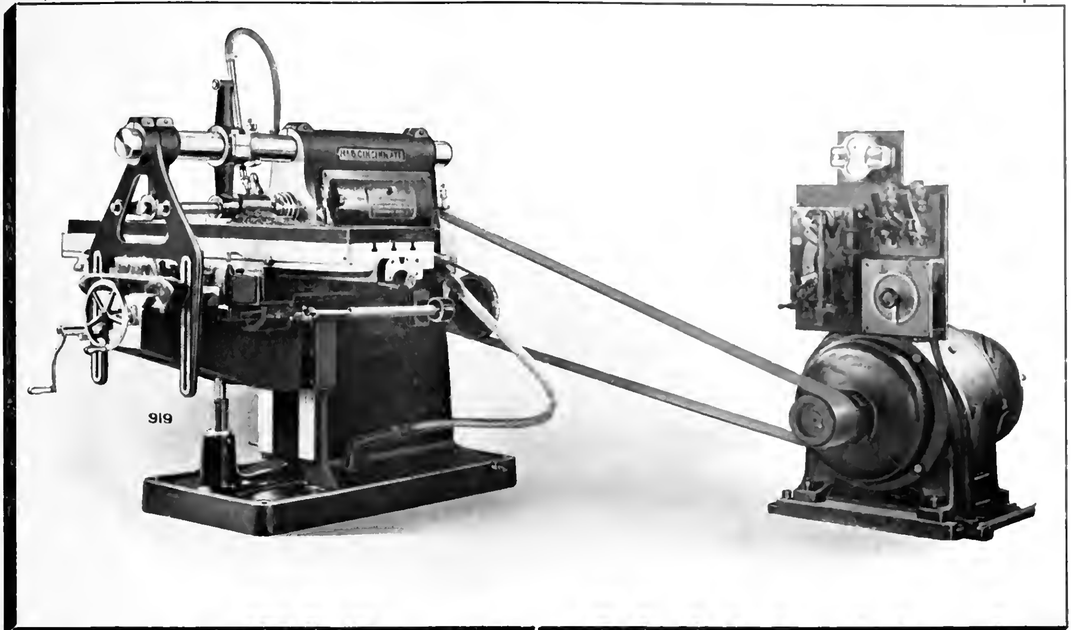
Henry J. Marks, manager of the New York office of the American Engine & Electric Co., has been made sales manager of the company. Mr. Marks is a member of the American Society of Mechanical Engineers, and of other engineering societies, and has had about twenty years active experience in the operation, manufacture, design and sale of steam engines. He will divide his time between the New York office, 90 West St., and the main office of the company at Bound Brook, N. J.

Charles S. Batdorf of New York was awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute, for his coin counting and wrapping machine, which accurately counts and wraps coins of one, five, ten, twenty-five or fifty cent denominations into crimped cartridges containing twenty, twenty-five, forty or fifty coins as desired. The machine handles 350 coins a minute and automatically rejects counterfeit coins.

Albert Pott, sales manager, Baird Machine Co., Bridgeport, Conn., sailed July 15 on the steamship *France* for a two months' trip through Great Britain and France, to visit the company's foreign representatives and to get in touch with foreign trade in general. The company has experienced a revival of its foreign trade in the past few months, and Mr. Pott is making the trip at this time in order to become thoroughly acquainted with any new phases of foreign business, and to provide for its extension.

Albrecht F. Leue, recently purchasing agent of the Triumph Electric Co., Cincinnati, Ohio, resigned June 30 to enter upon the practice of law. Mr. Leue was born in Cincinnati in 1877, and graduated from the University of Cincinnati in

Milling Extraordinary



THE Cincinnati No. 5 Plain High Power Milling Machine has removed as high as 37½ cubic inches of steel per minute — the heaviest recorded cut ever handled by a Knee and Column Milling Machine—and not once nor twice only; this was a frequent performance in our Demonstrating Room during a period of nine months. This is MODERN MILLING!

"Stream Lubrication," the patented Cincinnati Work and Cutter Cooling System, makes this heavy cutting not only possible, but practical. The essential factor is the hood which keeps the cutter in an inverted bath, effectually cooling every part of it.

"COLD CHIPS" tells the whole story. You should send for a copy. There is something of interest on every page.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

1898. He entered the employ of the Triumph Electric Co. in January, 1900, being engaged successively in the stock, order, correspondence and advertising departments; he has been purchasing agent since April, 1906. He studied law at the Y. M. C. A. night law school, Cincinnati, and was admitted to the Ohio bar in 1905. It is Mr. Leue's intention to give special attention to commercial and corporation law work.

* * *

OBITUARIES

Charles S. Barton, president of the Rice, Barton & Fales Machine & Iron Co., Worcester, Mass., died July 11 of a cancer in the throat, aged fifty-six years.

John S. Langwill, superintendent of the Rockford Drilling Machine Co., Rockford, Ill., died June 22 from cerebral hemorrhage, following an illness of about three months. He is survived by his widow and one child.

Morris G. Loder, sales manager of the Carborundum Co.'s branch store in Cleveland, Ohio, died after a long illness July 9 at his home in Cleveland, aged forty-one years. He was born at Strongsville, Ohio, near Cleveland. For some years he was connected with the purchasing department of the Deering Harvester Co., Chicago, Ill., and entered the employ of the Carborundum Co. as sales manager of the Cleveland branch store in 1902. He is survived by Mrs. Loder, his mother, three brothers and a sister.

COMING EVENTS

September 5-11.—Foundry and machine exhibition, showing machinery, tools, equipment and supplies for the foundry and machine shop, Chicago, Ill. C. E. Hoyt, secretary, Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 15-18.—Twenty-second annual convention of the Traveling Engineers' Association at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Central Car Shops, East Buffalo, N. Y.

September 17-22.—Autumn meeting of the Iron and Steel Institute in Paris, France. Offices of secretary, 28 Victoria St., London, S. W., England.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

Upper Iowa University, Fayette, Iowa. Catalogue 1913-1914.

University of Utah, Salt Lake City, Utah. Catalogue for 1914-1915, and announcements for the School of Arts and Sciences, School of Education, State School of Mines, School of Medicine and School of Law.

National Association of Corporation Schools. Papers, reports and discussions of the first annual convention, Dayton, Ohio, September 16-19, and proceedings of the organizing convention, New York City, June 24, 1913. 438 pages, 6 by 9 inches. Lee Galloway, secretary, New York University, New York City.

Johns Hopkins University, Baltimore, Md. Five lectures by Logan G. McPherson, as follows: "The Economic Transition," "Railway Competition and Combination," "Government Ownership of Railways," "The Valuation of Railways," and "The Service of Accounts and Statistics." 110 pages, 6 by 9 inches.

American Institute of Metals. Transactions of the seventh annual meeting held in Chicago, Ill., October 13-17. Edited by W. M. Corse, secretary. 381 pages, 6 by 9 inches, exclusive of bulletins 20 to 26, containing abstracts of metallurgical patents, notes and reports during 1913, together with a list of members. Published by the American Institute of Metals, Buffalo, N. Y. W. M. Corse, secretary and treasurer, 106 Morris Ave.

NEW BOOKS AND PAMPHLETS

Report of the Commissioner of Education for the Year Ending June 30, 1913. Volume I. 931 pages, 6 by 9 inches. Published by the United States Bureau of Education, Washington, D. C.

Acoustics of Auditoriums. By F. R. Watson. 34 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin 73.

International Conference of Mine-experiment Stations. By George S. Rice, 99 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 82.

Lumbering Industry of the Philippines. By John R. Arnold. 22 pages, 6 by 9 inches. Published by the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C., as Special Agents Series, No. 88.

The Effect of Titanium on the Magnetic Properties of Iron. By Kenneth P. Applegate. 19 pages, 6 by 9 inches. Published by the Department of Electrical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., Engineering and Science Series, Bulletin 5.

Relative Effects of Carbon Monoxide on Small Animals. By George A. Burrell, Frank M. Seibert and I. W. Robertson. 23 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 62.

Investigations on Drain Tile. 112 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin 36, authorized by the American Society for Testing Materials.

Effect of an Iron Core on the Secondary Currents of a Telephone Transformer. By Eugene C. Helwig. Published by the Department of Electrical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., as Engineering and Science Series Bulletin 6.

The Electrical Resistance and Temperature Coefficient of Copper-Nickel-Manganese Alloys. By George L. Gray. 26 pages, 6 by 9 inches. Published by the Department of Electrical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., as Engineering and Science Series Bulletin 4.

Metric-English and English-Metric Lengths. By G. A. Rosetti. 80 pages, 3½ by 4 inches. Published by E. & F. N. Spon, London, and Spon & Chamberlain, New York City. Price, 40 cents.

This useful work gives equivalents in millimeters (to five significant figures) of English lengths from 1/64 inch to 10 feet, advancing by 1/64 inch; and equivalents to the nearest 1/64 inch of all metric lengths from 1 to 3200 millimeters, advancing by millimeters.

The Tractive Resistance of a Twenty-eight-ton Electric Car. By Harold H. Dunn. 53 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 74.

The bulletin records the results of tests made with a twenty-eight-ton electric car of the double-end type for the purpose of determining the resistance offered to its motion when running on straight level track in still air at uniform speed, and to ascertain the relation existing between that resistance and the speed of the car.

Location of Motorcycle Power Plant Troubles Made Easy. Chart arranged by Victor W. Page. Size, 31 by 22 inches. Published by Norman W. Henley & Son, New York City. Price, 25 cents.

This chart contains a sectional view of the power plant of a motorcycle, the name of each part being plainly indicated. The descriptive part of the chart contains a list of the common derangements that interfere with the proper action of the engine and auxiliary systems, enabling the user to discover quickly the trouble under different conditions.

Link Motion, Valve Gears and Valve Setting. By Fred H. Colvin. 101 pages, 4 by 6 inches. 45 illustrations. Published by Norman W. Henley & Son, New York City. Price, 50 cents.

This practical work on locomotive valve motion was first published in 1905, and the present edition is the third enlarged and revised. Contents by chapter heads are Locomotive Link Motion; Valve Movements; Setting Slide Valves; Analysis by Diagrams; Modern Practice; Slip of Link Block; Slide Valves; Piston Valves; Setting Piston Valves; Other Valve Gears (comprising Joy-Allen, Gooch, Allfree-Hubbell, Walschaerts, Baker, and Southern).

Fitchburg Plan of Cooperative Industrial Education. By Matthew R. McCann. 28 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Education, Washington, D. C., as Bulletin 1913, No. 50.

The bulletin describes the successful high school cooperative course begun in Fitchburg, Mass., in 1908, in which high school students work in the shops one week and go to high school the following week, alternating with another student so that the places in the shop and the school are constantly filled. This method has proved so successful that it has been widely noticed and is known generally as the "Fitchburg plan."

Methods of Oil Recovery in California. By Ralph Arnold and V. R. Garfias. 57 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 70, Petroleum Technology 16.

The report was published by the Bureau of Mines, as one of a series describing the investigations conducted by the bureau in an effort to minimize waste in the production of petroleum from lands belonging to or controlled by the United States government. It treats of the factors controlling production, recoverable oil, oil pumping, plunger pumps, air lifts, bailing, swabbing, tunneling, generation and distribution of power, including steam engines, gas engines, electric motors and windmills.

Mechanical Movements, Devices and Appliances. By Gardner D. Hiscox. 409 pages, 6 by 9 inches. Published by Norman W. Henley & Son, New York City. Price $2.50.

This treatise, describing mechanical movements and devices used in machinery, which is practically a mechanical dictionary, was first published in 1899. It has been well received and the present edition is the fourteenth enlarged. The scope of the work is indicated from the fact that 1890 movements are illustrated and briefly described under the following heads: The Mechanical Powers, Transmission of Power, Measurement of Power, Steam Power, Steam Appliances, Motive Power, Hydraulic Power and Devices, Air Power Appliances, Electric Power and Construction, Navigation and Roads, Gearing, Motion and Devices Controlling Motion, Horological, Mining, Mill and Factory Appliances, Construction and Devices, Drafting Devices, Miscellaneous Devices.

Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo. By Trygve D. Yensen. 73 pages, 6 by 9 inches. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 72.

The efficiency of electrical machinery depends largely upon the magnetic quality of the iron used in the pole pieces and armatures. Many investigations have been conducted with a view to decreasing the hysteresis and eddy current losses of iron and to increase its permeability. The bulletin records the results obtained by melting electrolytically refined iron in a vacuum furnace. It is possible by this means to obtain iron with a carbon content of 0.01 per cent or less without oxidation of the iron. The maximum permeability of this iron at ordinary temperatures is shown to be 19,000, occurring at a flux density of 9500 gausses. The hysteresis loss is from one-half to one-third of that for the best transformer steel used at the present time.

Methods of Machine Shop Work. By Frederick A. Halsey. 286 pages, 6 by 9 inches. 285 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.50.

This interesting and valuable book contains the substance of a number of lectures delivered by the author before the students in mechanical engineering at Columbia University during the past three years. These lectures were published in the belief that they would prove useful elsewhere in the trade as well as in engineering schools and to apprentices. The volume presupposes a fair knowledge of the common machine tools and their general construction, use and application, such as an apprentice would have acquired during one or, at most, two years' work in a modern machine shop. The chapters are headed as follows: Two Systems of Machine Production; Precision Work and Workmanship; Measures of Length; Measurement of Errors; Gages, Fits and Limits; Driving Systems for Machine Tools; Turning and Boring; Floorplate Work; Drilling; Milling; Gear Cutting and Grinding. The book gives a good general idea of the most important machine shop methods and operations. It is to be regretted that ten pages of Chapter III are devoted to an attack on the metric system, a digression hardly warranted in a work of this kind.

Motorcycles, Side Cars and Cycle Cars. By Victor W. Page. 550 pages, 5 by 7¼ inches. 350 illustrations. Published by Norman W. Henley & Son, New York City. Price, $1.50.

This book deals with the construction, management and repair of motorcycles and cycle cars. The subject is handled as far as possible in a non-technical manner, and while some technical information and data are given, the material for the most part is of a practical nature and should be readily assimilated and understood by anyone. The instructions given for the control, maintenance and repair of the machines dealt with should be valuable to any user of motorcycles or cycle cars, and the discussions of mechanical principles will appeal to a still wider circle of readers, including dealers and those connected with the trade in various capacities. An effort has been made to discuss the salient points of representative domestic and foreign makes and to show clearly the mechanical points and distinctive features of each. The book is divided into eight chapters, headed as follows: Motor Cycle Development and Design; Motor Cycle Power Plant Group; Construction and Design of Engine Parts; Lubrication, Carburetion and Ignition; Power Transmission System Parts; Design and Construction of Frame Parts; Constructional Features of Cycle Cars; Motorcycle Maintenance, Operation and Repair.

Brass-Furnace Practice in the United States. By H. W. Gillett. 298 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 73, Mineral Technology 14.

The bulletin records the investigations made by the Bureau of Mines, with a view of eliminating waste in America's miscellaneous mineral industries. There are in America about 3600 plants melting brass and bronze, and 1000 of these melt

nonferrous alloys exclusively. It was shown that in the melting of nonferrous alloys 90 to 95 per cent of the heat units in the fuel do no useful work. On the basis of $120,000,000 being the value of the metal melted each year a 2½ per cent melting loss, equivalent to 5 per cent loss on metal bought means an annual loss of $3,000,000 in metal alone. Reducing the average metal loss to that of the present best practice would mean a saving of over $1,500,000 a year. The bulletin treats of the magnitude of the brass industry; the general types of furnaces in use; describes pit furnaces; natural-draft, pit, coke or coal furnaces; forced-draft coke or coal pit furnaces; oil or gas pit furnaces with burners; tilting furnaces; tilting forced-draft coke furnaces; tilting oil furnaces; open flame tilting furnaces; reverberatory furnaces; cupola furnaces; and semiproducer furnaces. Possible improvements in furnaces and accessories are discussed. The causes of disease and danger, and essentials for health and safety are also dwelt upon, forming an important and valuable conclusion to the work.

Spur and Bevel Gearing. 306 pages, 6 by 9 inches, 142 engravings. Published by the Industrial Press, New York City. Price, $2.50.

During the past six years MACHINERY has published over 125 25-cent reference books. These well-known books include the best of the material that appeared in MACHINERY during the past years. Many subjects, however, cannot be adequately covered in all their phases in books of this size, and in order to meet the demand for more comprehensive and detailed treatments on the more important mechanical subjects, it has been deemed advisable to bring out a number of larger volumes, each covering one subject completely. The book under review is one of these volumes. In bringing out this book the first consideration was to make its contents meet the practical needs of the machine building trade. Mere theory and academic discussions have been avoided. The rules, formulas and instructions are illustrated whenever practicable, and examples are given to show applications to everyday problems. Theoretical considerations, however, have not been neglected in cases where they are necessary to fully explain a practical process. Hence, this book on spur and bevel gearing is a treatise on both the practice and the theory along such lines as will make it especially useful to practical men. The book contains fifteen chapters headed as follows: Principles and Dimensions of Spur Gearing; Materials used for Gears; Strength and Durability of Spur Gearing; Simplified Formulas for Strength of Gears; The Stub-tooth Gear; Noisy Gearing; The Design of Spur Gearing; Methods of Cutting Spur Gear Teeth; Production and Heat-treatment of Gears; Bevel Gear Rules and Formulas; Strength and Design of Bevel Gears; Methods for Forming the Teeth of Bevel Gears; Milling the Teeth in Bevel Gears; Long and Short Addendum Gears; Skew Bevel Gears.

NEW CATALOGUES AND CIRCULARS

Cutler-Hammer Clutch Co., Milwaukee, Wis. Bulletin 15020 on magnetic couplings, clutches and brakes for rubber mill service.

James Clark, Jr., Electric Co., 520 W. Main St., Louisville, Ky. Leaflet showing "Willey" direct- and alternating-current sensitive drills.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue S of "Brownhoist" suspended concrete bins for coal, ashes, ore and other materials.

William Gaertner & Co., 5345-5349 Lake Park Ave. Chicago, Ill. Catalogue of universal laboratory supports, balances, weights, glassware and supplies.

J. Davidoff, 563 Forty-eighth St., Brooklyn, N. Y. Circular of the Davidoff automatic driving belt, clutch and cam protector for preventing accidents on type-setting machines.

Yale & Towne Mfg. Co., Stamford, Conn. Pamphlet entitled "Safety First" illustrating and describing a simple device for the prevention of accidents on power presses.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Leaflet treating of the operating principle of S. K. F. ball bearings and the advantages to be secured through their use.

Marvin & Casler Co., Canastota, N. Y. Leaflet descriptive of rotary center indicator, an instrument designed to indicate quickly and accurately the center or axis of a rotating spindle or shaft.

Kasenit Ltd., 8-9 Ludgate Square, Ludgate Hill, London, England. Circular of the Keen impact ball tester described in the July, 1913, number of MACHINERY. Kasenit Ltd. is marketing the tester abroad.

Newark Gear Cutting Machine Co., 67 Prospect St., Newark, N. J. Leaflet advertising "Newark" gears. This company makes gears of all kinds of the highest degree of precision, for heavy duty and for ordinary work.

Warner & Swasey Co., Cleveland, Ohio. Catalogue of No. 4 universal turret screw machine for manufacturing duplicate parts from bar stock, castings and forgings. The machine is provided with power traverse for both carriage and turret simultaneously.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 4 discusses the importance of large die opening and shows how this effects economy in the forging machine. National heavy-pattern forging machines are made with four-five- and six-inch die openings.

F. W. King Optical Co., Euclid Arcade, Cleveland, Ohio. Circular of the "I-Safe" goggle for workers in steel works, foundries, machine shops and wherever eyesight is endangered by flying particles; also of colored glasses for electric arc and oxy-acetylene welding operators, etc.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-N, describing class "N" "Chicago Pneumatic" steam and power driven enclosed compressors. Simplicity, rigidity, exceptionally large bearing surfaces, automatic lubrication and indestructible flat disk valves are the salient features of this type of compressors.

Stow Mfg. Co., Binghamton, N. Y. Catalogue 14, 96 pages, 6 by 9 inches, describing the general line of portable tools of this company's manufacture, including flexible shafts, drill presses, tapping and reaming machines, grinders, motors and electric drills, boring machines, etc. The company also makes motors and grinders of the stationary type.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48901, describing the construction and giving dimensions of electric winches and winding drums. These machines are designed for use on work for which the ordinary overhead hoist is not adapted. The application for hauling cars, locomotives in repair shops, and heavy trucks up inclines at ferries, is illustrated.

Joseph T. Ryerson & Son, Chicago, Ill. Bulletins 9071 and 13071, illustrative of the Ryerson high-speed friction saw and the Lennox serpentine shear, respectively. Books Nos. 4 and 8 of the Technical Library Series, treating of internal furnace boilers with Morison corrugated furnaces, and concrete reinforcing, respectively. The last book shows steel bars, expanded metal and corrugated sheet steel centering used in reinforcing concrete.

Allen-Bradley Co., Milwaukee, Wis. Bulletin B-571 illustrating type CR speed regulators for reducing the speed of two- and three-phase slip ring motors and containing tables of dimensions and prices. The features claimed for this device are compactness, overload capacity, and infinite speed adjustment between minimum and full speed of motor, regardless of load. The company will gladly furnish additional details to those interested.

Cleveland Twist Drill Co., Cleveland, Ohio, has issued a special anniversary number of its monthly house organ "Drill Chips" which contains an interesting description of the making of a twist drill, from the inspection of the bar stock in the laboratories to the testing of the finished product. The booklet is illustrated with views taken in the plant of the Cleveland Twist Drill Co., and the information contained is of considerable general interest.

Colburn Machine Tool Co., Franklin, Pa. Bulletins 68, 69, and 71, illustrating and describing Colburn vertical boring and turning mills of 42, 48, and 60-inch capacities, respectively. Bulletins 55, 67 and 70, treating of special attachments for Colburn boring mills including pulley crowning attachment, faceplate jaws and chucks, adjusting and safety devices, etc. Bulletins 53, 62, and 64 on Colburn D-5 heavy-duty drill press of 36-inch swing and attachments.

Tate-Jones & Co., Inc., Pittsburg, Pa. Catalogue on heat-treating furnaces, telling of the uses, features of construction and points of advantage of Tate-Jones annealing, packhardening, casehardening, general hardening, muffle, lead hardening, crucible oil-tempering and other furnaces. The various types of furnaces are illustrated and tables giving stock sizes of each are included. The book is an attractive publication, illustrated with good half-tones and tastefully arranged.

Halcomb Steel Co., Syracuse, N. Y. Booklet on "Ketos" tool steel, containing 49 pages, 4¼ by 8 inches. "Ketos" steel is of especial value for use in intricate tools where the labor cost greatly exceeds the cost of the steel. The features claimed for it are durability, keen cutting power, and non-shrinkage and non-warping properties. The book is illustrated with views showing a number of intricate tools made from "Ketos" steel without distortion, warping or cracking troubles.

Link-Belt Co., Chicago, Ill. Section A of catalogue 110 on Ewart detachable link-belt, and sprocket wheels, containing complete information on detachable link-belt and illustrated with halftones made from unretouched photographs of chain links, full size. Rules for obtaining the working strains and horsepower of link-belts are given, and directions for determining the position of link-belt on sprockets showing whether the hook or the bar of the chain should run first. Users of link-belt will find this sectional catalogue a valuable instruction book.

Colonial Steel Co., Pittsburg, Pa. Catalogue 13 descriptive of the process of manufacturing Colonial tool steel. 49 pages, 5 by 7 inches, printed in colors. The method of manufacturing tool steel is described step by step, and the illustrations show the iron being melted in the crucible furnace, drawing the ball, drawing off the slag, packing the crucibles, casting the metal into molds, stripping ingots from molds, hammering, and inspection. Information is also given on annealing, hardening and tempering carbon steels, and selecting tool steel.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Booklet outlining the company's plan of pensioning employes and its life insurance and vacation allowance systems. A fund is set aside by the company for payments on account of the pension, life insurance and vacation systems. Any employe who has reached the age of 65 and has been for twenty-five years continuously in the employ of the company may be retired on a pension. Employes may also be retired at 55 at the option of the company. Special provision is made for those engaged in hard physical service in the forge, blacksmith and polishing departments. All employes who have worked continuously for three or more years for the company are entitled to have insurance paid to their beneficiaries in case of death. Employes who have worked two or more years for the company are given one-half week's pay as a vacation allowance and those who have been five or more years with the company are allowed one week's pay.

Kearney & Trecker Co., Milwaukee, Wis. Catalogue on "Milwaukee" milling machines, 86 pages, 6 by 9 inches. This book contains a complete description of the line of milling machines and their various parts and attachments manufactured by this company. The "Milwaukee" milling machines are made in both horizontal and vertical types. A special feature of the horizontal type is the double over-arm which provides exceptional rigidity to the cutter and insures positive alignment of the arbors. The cascade system of lubrication is also an exclusive feature of the "Milwaukee" milling machines. The lubricant is stored in a reservoir at the bottom of the machine, and pumped to the top, from where it "cascades" down over all gears and bearings, providing a continuous system of lubrication. There is a separate lubricating system for the cutter, which operates only when the spindle is rotating. Special safety provisions have been made, all gears, belts, pulleys, etc., being carefully guarded.

R. K. Le Blond Machine Tool Co., Cincinnati, Ohio, has brought out a treatise on Le Blond milling machines, and milling practice. This book contains 220 pages, 6 by 9 inches, and sells at 50 cents per copy. It contains information on kinds of milling, feeds and speeds, cutter design, milling machine construction, care and adjustments of milling machines, dividing heads and systems of indexing, spiral cutting, and data on bevel, worm and spur gearing. The section on milling practice shows a variety of interesting examples of milling, including slab and face milling, form milling, surface milling, straddle milling and a great many special jobs. A number of tables giving the equivalents of millimeters in inches and inches in millimeters, Morse tapers, cutting speeds, decimal equivalents, angles for fluting spiral milling cutters, sines and cosines, tangents and cotangents, etc., are included. The table of leads obtainable with the change gears furnished with Le Blond spiral cutting head covers twenty-nine pages. This book should be of great value to all engaged in milling machine practice, and practically indispensable to those using Le Blond milling machines.

TRADE NOTES

Bosch Magneto Co., 223 W. 42nd St., New York City, has taken over the Rushmore Dynamo Works of Plainfield, N. J., which will be operated in conjunction with the company's factory in Springfield, Mass., in the manufacture of Bosch lighting and starting systems.

Adams-Campbell Co., Los Angeles, Cal., has just completed a modern factory building at 1730-1734 S. Los Angeles St., and will install additional equipment in shop, foundry and plating plant, for the manufacture of brass goods, sheet metal and wire novelties, for tool and die making and general machine work.

National Business Bureau, Fourteenth St. and Pennsylvania Ave., Washington, D. C., offers its services to corporations and various business interests in matters affecting trade conditions and business relations. The bureau advises its subscribers of all legislation, past, present and pending, affecting tariff, banking currency, income tax, etc.

Clipper Belt Lacer Co., 1020 Front Ave., Grand Rapids, Mich., shipped a carload of No. 2 "Clipper" lacers and hooks to its European agents, Schuchardt & Schutte, Berlin, Germany, the latter part of June. This was the company's first shipment abroad, and was placed through the efforts of W. K. Lee, who is spending some time in Europe in the company's interest.

Michigan Electric Welding Co., 514 Hart Ave., Detroit, Mich., has completed an addition of 4017 square feet area, making the total increase of floor area within the year 8070 square feet. Equipment has been added which increases the scope of the work. The company manufactures automobile parts and does butt and spot job welding. Drag links and brake rod assemblies are its specialties.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y., has organized a bronze department for the manufacture of titanium-bronze specialties under its various patents. William M. Corse, formerly works manager of the Lumen Bearing Co. of Buffalo, and lately general manager of the Empire Smelting Co., Depew, N. Y., will be associated with the company as manager of this new department.

Butterfield & Co., Derby Lane, Vt., and Rock Island, Quebec, are building an addition to their factory at Rock Island. The building will be 185 feet long, 60 feet wide and three stories high, and will be constructed of brick and concrete. A portion of the new structure will be used for manufacturing twist drills and milling cutters; it is hoped that the new factory will be in operation January 1, 1915.

H. A. Strauss Data-Card Service, Harris Trust Bldg., Chicago, Ill., has begun the publication of technical data cards 5 by 8 inches, which are intended to cover the entire field of engineering and the allied trades and sciences. The copy for the cards is done in India ink, free-hand. The cards are printed from zinc etchings reduced to the required size, and the data is thus presented in a very compact but readable style.

THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

MACHINERY

PUBLICATION OFFICES 140-148 LAFAYETTE STREET, CORNER HOWARD, NEW YORK

VOL. 20. NO. 12
ENGINEERING EDITION

AUGUST, 1914

$2.50 A YEAR
COATED PAPER

ADVERTISERS INDEX, PAGE 230—PRODUCT INDEX, 216-228

ENGINEERING EDITION

84 PAGES
$2.00 A YEAR

MACHINERY

PUBLISHED BY THE INDUSTRIAL PRESS
140-148 LAFAYETTE ST., NEW YORK CITY

SHOP EDITION

56 PAGES
$1.00 A YEAR

VOL. 20

CONTENTS FOR AUGUST 1914

NO. 12

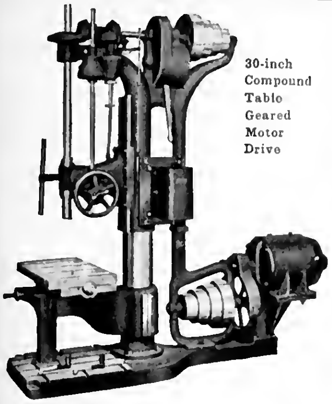
Classifying the Reader

One of the most interesting things about human beings is their variety. The moment you attempt to classify them specifically you find that your labels don't fit. Take the reader of MACHINERY for example. Each advertiser has a label in his mind, more or less definitely outlined, which, from his viewpoint, fits the average reader. We have no doubt that in general terms it does fit, but we know that the labels themselves differ, especially in the effort to define the habits and viewpoints of readers.

It is our business to know definitely not only *who* MACHINERY'S readers are, and *where* they are, but *what* they are. By which we mean that we must know their business and occupation as well as their name and address. In most cases we know who they are and their business or occupation long before they subscribe, because it is of the utmost importance for us to know it. The names of more than 90 per cent of new subscribers for MACHINERY *come out of our own working lists*, which is , we think, definite enough.

MACHINERY'S working lists are in two divisions. One division, comprising only principals and mechanical executives, contains nearly 65,000 names. The other, with nearly 180,000 names, is a list of designers, toolmakers, machinists and others variously occupied in the mechanical field. From the names in this list, MACHINERY'S mail-order work constantly segregates the intelligent, ambitious and progressive. Our readers are necessarily the brightest minds in the metal-working industries. The others neither read nor study and MACHINERY is not for them any more than Shakespeare is.

The labels which form unconsciously in the minds of our 470 advertisers agree in classifying the reader as a man engaged in mechanical work—proprietor, works manager, chief designer, master mechanic, foreman, head machinist, or by whatever titles the responsible men are designated. They differ only in trying to classify the reader rigidly as to his habit of reading advertising. Some read all the advertising regularly, but a great many, having familiarized themselves at one time or another with the tools advertised, read only the new points developed; while the busiest men in the field aim only to keep posted on the latest tools and practice and use the journal as a directory of the trade. No label fits them all. But the facts emphasize the vital importance to the advertiser of keeping his advertising always up to the highest standards, keeping it fresh and interesting and putting definite information into it.



30-inch Compound Table Geared Motor Drive

SNYDER DRILLS

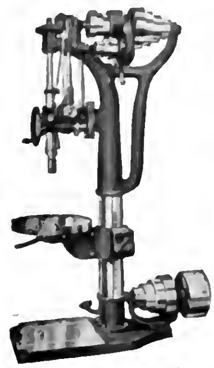
None better, and few equal. Accurate in Construction, Rigid in Operation, Great Time Savers in Production. They have met the demands for all purposes, at all times, in all countries for the past thirty years. We have sold thousands of them, and none have been returned. On these statements our reputation, established for thirty years, is based.

MANNING, MAXWELL & MOORE, Inc., Selling Agents

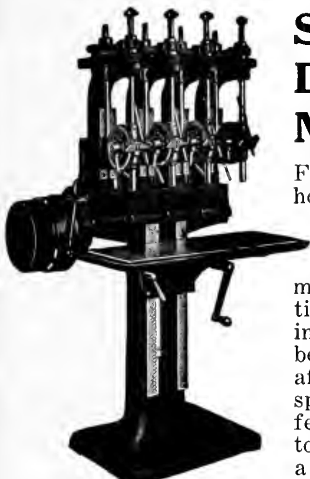
J. E. SNYDER & SON

WORCESTER, MASS.

Sizes 20", 21", 23", 25", 28", 30", 36" and 46"



23" B. G. and P. F.



Small Drills in Multiple

For drilling small holes, working fast and holding its accuracy, the Taylor & Fenn manufacturing Multiple Spindle Drilling Machine cannot be surpassed. It affords the right speed and the right feed for drilling up to 3/4" diameter, and a 1/2" hole one inch deep can be drilled in cast iron in four seconds. A series of gears and silent chains have proven much better and more efficient than belts for driving a machine of this type—they will not slip, there is less friction, and speed changes are more readily made.

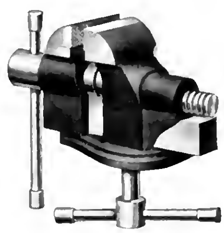
Send for specifications—ask for catalogue.

THE TAYLOR & FENN COMPANY

HARTFORD, CONN.

EUROPEAN AGENTS: E. Sonnenthal, Jr., Berlin, Cologne and Vienna. R. S. Stokvis & Zonen, Ltd., Rotterdam and Brussels. Alfred H. Schutte, Paris, Milan and Barcelona. Schuchardt & Schutte, Stockholm, Copenhagen and St. Petersburg. C. W. Burton, Griffiths & Co., London.

WALWORTH MAKES THEM



THE OLD RELIABLE WALWORTH VISE

Walworth Mfg. Co.

BOSTON, U. S. A.

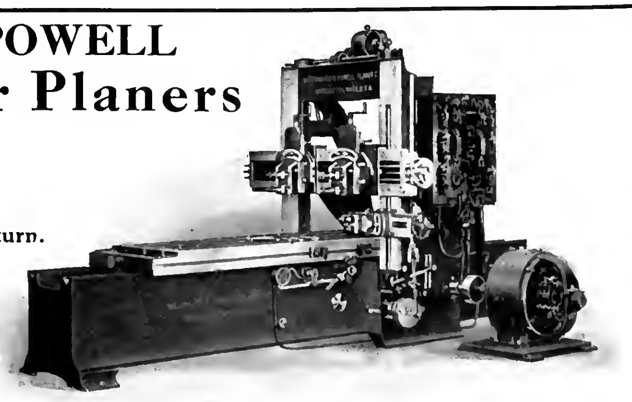
NEW YORK 42 Broadway

CHICAGO 15-21 So. Desplaines St.

WOODWARD & POWELL Reversing Motor Planers

ADVANTAGES

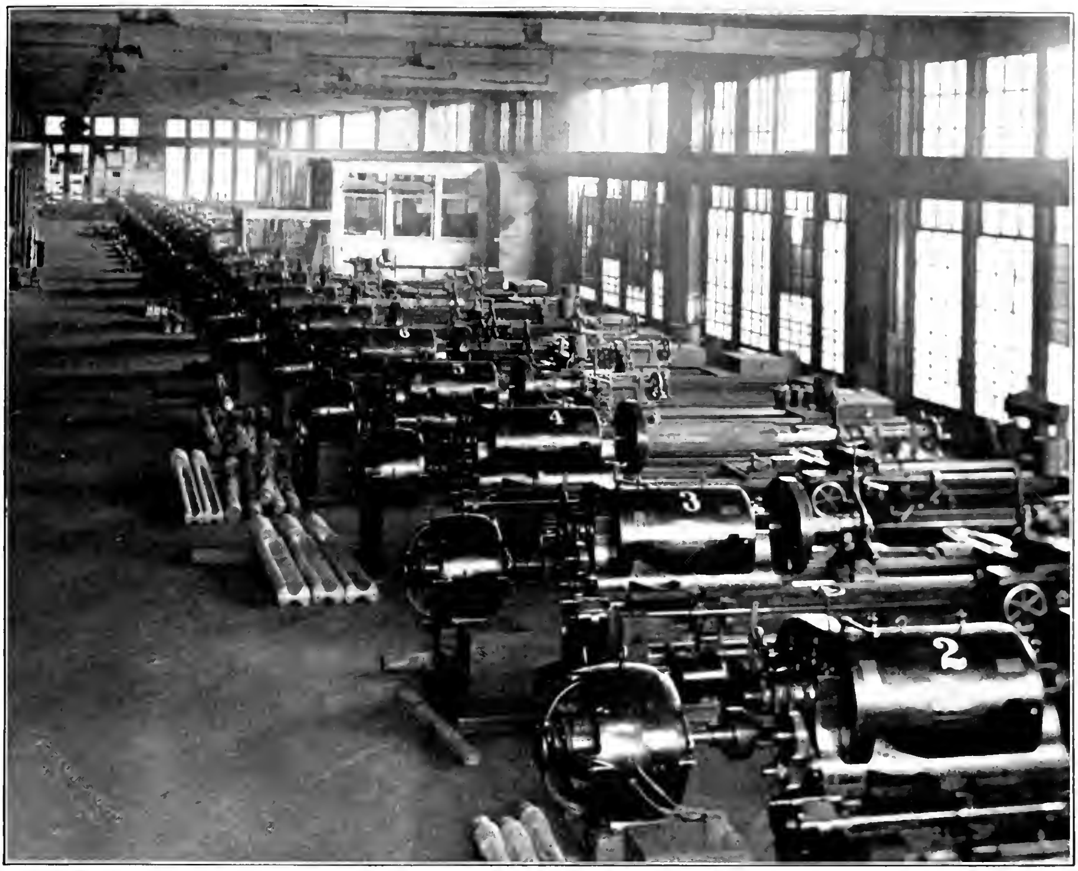
Elimination of belt slippage,
Increased output with less power,
Variable speeds on both cut and return.



Woodward & Powell Planer Co.

WORCESTER, MASS., U. S. A.

AGENTS: Manning, Maxwell & Moore, Inc., New York, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Milwaukee, Philadelphia, Pittsburgh, St. Louis, San Francisco. Alexander & Garsed, Charlotte, N. C. The Allied Machinery Co. of America, Paris, France; Brussels, Belgium.



The Oil Well Supply Co.,
Grant Hubley, Sec'y, Pittsburgh, Pa.,
writes as follows:

"The battery of twenty-five 27" Lodge & Shipley lathes as shown in the picture has been in service for four years, day and night, the output per lathe being materially increased, and the upkeep during these years has been practically nothing."

This bears eloquent testimony to the durability of Lodge & Shipley lathes and their value as manufacturing units.

THE LODGE & SHIPLEY MACHINE TOOL COMPANY

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS: Alfred Herbert, Ltd., Coventry, England, Berlin, Frankfurt, a M.; V. Lowener, Copenhagen, Christiania, Stockholm; Donauwerk Ernst Krause & Co., Vienna, Prague, Budapest; R. S. Stokvis & Zonen, Ltd. Rotterdam, R. S. Stokvis & Fils, S. A., Paris, Brussels; Schuchardt & Schutte, St. Petersburg, Helsingfors; W. Vogel, Milan; Schaufelberger Co., Zurich.
OTHER AGENTS: Andrews & George, Yokohama; Krajewski-Pesant Co., Havana; Mussens, Ltd., Montreal, Toronto, Quebec, Cobalt, Winnipeg, Calgary, Vancouver.

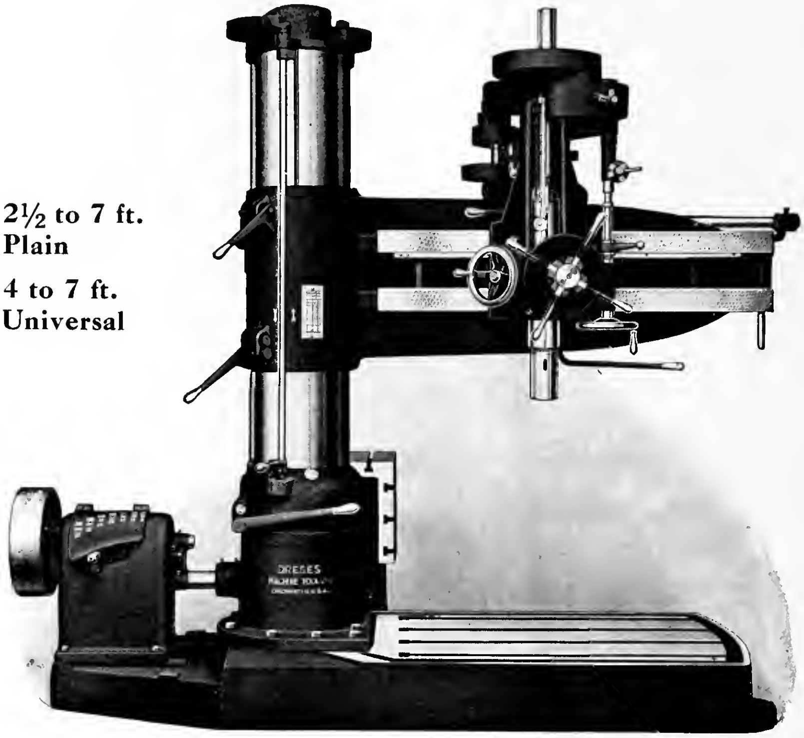
Originality in Design

DISTINGUISHES THE

New Line of "Dreses" Radials

**2½ to 7 ft.
Plain**

**4 to 7 ft.
Universal**



Here Are a Few of the New Features

Pulley shaft on speed variator has annular ball bearing, gears are of steel and hardened and run in oil baths.

Base has oil groove so designed to increase the working surface.

Column is greatly enlarged at lower end and has a third bearing in the middle, doubling the strength and rigidity.

Arm has double webbed box shaped lower rib, preventing twisting.

Head has a third bearing in the rear, adding to the support, preventing bending and straining of rear shaft and rapid wear of bevel gears and bearing. Friction bevel gears and worm wheel run in oil bath.

Quick return has four levers serving as pilot wheel to move spindle; each lever engages and disengages the feed.

Friction for starting, stopping and tapping is double expanding, powerful in gripping, easy to operate and adjust.

Steel gearing, hardened; phosphor bronze bushes; ball bearings in all places essential.

High spindle speeds.

Least friction and power consumption.

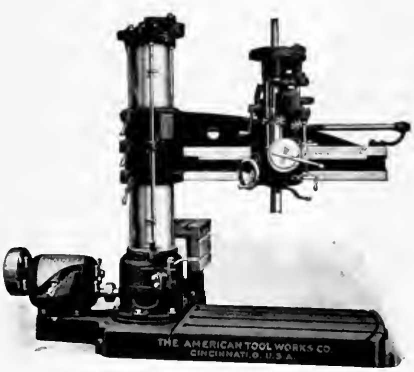
DRESES MACHINE TOOL CO.

CINCINNATI, OHIO, U. S. A.

REPRESENTATIVES: Manning, Maxwell & Moore, Inc., New York, Boston, Philadelphia, Cleveland, Chicago, Detroit, Atlanta, Mexico City; Carey Machinery and Supply Co., Baltimore; Baird Machinery Co., Pittsburgh; William C. Johnson & Sons Mchy. Co., St. Louis; Mine & Smelter Supply Co., Denver and Salt Lake City; Pacific Tool & Supply Co., San Francisco and Los Angeles; Schuchardt & Schutte, London, Berlin, Cologne, Vienna, Prague, Budapest and Stockholm; Moscow Machine Tool & Engine Co., Moscow; Stussi & Zweifel, Milan; R. S. Stokvis & Zonen, Rotterdam; R. S. Stokvis & Fils, Paris and Brussels; Shewan Tomes & Co., Shanghai, Peking and Canton; Pacific Engineering Co., Manila.

FEATURES

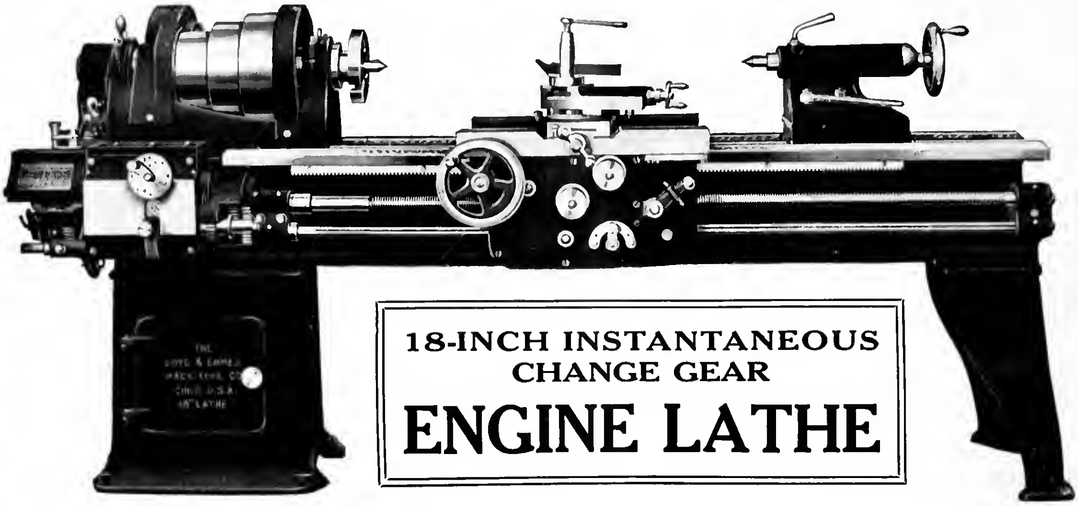
which make such results possible:
High initial driving power.
Patented Double Band Frictions in tapping mechanism.
Frictions run at higher speeds than on any other Radial.
Very high gear ratios.
STEEL GEARS throughout.
All Bearings BRONZE BUSHED.



OMPANY, CINCINNATI, U. S. A.

SHAPERS **RADIALS**

THE BOYE & EMMES MACHINE TOOL CO.



18-INCH INSTANTANEOUS CHANGE GEAR

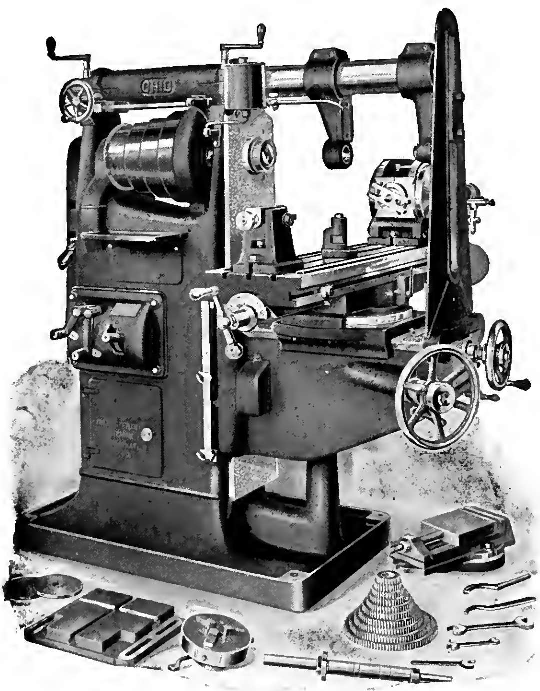
ENGINE LATHE

THREE-STEP CONE, DOUBLE BACK GEAR, permitting of a wide belt at a high velocity for high cutting speeds. DOUBLE PLATE APRON preventing all overhang and straining of studs and pinions. INSTANTANEOUS CHANGE GEAR DEVICE, all changes for feeds and screw cutting made without removing a gear and without duplication.

(MAXIMUM BELT PULL TRANSMITTED TO THE CUTTING TOOL)

THE BOYE & EMMES MACHINE TOOL CO.

ENGINE LATHES — Successors to Schumacher & Boye — CINCINNATI, OHIO, U. S. A.



A Challenge Without Limitation

We challenge you to put up any job on any Cone Type Milling Machine on the market today which cannot be equaled or bettered in every sense of the word on the new

"OHIO"

model Cone Type Miller of equal range under equal surrounding conditions. Ask us for particulars. Why not investigate?

The Oesterlein Machine Company

Manufacturers of Milling Machines, Universal Cutter and Tool Grinders

CINCINNATI, OHIO, U. S. A.

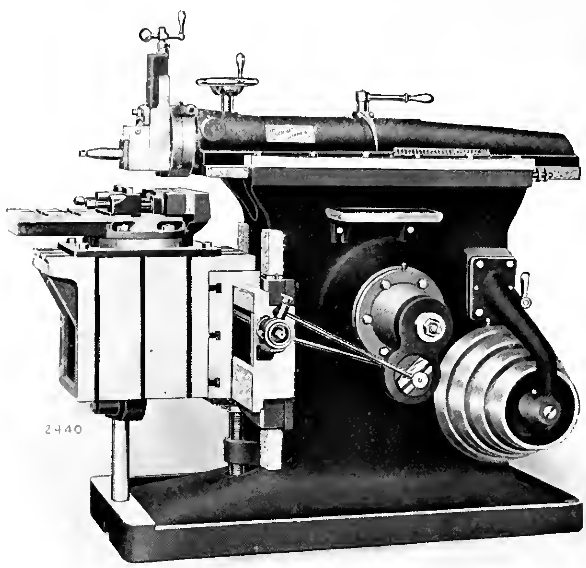
SHAPERS SHAPERS

SHAPERS SHAPERS

Rigid

Accurate Powerful

Catalogue G on Request



16", 20", 24" and 32", B. G. Shapers in Stock.

The Cincinnati Shaper Co.

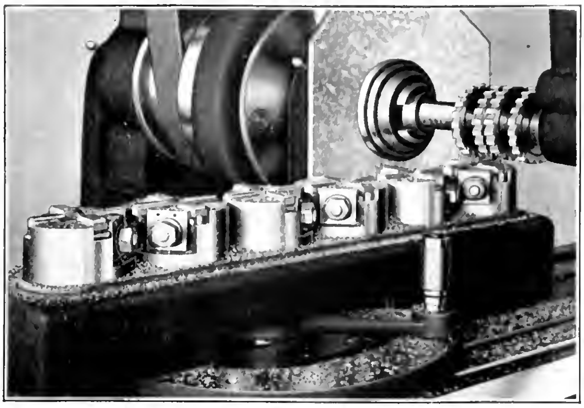
Cincinnati, Ohio

AGENTS. Manning, Maxwell & Moore, Inc., New York, Philadelphia, Chicago, Boston, St. Louis, Detroit, Cleveland, Buffalo, Milwaukee and Mexico City. Brown & Zortman Machinery Co., Pittsburgh. The National Supply Co., Toledo, Ohio. Eccles & Smith Co., San Francisco, Cal. Zimmerman-Wells-Brown Co., Portland, Oregon. C. T. Patterson Co., Ltd., New Orleans, La. Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. A. H. Schutte, Cologne-Deutz, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Prague and Budapest. McPherson's Proprietary, Ltd., Melbourne, Sydney. Andrews & George, Yokohama.

SHAPERS SHAPERS

SHAPERS SHAPERS

INTENSELY PRACTICAL



It doesn't require a "student of economics" to realize the practical working value of

THE LeBLOND RAPID POWER TRAVERSE

It has a cold dollars and cents appeal to the man who pays the bill.

The use of this feature enables the pieces illustrated to be finished at the rate of

40 SECONDS EACH.

Full Size Detail of Buttons

These pieces are milled from the solid in 40 seconds each. They are tough bronze buttons, to be used in ornamental iron work and are 1¼" long by ¾" wide (see full size detail). There are 8 milled surfaces on each piece. The cutters, 4" in diameter, run 240 R. P. M. at a feed of .041" per revolution. The fixture consists of a battery of six chucks, each holding four pieces or 24 at each loading. The chucks are indexed through 90 degrees with a single index crank. The cutters are so placed that one set of cutters finishes the ends of 2 pieces, while the other cutters are milling the length of the remaining pieces in the same chuck. After indexing through 90 degrees, the chuck is again passed under the cutters, completing the operations.

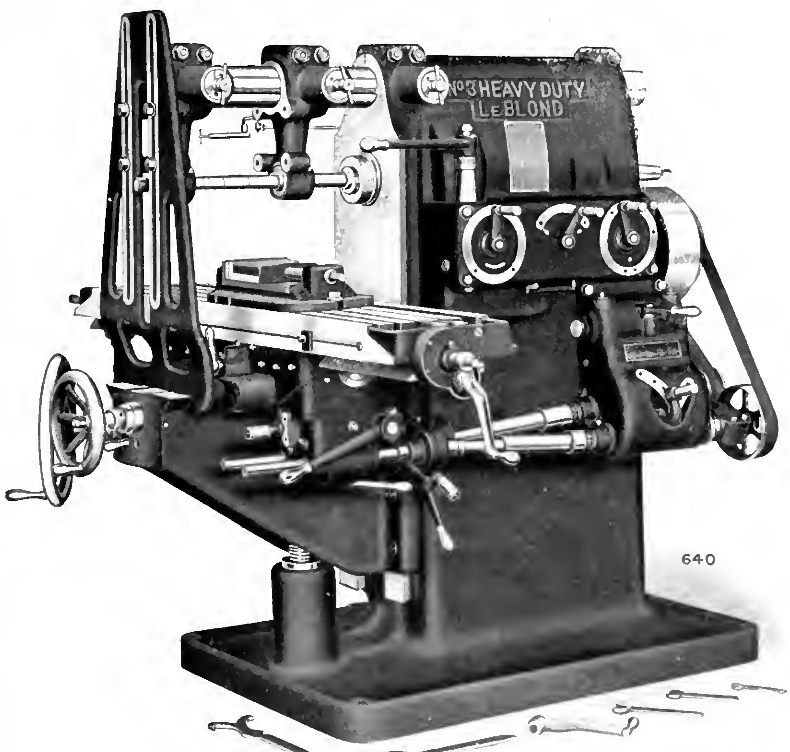
The table is returned and the space between the chucks traversed at the rate of 25 feet per minute by a movement of one lever.

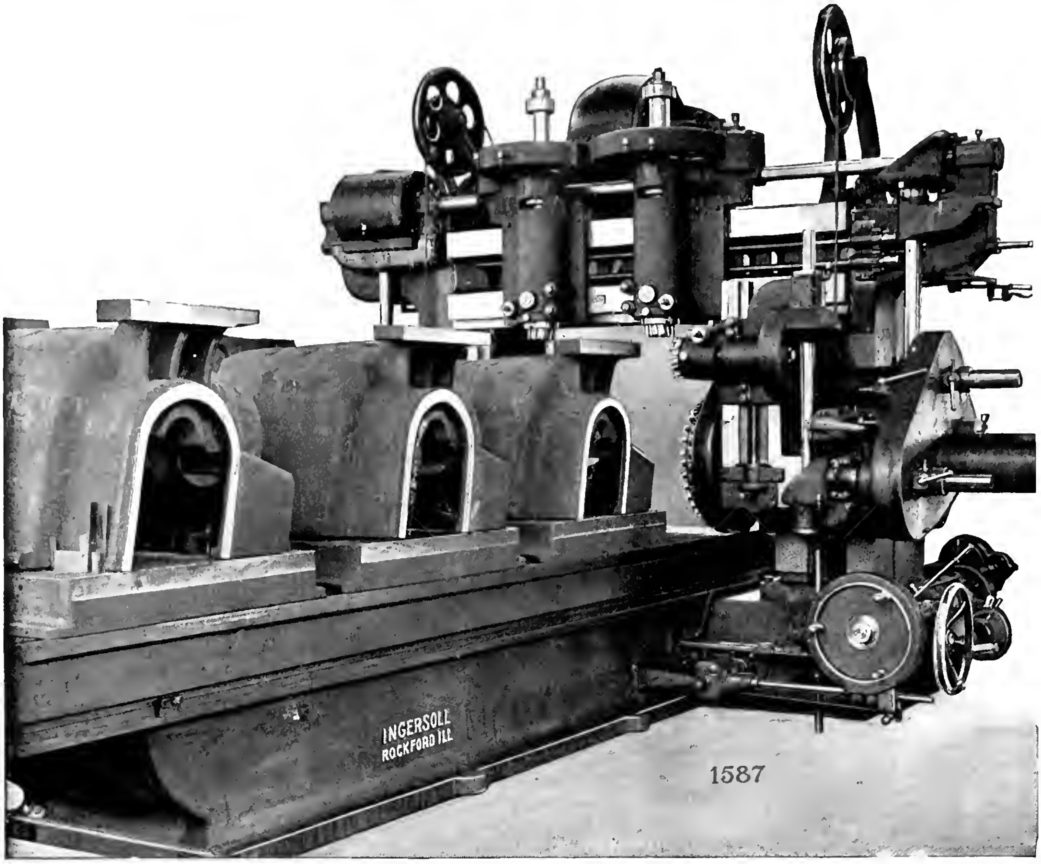
Apply the possibilities of this intensely practical machine to your work.

A miller not equipped **with the LeBlond Rapid Power Traverse** could never equal this production.

THE R. K. LeBLOND MACHINE TOOL COMPANY

Cincinnati, Ohio





Milling Engine Frames for Traction Engines

The demand for internal combustion traction engines for farm purposes has in a very short period grown from practically nothing to tremendous figures. Of the machine tools which have enabled manufacturers to meet this ever increasing demand, none has shown greater individual efficiency on duplicate work than the Milling Machine, and for finishing duplicate parts such as engine housings, frames, etc.—

THE INGERSOLL MILLING MACHINE

stands at the head. The work of these machines is at once a revolution and a revelation in manufacturing methods.

A recent installation is shown in the illustration—a 50″ x 16′ Five Spindle Ingersoll Milling Machine milling engine frames for the Rumley "Oil Pull Tractor"—and this is the third large Ingersoll Milling Machine to go into this plant. Repeat orders are concrete evidence that Ingersoll Milling Machines have not only made good but have become indispensable —in many places we have cut down planing time twenty-five to seventy-five per cent.

If you are interested in securing greater production and at the same time reducing cost of production, write us your requirements—no expense nor obligation attached. We should be glad to tell you what an Ingersoll Milling Machine would do on your work.

We specialize on Milling Machines exclusively.

THE INGERSOLL MILLING MACHINE COMPANY

Main Office and Works—ROCKFORD, ILL., U. S. A.

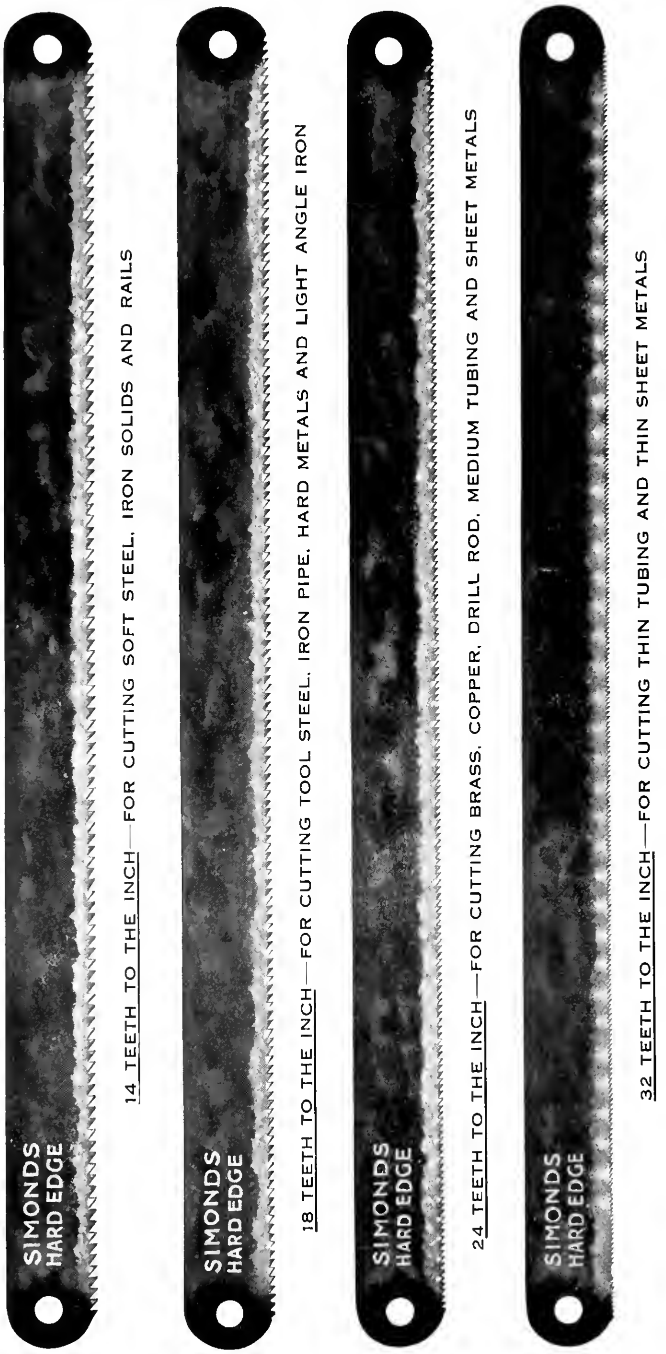
Eastern Office: 50 Church Street, The Walter H. Foster Co., Mgrs. Detroit Office: 827 Ford Bldg., H. C. Rose & Co., Mgrs.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. R. S. Stokvis & Zonen, Rotterdam, Holland. Fenwick Freres & Co., Paris, France. Schuchardt & Schutte, Yokohama, Japan.

SIMONDS

Hard Edge Hack Saw Blades

(NON-BREAKING)



Yes! Hack Saw Blades have made some great strides in quality in the past year or two.

Formerly they broke; the new Simonds Hard Edge Blades overcome that difficulty—**they are practically unbreakable.**

Think of what a tremendous advantage that is, especially when this blade for all general work will cut as much—and as fast—as the all-hard blades you have used.

It's the newest blade on the market—and the most economical; it lasts longer and **will save you fifty per cent on your hack-saw blade purchases** in a year's time over other kinds of blades.

Select the kind of blade you require for your work—for general purposes 18 teeth are the best—and order a gross on trial from your supply dealer; if he does not have them we will send them to you on receipt of price; 8-inch \$4.80, 9-inch \$5.40; 10-inch \$6.00, or 12-inch \$7.20. No man ever made money buying poor goods; buy the best.

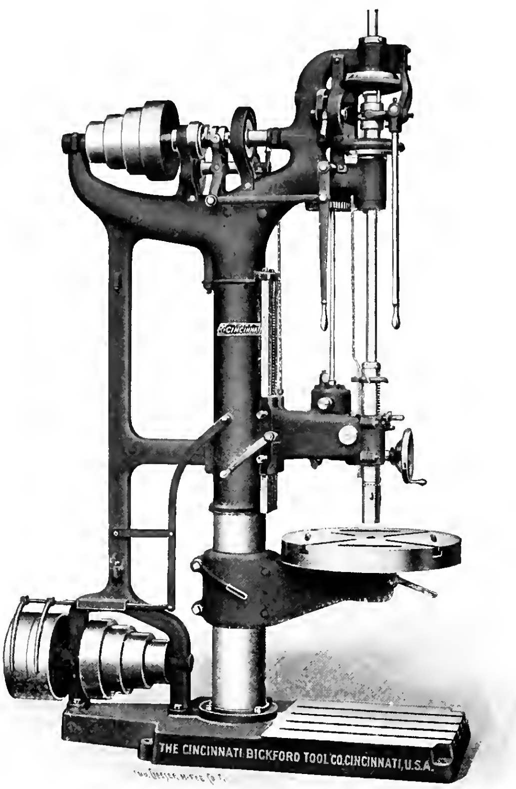
Simonds Mfg. Co.

Fitchburg, Mass.

40 Murray Street, New York

17th Street and Western Avenue, Chicago, Ill.

WE SAY THAT
WE ALWAYS ORIGINATE AND
Better Improvements Were Never Made on Upright Drills



THE CINCINNATI

20" to 42" Latest Design Heavy Pattern Upright Drill

NOTE:—The column, spindles, sleeves and shafts are accurately ground.

NOTE:—The bevel gearing, planed theoretically correct.

NOTE:—The patent positive geared feed, indexed, located directly on head.

NOTE:—The patent geared tapping attachment, located on spindle.

NOTE:—The friction back gears, for instantaneous engagement.

NOTE:—The auxiliary locking device for head.

NOTE:—The enlarged table and table arm bearings.

NOTE:—The choice of round, square or compound tables.

NOTE:—The choice of drives, cone, speed box, motor (geared or belted), or right angle.

NOTE:—Each size may be furnished in gangs from two to six spindles.

NOTE:—Complete catalog describes this entire line.

NOTE:—We manufacture nothing but drilling machinery in two distinct classes; one for the use of the regular twist drill to its limit of endurance; the other for high-speed twist drills to the point of their destruction.

THE CINCINNATI BICKFORD TOOL

DOMESTIC AGENTS: Prentiss Tool and Supply Co., New York City, Buffalo, Rochester and Syracuse, N. Y.; Boston, Mass.; Scranton, Pa. Marshall & Huschart Machinery Co., Chicago, Ill.; Indianapolis, Ind.; St. Louis, Mo.; Motch & Merryweather Mchy. Co., Cleveland and Cincinnati, O.; Detroit, Mich. W. E. Shipley Machinery Co., Philadelphia, Pa. Brown & Zortman Machinery Co., Pittsburgh, Pa. Harron, Rekard & McCone, San Francisco and Los Angeles, Cal. Robinson, Cary & Sands Co., St. Paul and Duluth, Minn. Hallidie Machinery Co., Seattle, Wash. The Hallidie Co., Spokane, Wash. C. T. Patterson .oC, Ltd., New Orleans, La. Dewstoe Machine Tool Co., Birmingham, Ala. Seeger Machine Tool Co., Atlanta, Ga. Kemp Machinery Co., Baltimore, Md. H. W. Petrie, Ltd., Toronto, Ontario and Montreal, Quebec, Canada. Taylor & Young, Ltd., Vancouver, B. C., Canada. General Supply Co., Winnipeg, Man., Canada. Zimmerman-Wells-Brown Co., Portland, Ore. Galligher Machinery Co., Salt Lake City, Utah. Hendrie & Bolthoff Mfg. and Supply Co., Denver, Colo. The Equipment Co., Kansas City, Mo. The Charlotte Supply Co., Charlotte, N. C.

The "GIANT"

No. 5—With a 4 7-8" Post

A Keyseater of the Right Design

Many of the keyseaters on the market are made especially for certain lines of keyseating, and must be adapted for other work as it comes. This Keyseater will cut a keyway in any piece of work, of any size or shape, and the work can be fastened and released in the time usually required by other machines for "getting ready." In this machine the work is fastened by the bore alone; the hub does not need to be faced and a quantity of parts, spur gears or similar pieces, may be keyseated at the same time; taper keyseats as easily cut as straight keyways.

Accuracy is not a matter of guess on this machine, for the post which holds the work serves as a guide for the cutting tool. Six different sizes to handle the lightest and the heaviest work. When thinking of keyseating think of the **GIANT**.

Our catalogue describes all sizes. Want one?

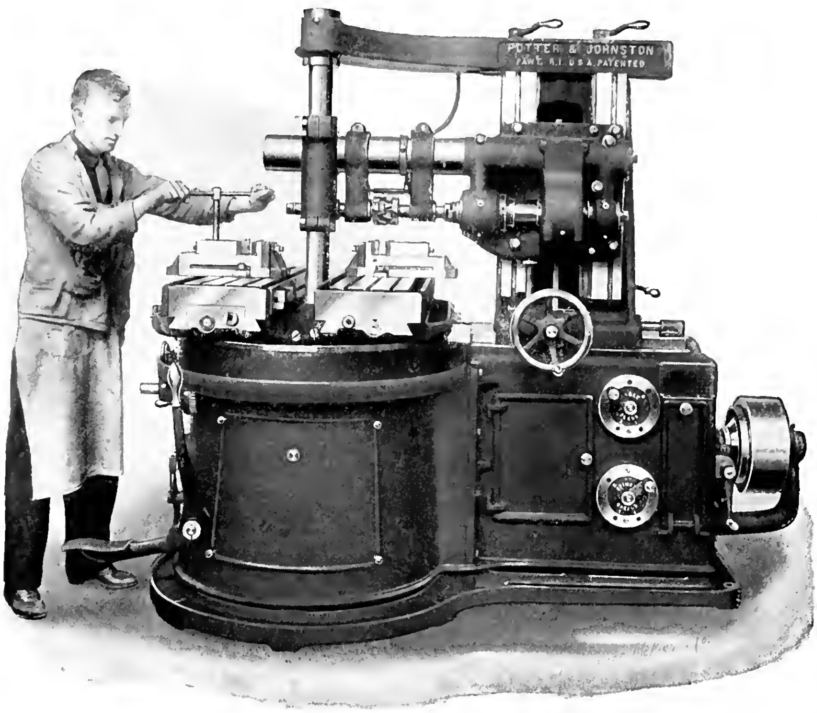
MITTS & MERRILL, Saginaw, Mich.

843 WATER STREET

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. Heinrich Dreyer, Berlin, Germany; Austria and Russia. Leon Chapuis, Paris, France; Belgium and Switzerland. V. Lowener, Stockholm, Sweden.

29

atic Milling Machines Double Production Because they are Continuous Millers



Horizontal Automatic Milling Machine

The finished work is never returned under the cutter, thus avoiding all marks or scratches on the milled surface.

The operator is loading one vise or fixture while the cutter is operating on work carried in the other vise.

The machine is actually cutting metal sixty minutes to the hour every working hour of the day.

Let us send you a copy of Bulletin No. 30.

Also Patentees and Builders of Manufacturing Automatic Chucking and Turning Machines.

POTTER & JOHNSTON, Pawtucket, R. I., U. S. A.

OFFICES AND REPRESENTATIVES: Office for Great Britain and France: 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager. New York Office: Fulton Bldg., 50 Church St., Walter H. Foster, Manager. Detroit Office: Modern Machinery and Engineering Co., 1514 Ford Bldg. Chicago Office: 1228 McCormick Bldg., Chas. H. Shaw, Manager. Toronto Office: Modern Machinery & Engineering Co., 1410 C. P. R. Bldg.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, England and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Milan, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg.

RESULTS COUNT

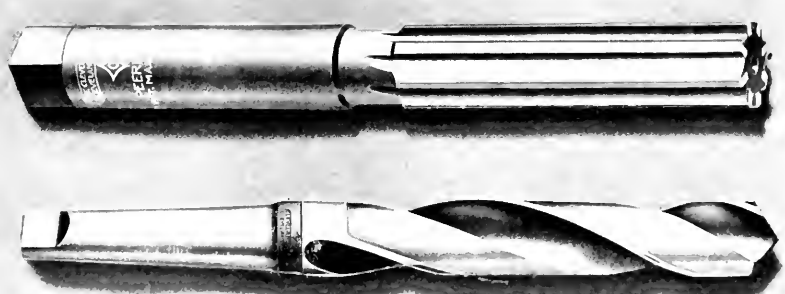
DRILLS ARE JUDGED BY WHAT THEY DO—NOT BY WHAT SOMEONE SAYS THEY SHOULD DO—NOR BY WHAT THEY COST. ¶THEY MAY LOOK ALIKE BUT IN THE RESULTS OBTAINABLE THE DIFFERENCE LOOMS LARGE. ¶IN THE FINAL ANALYSIS, A DRILL'S REAL WORTH MUST BE ESTABLISHED BY ITS POTENTIAL HOLE PRODUCTION—ITS ABILITY TO MAKE HOLES QUICKLY, IN LARGE VOLUME, AND WITH THE MINIMUM LABOR FOR GRINDING. ¶AS IN THE PAST, OUR MEASURE OF SUCCESS SHALL BE DETERMINED BY THE RESULT-GETTING QUALITIES OF CLEVELAND TOOLS.

THE CLEVELAND TWIST DRILL CO.

CLEVELAND

CHICAGO: 9 NORTH JEFFERSON ST. NEW YORK: 30 READE ST.

AGENTS: ALFRED HERBERT, LTD., COVENTRY, FOR GREAT BRITAIN; FENWICK FRERES & CO., 8 RUE DE ROCROY, PARIS, FOR FRANCE, SWITZERLAND, AND ITALY; V. LOWENER, STOCKHOLM, CHRISTIANIA, COPENHAGEN, FOR SCANDINAVIA; E. SONNENTHAL, JR., BERLIN AND VIENNA, FOR GERMANY AND AUSTRIA; IGNACZ SZEKELY, BUDAPEST, FOR HUNGARY; R. D'AULIGNAC, CORTES 559, BARCELONA, FOR SPAIN; S. G. WEINBERG, 1 KIRPICHNIE PEREULOK, ST. PETERSBURG, FOR RUSSIA; A. ASHER SMITH, 56 MARKET ST., SYDNEY, N. S. W., FOR AUSTRALIA AND NEW ZEALAND.



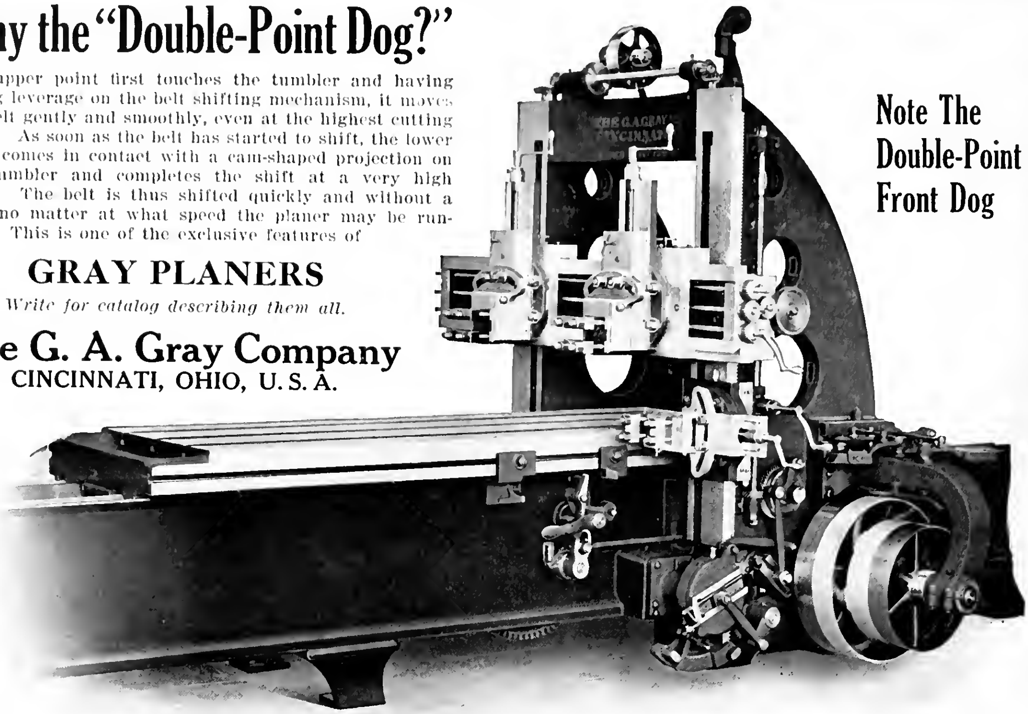
Why the "Double-Point Dog?"

The upper point first touches the tumbler and having a long leverage on the belt shifting mechanism, it moves the belt gently and smoothly, even at the highest cutting speed. As soon as the belt has started to shift, the lower point comes in contact with a cam-shaped projection on the tumbler and completes the shift at a very high speed. The belt is thus shifted quickly and without a jerk, no matter at what speed the planer may be running. This is one of the exclusive features of

GRAY PLANERS

Write for catalog describing them all.

The G. A. Gray Company
CINCINNATI, OHIO, U. S. A.



Note The Double-Point Front Dog

ONE HUNDRED AND FOUR INCHES

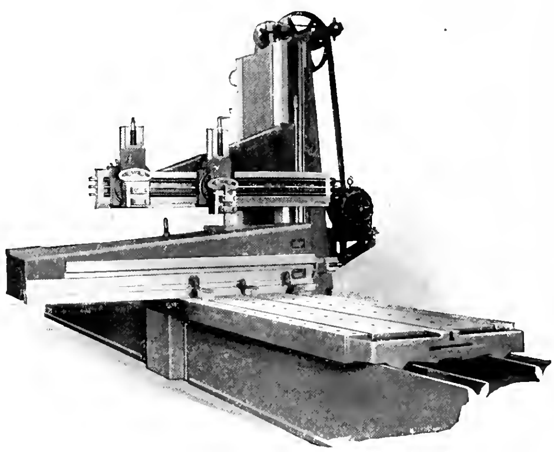
Between Housings would be Necessary for Handling this Casting

A 48" "CLEVELAND" OPEN SIDE

Handles it with Ease.

There are doubtless many jobs coming through your plant which could be taken care of in the same way.

A comparatively small size "Cleveland" handles a large amount of work, as it is rigid and accurate; the simplest planer on the market today, with all gears in the drive, except the bull gear and its pinion, enclosed and running in oil.



THE CLEVELAND PLANER WORKS

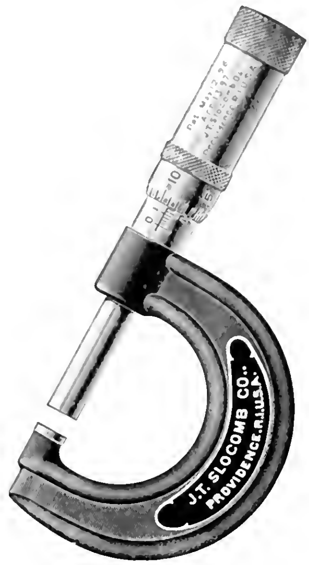
3150-3152 SUPERIOR AVENUE — CLEVELAND, OHIO, U. S. A.

JAMES G. DORNBIRER — GEO. W. FORD

"SLOCOMB"

The Longest Lived Micrometer that Can Be Bought

Some of the Reasons Why

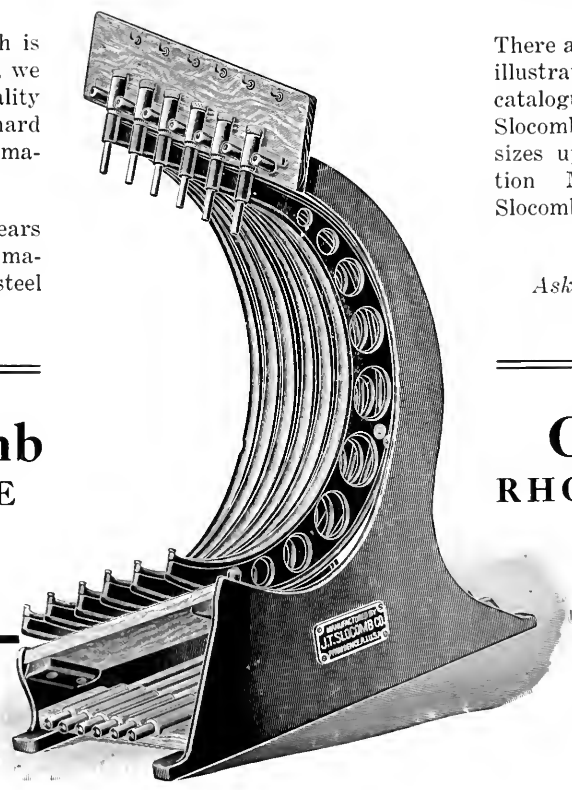


SLOCOMB MICROMETERS ARE USED ALL OVER THE WORLD

Slocomb Micrometers have many features exclusive to themselves—advantages which contribute accuracy and durability—constructional features not found in other micrometers.

The screw, or spindle, which is the heart of the micrometer, we make of the very highest quality unannealed tool steel—as hard as it can be and still be machined.

Naturally, this screw wears longer than one made of machinery steel or some other steel which cannot be hardened.



The Slocomb screw runs in a soft steel nut inserted in the frame and readily renewable. Wear takes place in the nut—the part which can be replaced at the least cost.

There are other features, too, all illustrated and described in the catalogue. It shows also the Slocomb combination sets in sizes up to 24″, the new Friction Micrometer and other Slocomb tools of precision.

Ask for Catalogue 14-M.

J. T. Slocomb Company
PROVIDENCE RHODE ISLAND

NICHOLSON FILES

THE BEST FILES MADE

The best—yes! and here's why:

Finest equipped file factory in the world; exclusive methods; highest grade materials; intimate knowledge of file users' requirements gained by 50 years' experience devoted exclusively to file making; world-wide sales.

NICHOLSON FILES

CANNOT BE EQUALLED

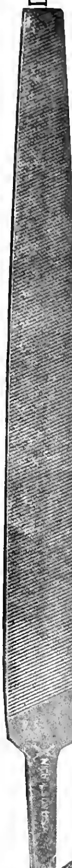
Every "**Nicholson**" file is rigidly examined for shape, cutting qualities, soundness, and temper before it is wrapped in our anti-rust paper, boxed and sealed.

These rigid examinations guarantee to the purchaser of this Company's files a uniformly high efficiency not possible by any other system.

Most every dealer can supply you with "**Nicholson**" brand files. Never sold under any other name. Boxes so plainly labeled you cannot make a mistake.

Find the "**Nicholson**" dealer in your town.
He is a good man to know.

NICHOLSON FILE CO.
PROVIDENCE, R. I., U.S.A.



Putting on a NICHOLSON file handle correctly.

"To have the file truly and firmly handled is the first step in point of economy as well as in the production of good work."

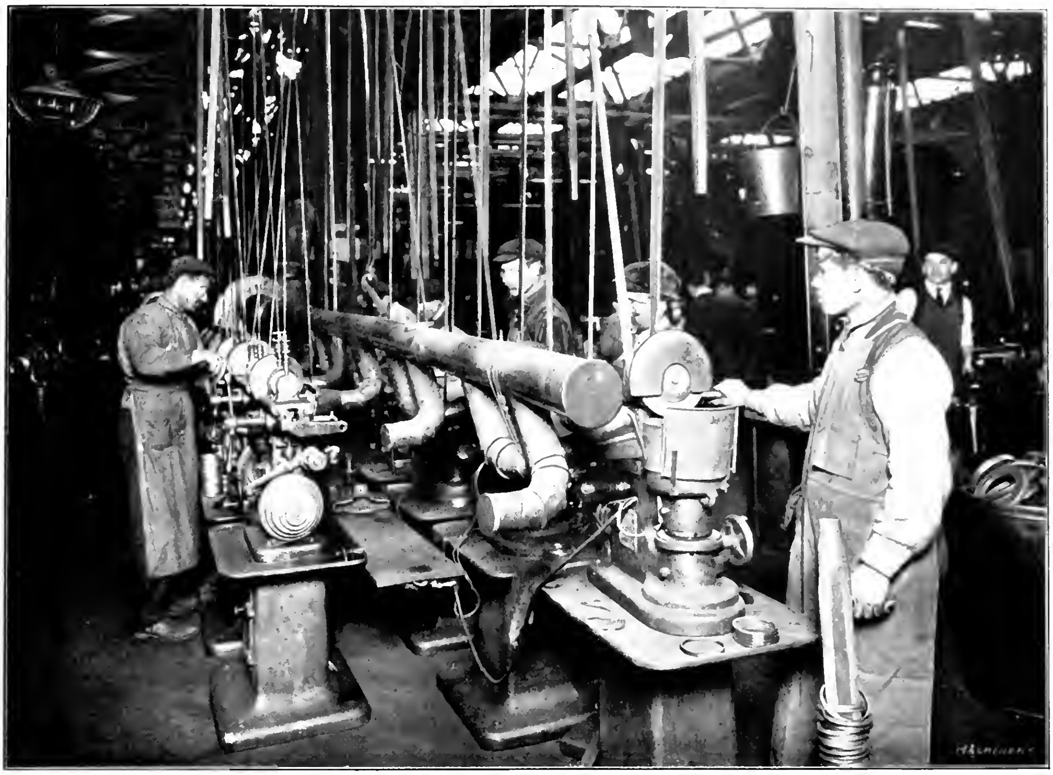
(ONE of many valuable hints to file users told in our booklet, "FILE FILOSOPHY.")

A copy sent FREE on request

NICHOLSON U.S.A.

THE MARK OF TRADE THAT MEANS BEST GRADE

The "Heald" Installation at the Ford Plant



Piston Ring Grinding as it Should Be

The Heald Piston Ring Grinder is recognized as the one successful machine for this type of work. Learn more about it by getting our latest catalogue. Study it out for yourself.

There are thirteen Heald Piston Ring Grinders in the Ford plant used exclusively for grinding piston rings. Each machine turns out from 2000 to 2400 piston rings in eight hours, grinding one side of the ring only, two operators as well as two machines being required to complete a ring.

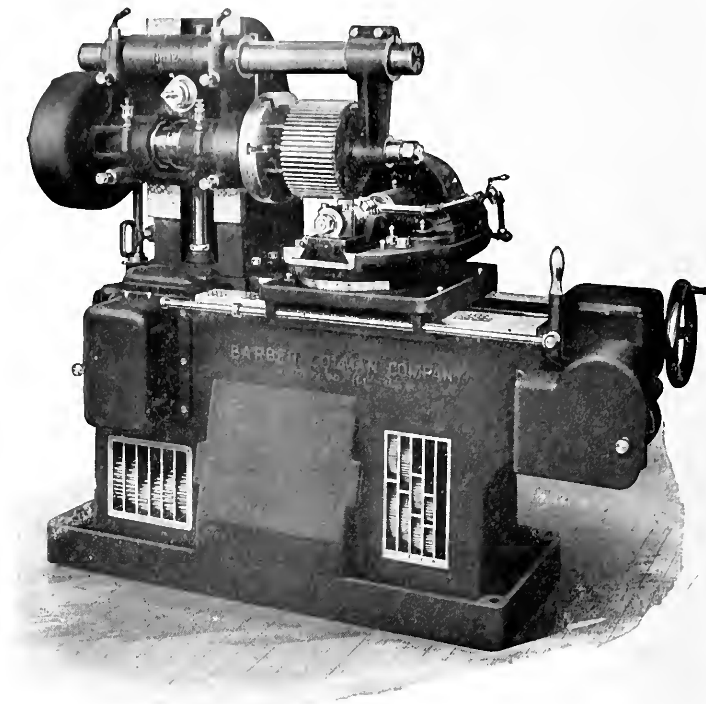
Heald Ring and Surface Grinding Machines have many features which adapt them for grinding surfaces on work, such as small washers, piston rings, thrust collars, etc.—a magnetic chuck for holding work, micrometer adjustment for obtaining the exact thickness, angular adjustment for grinding convex or concave surfaces, adjustable bearings for taking up all wear, variable cross feed to the grinding wheel, and a demagnetizing switch for the magnetic chuck. These all help production without sacrificing accuracy.

THE HEALD MACHINE CO. 20 New Bond Street **Worcester, Mass.**

CHICAGO OFFICE: 24 South Jefferson Street.

FOREIGN AGENTS: Alfred Herbert, Ltd., England, Italy, France, Belgium, Switzerland, Spain and Portugal. Ludw. Loewe & Co., Germany, Austria, Russia, Holland, Denmark and Norway. Wilh. Sonesson & Co., Sweden.

The B-C No. 12 Hobbing Machine



These Features Help Reduce Your Gear Production Costs

Machine is extra heavy and compact, with weight carefully and properly distributed. Bed and column are of rigid box section. Hob slide is close to the solid bed. Work sets close up to spindle bearings in the work slide.

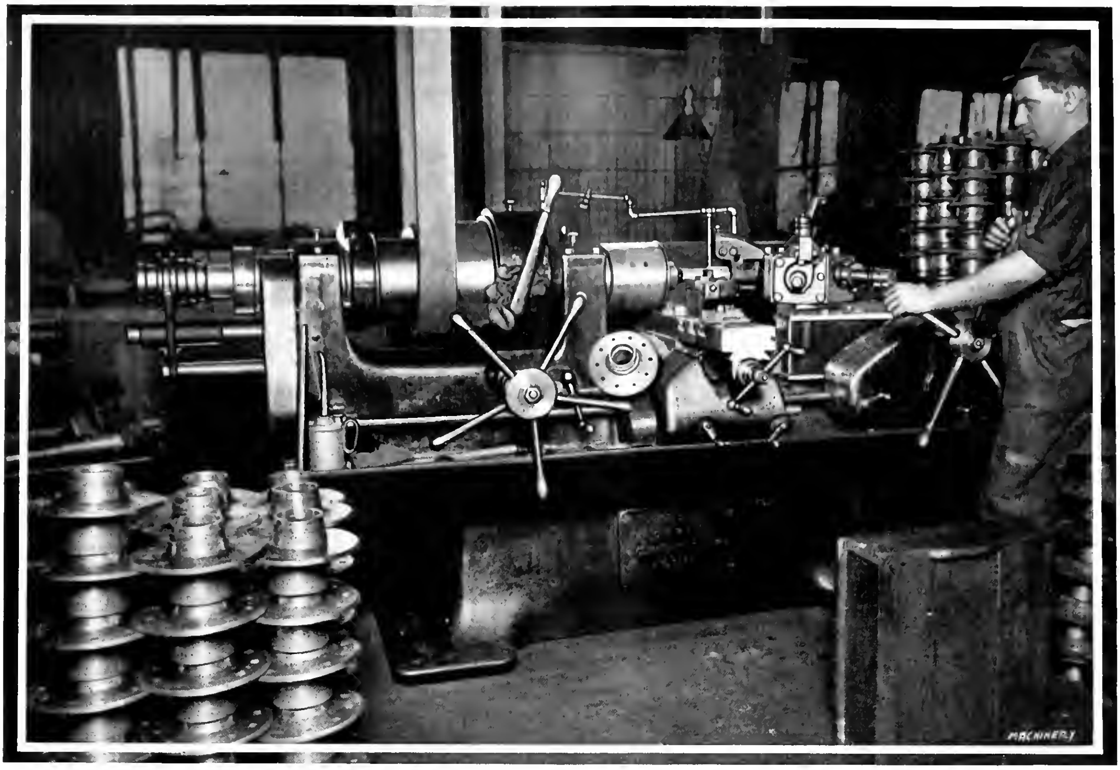
Control handles are on one side. Hob slide is mounted on horizontal ways. Work arbor is horizontal.

You can readily see how these features give ease of operation and ability to take fast, heavy cuts—and those are what increase your rate of production and so reduce production costs.

If you produce spur or spiral gears in quantities, you can cut costs by installing a B-C No. 12 Machine. Send samples or blue prints for estimated rate of production.

BARBER-COLMAN COMPANY

ROCKFORD, ILLINOIS, U. S. A.


MACHINERY

Grind Milling Cutters More Accurately

TO grind a milling cutter accurately is fully as important as to buy a correctly formed, properly tempered cutter in the first place, for the efficiency of the tool largely depends on how well it is sharpened. Union Milling Cutters and Union Cutter Grinders are an ideal combination—the Cutter correct to begin with and the Grinder to keep it so until it is worn out.

This Union No. 2 Formed Cutter Grinder is entirely new, and, we believe, a great improvement over the old form of grinder. The grinding wheel on this new machine is mounted on a stationary vertical arbor, and the work, which is on a horizontal table, is passed back and forth across the face of the wheel. A gauge is provided which regulates the cut so that each tooth of the cutter is ground on an exact plane with the center of the cutter and equally distant.

Cutters up to 8″ diameter by 3″ face can be sharpened on this Union Grinder, which has a 6″ wheel with a 4″ adjustment to or from the work.

"Union" milling equipment is unsurpassed.

May we mail further details?

The Cutter and Drill Makers

The Union No. 2 Formed Cutter Grinder

UNION TWIST DRILL COMPANY

Twist Drills, Gear and Milling Cutters

ATHOL, MASSACHUSETTS

STOP PAYING FANCY PRICES

PATENT APPLIED FOR

Many users pay entirely too much for their hollow set screws.

They must be hypnotized, because there is no justification for fancy prices.

Combine **special steel bar stock** and up-to-date hardening with knowing how, and the product is

The "STANDCO"

That can't be beat for quality and price.

Cut with either U. S. S.—V—or Whitworth threads.

All styles of points; any length and diameter.

The "STANDCO" is NOT made of pressed steel.

SPECIFY and INSIST upon the "STANDCO"

PATENTED PROCESS CUTS COST

PATENTED

The new "Hallowell" SAFETY COLLAR of COLD-ROLLED STEEL—just out—is so NEAT and HIGHLY POLISHED that it improves the looks of any machine.

Machinery manufacturers the world over have quit making collars and now buy the "HALLOWELL"—because IT PAYS THEM.

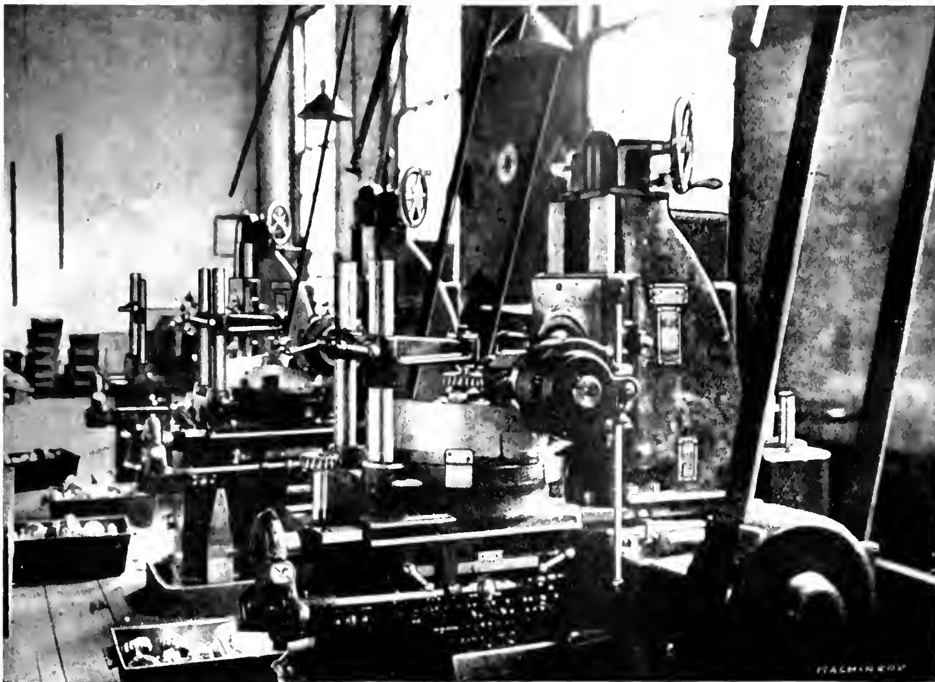
They get a FAR BETTER PRODUCT, or a MUCH LOWER PRICE, or BOTH.

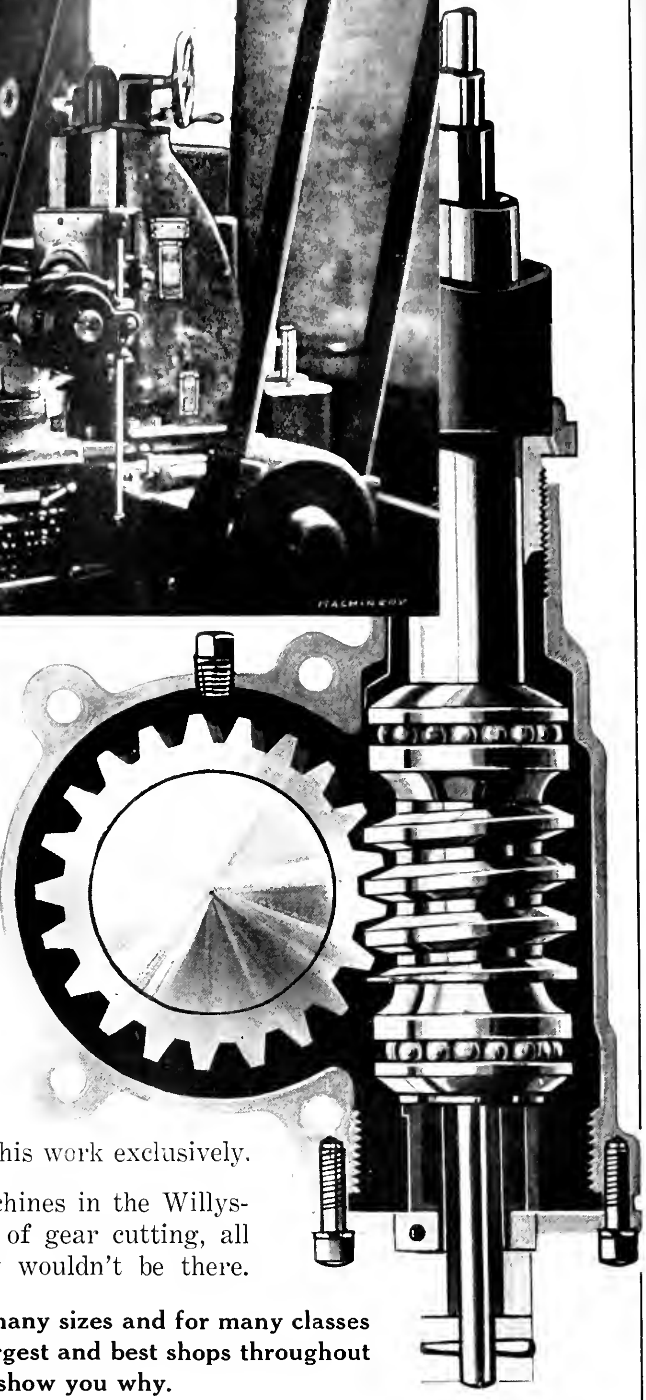
Fitted with "STANDCO" if specified.

SPECIFY and INSIST upon the "HALLOWELL"

NOTE:—You might as well make your own nuts and bolts as make your own collars.

STANDARD PRESSED STEEL





Gould & Eberhardt Gear Hobbers

Cutting Steering Worm Gears

The worm gears for the steering units in Overland cars are cut on our Hobbing Machines—cut to close limits of accuracy, and fast. The drop forgings are of alloy steel; there are 20 teeth of ½″ pitch; and output is 70 per day on each machine. Three of our Hobbers are used on this work exclusively.

There are many groups of our machines in the Willys-Overland plant, used for all kinds of gear cutting, all giving the best of service or they wouldn't be there.

Our Gear Hobbers are built in many sizes and for many classes of work; they are used in the largest and best shops throughout the country. We would like to show you why.

GOULD & EBERHARDT

"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY

ESTABLISHED 1833 NEWARK, N.J. U.S.A.

ANOTHER "GEOMETRIC" INSTALLATION

THE USUAL "EFFICIENCY" STORY

The Garford Company (Elyria, Ohio) is another automobile manufacturer that has found the Geometric Threading Machine the cheap and practical way to thread studs. One machine is kept on this work almost entirely, threading studs after they have been cut off in the automatic screw machine. The particular stud shown is 3/8" diameter by 24 pitch, 5/8" length of thread, and production is 350 per hour. Material, cold-rolled steel. If it is threading in quantities, any kind, any size, any machine, you need Geometric Machines and Die Heads. Let us show you.

THE GEOMETRIC TOOL COMPANY, New Haven, Conn.

REGULAR AGENTS: The Chas. A. Strelinger Co., Detroit, Mich.; Hill, Clarke & Co., Boston; Vandyck Churchill Co., New York and Philadelphia; Brown & Zortman Machinery Co., Pittsburgh, Pa.; The E. A. Kinsey Co., Cincinnati, O.; Strong, Carlisle & Hammond Co., Cleveland, O. **PACIFIC COAST:** The Compressed Air and General Machinery Co., San Francisco, Cal.; Perine Mchy. Co., Inc., Seattle, Wash. **CANADA:** The A. R. Williams Machinery Co., Ltd., Toronto; Williams & Wilson, Montreal. **FOREIGN:** Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao, Lisbon and St. Petersburg. Donauwerk Ernst Krause & Co., Vienna. V. Lowener's Maskinforretning, Sverre Mohn, Norway. Also all manufacturers of Screw Machines and Turret Lathes.

Users of "REED" LATHES

An Inquiry from Manchuria

There is a world-wide market for "Reed" Lathes—a market which these machines have built up for themselves solely through past and present performances. This man, in Manchuria, had used "Reed" Lathes in this country—consequently, when he needed lathe equipment he wanted "Reed" Machines.

And this is the way with all "Reed" purchasers. Once a buyer—always a buyer. Many of the largest and best-known concerns in this country and abroad, those whose product requires extreme accuracy and A-1 finish, are constantly reordering "Reed" Lathes.

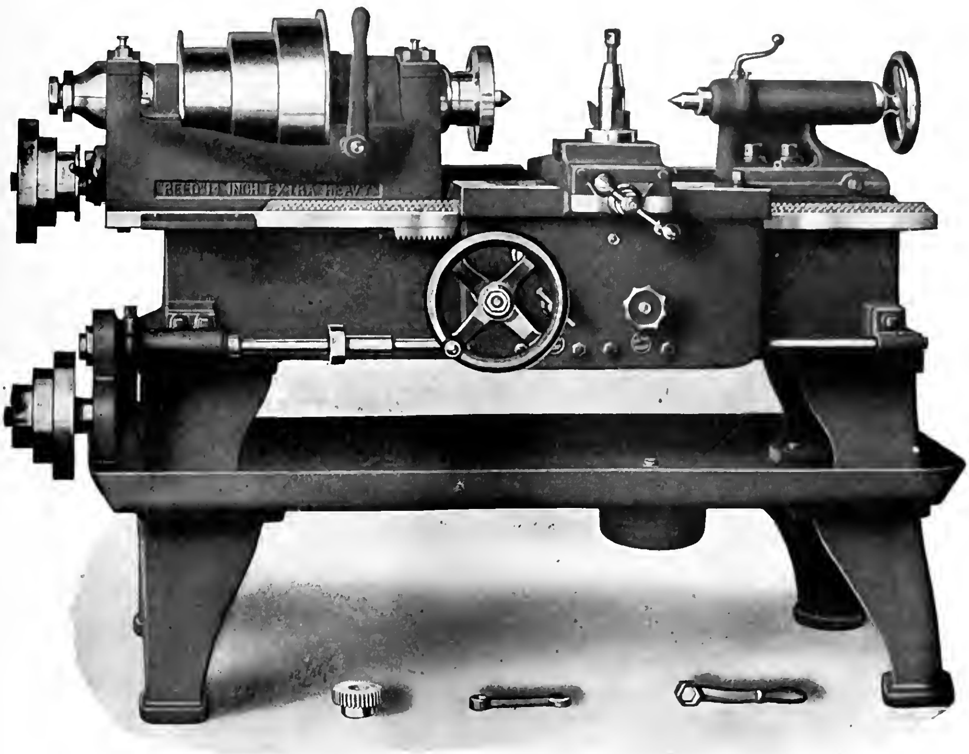
There are many reasons. May we show you?

REED-PRENTICE COMPANY

Selling Agents: Manning, Maxwell & Moore, Inc., 119 West 40th St., New York City

San Francisco, Philadelphia, Cleveland, Chicago, Boston, New Haven, Mexico City, Detroit, Buffalo, St. Louis, Yokohama, Japan, Pittsburgh

Always Come Back for More



Extra Heavy Plain Turning Lathe

This "Reed" High Power Turning Lathe is especially designed for the rapid production of duplicate parts in large quantities, at the same time maintaining, day in and day out, the highest degree of accuracy attainable.

A lathe of low swing that has all the Strength, Rigidity and Producing Capacity of the ordinary 20-inch Lathe.

With One Lever Control of Spindle for starting and stopping instantly, thus eliminating entirely the shifting of countershaft levers.

Workmanship and Material are "Reed" Standard.
Complete descriptive matter on request.

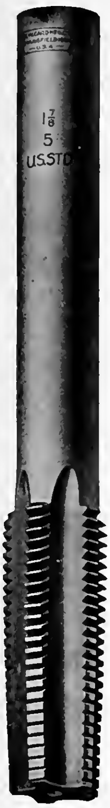
WORCESTER, MASS., U. S. A.

Brownell Machinery Co., Providence, R. I. H. A. Smith Mchy. Co., Syracuse, N. Y. Alexander & Garsed, Charlotte, N. C. Fenwick Freres & Co., Paris, France. Charles Churchill & Co., Ltd., London, England. Van Rietschoten & Houwens, Rotterdam, Holland. Moscow Machine Tool & Engine Co., Moscow, Russia. C. & J. W. Gardner Co., St. Petersburg, Russia. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. H. W. Petrie, Ltd., Toronto and Montreal, Canada.

TAPS

What if Card Screw Cutting Tools do cost more at first—"there's a reason." They wear longer, cut better, work faster and are cheaper in the long run. Card Tools are dependable; they have all the quality, uniformity, temper and finish that go to make up a high-grade tool, and when the time of reckoning arrives, the results produced by Card Taps will be found recorded on the profit side of the ledger.

If Card Taps are used in your shop, the efficiency engineer won't have to spend time on the cost sheets of your screw-cutting department.



Mansfield, Massachusetts, U. S. A.

Ltd., Paris; Fenwick Freres & Co., Turin; Ignacz Szekely, Budapest; V. Lowener, Stockholm, Copenhagen, Christiania; J. Lambercier & Co., Geneva; R. D'Aulignac, Barcelona, Spain; Arthur Kayser, Berlin, S. W. 68, Oranienstr., 126, Germany.

THE STANDARD SHIELD BRAND

METAL DRILL HOLDERS AND GAUGES


CONFUSION


ORDER

WHERE is the drill you took from your drill press a short time ago? You need it at once. No other size will do—and you cannot remember where you have placed it.

The Standard Metal Drill Holder and Gauge prevents this confusion.

It keeps the drills in plainly marked holes and in graduated size, making it possible to take out or put in any of them easily and quickly. It is always ready for systematic service. Therefore, "Put Your House—The Shop—In Order" by getting one of them—NOW.

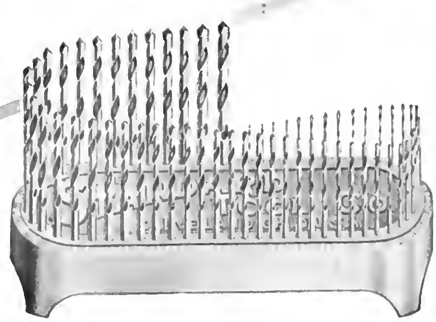
THE STANDARD TOOL CO.

CHICAGO 552 W. Washington Blvd.	Cleveland *Sixth City*	NEW YORK 94 READE STREET

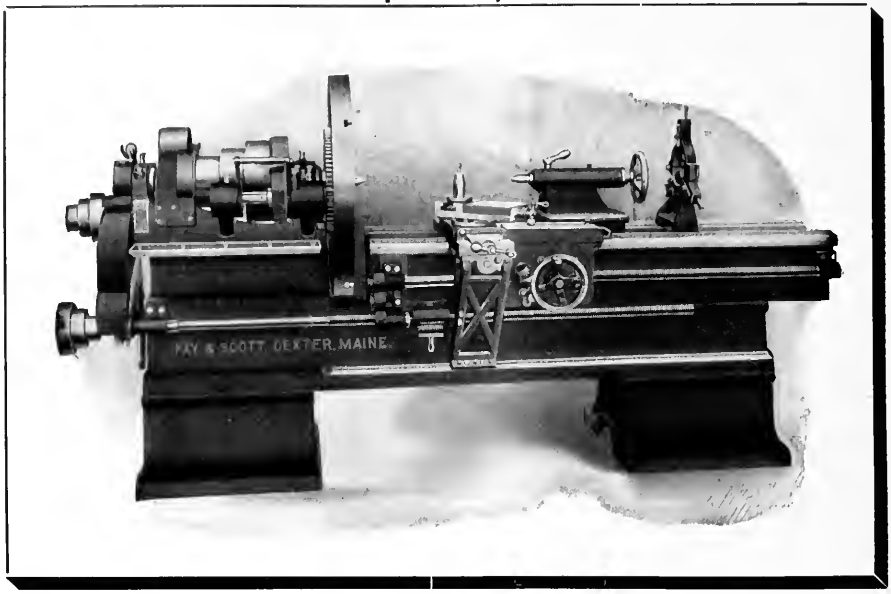
Representatives in all Foreign Countries.

This "Shield" appears on all of our DRILLS

Registered
STANDARD TOOL CO.
Trade Mark



The Standard Tool Co., 1914



Concerning Fay & Scott Gap Bed Lathes

Lathes are perhaps the most important factor of shop equipment, and for that reason it pays to make careful selection.

The Fay & Scott gap bed lathe has peculiar advantages for the everyday shop. It is an all-round lathe, suited for light or heavy work and is equipped with every appliance for turning out accurate work fast. Double back gears provide wide range of feed and speed changes, the bronze spindle bearings assure perfect alignment and there is plenty of power for the heaviest cuts.

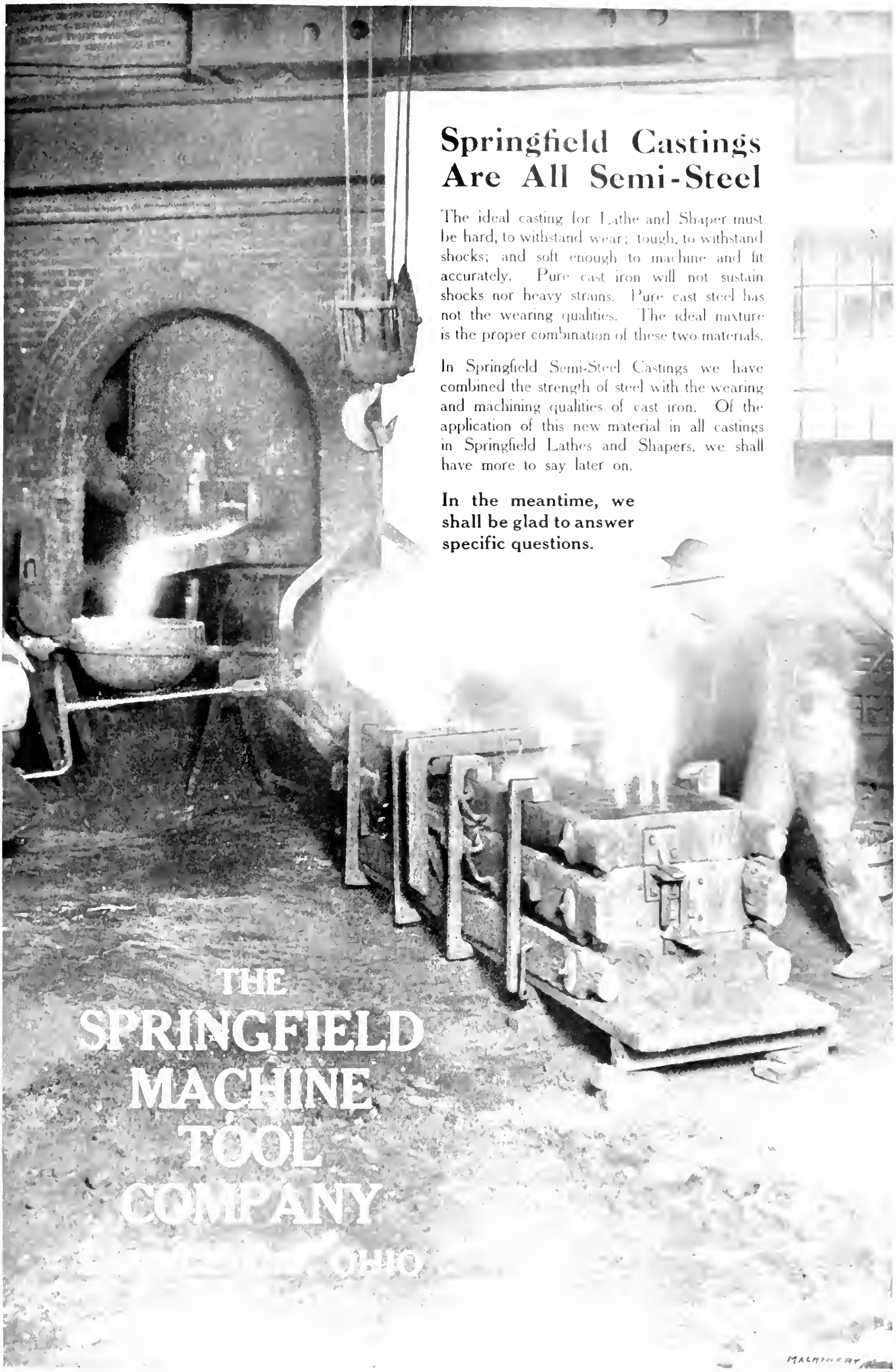
Before you purchase the new lathe you will doubtless look into the merits of various makes. Ask us about the F & S line—you can learn more about the Fay & Scott Lathes in a half-hour's talk with our representative than from all the catalogs ever issued. Drop in and see us, or let us drop in on you.

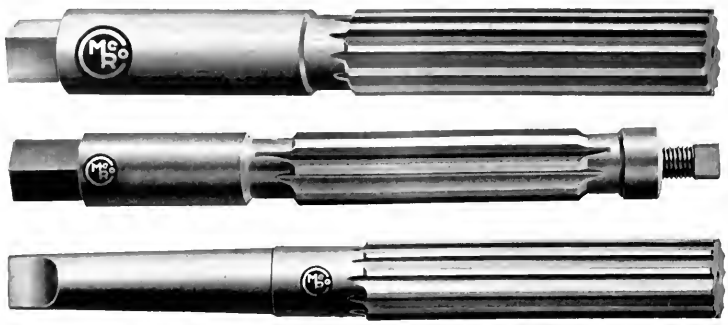
THE PRENTISS TOOL & SUPPLY CO.

Singer Building, 149 Broadway, New York

Warehouse: 439 Communipaw Ave., Jersey City, N. J.

BOSTON, MASS.	SCRANTON, PA.	ROCHESTER, N. Y.	SYRACUSE, N. Y.	BUFFALO, N. Y.
John Hancock Bldg.	720 Prescott St.	315 E. & B. Building	520 University Block	607 D. S. Morgan Building


Springfield Castings
Are All Semi-Steel
The ideal casting for Lathe and Shaper must be hard, to withstand wear; tough, to withstand shocks; and soft enough to machine and fit accurately. Pure cast iron will not sustain shocks nor heavy strains. Pure cast steel has not the wearing qualities. The ideal mixture is the proper combination of these two materials.
In Springfield Semi-Steel Castings we have combined the strength of steel with the wearing and machining qualities of cast iron. Of the application of this new material in all castings in Springfield Lathes and Shapers, we shall have more to say later on.
In the meantime, we shall be glad to answer specific questions.
THE
SPRINGFIELD
MACHINE
TOOL
COMPANY
OHIO
MACHINERY



Important Announcement

We take pleasure in announcing to our customers and friends that we have now brought out a complete line of Solid Reamers. The same guarantee is back of these tools that has been back of all McCrosky products for years, which means that any tool proving defective in either workmanship or material will be replaced at once, no charge.

Our earnest endeavor to deserve our rapidly increasing business, and our sincere purpose to render real service in the larger sense, have created a confidence in McCrosky products, which we believe wiil find expression in a ready demand for this new line of tools.

We are in a position to quote most attractive discounts on these tools. A yearly contract with us on your complete Reamer requirements should save you money.

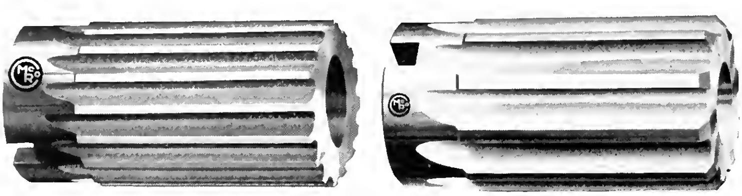
Ask for Bulletin A-4

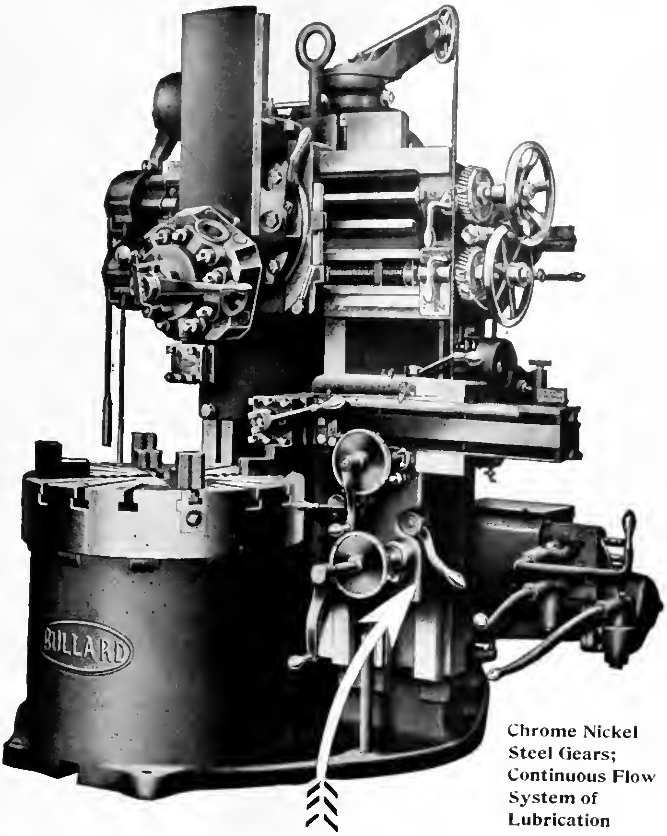
Our McCrosky and Ideal Adjustable Reamers, Wizard Quick-Change Chucks and Collets, McCrosky Expanding Mandrels, Wizard Variable Speed and Reversing Attachments, Searchlight Universal Lamp Brackets, etc., are fully described in our general Catalog No. 4. May we send you a copy along with the Solid Reamer bulletin? It may point the way to some big savings in your production cost.

THE McCROSKY REAMER CO.

MEADVILLE, PA., U. S. A.

EXPORT AGENT—Benjamin Whittaker, 21 State St., New York





THE SIDE HEAD

Of The Bullard Vertical Turret Lathe

is carried by a Side Rail or vertical guide-way (patented) secured to the bed and column in such manner as to rigidly support and absorb, without chatter or vibration, the most severe strains which may be imposed on the cutting tools.
There is no overhang of the Side Head Saddle (note wide bearing in illustration) and the feeding power is applied at a point close to the work, obviating any tilting and binding tendency under cutting strain.

This construction, the result of fourteen years' experience with the type, is absolutely essential if the Side Head is to be fully efficient.

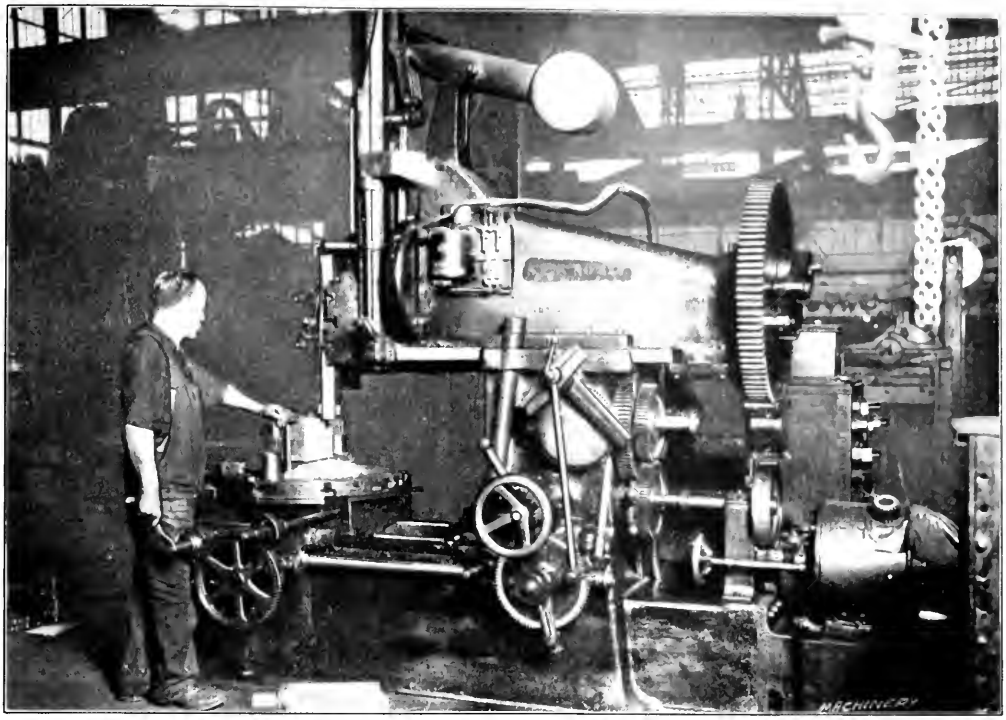
It will never be necessary to replane a Bullard bed to maintain alignment and take up wear in the Side Head bearing surfaces—the Side Rail takes the thrust and has provision for realignment. The Bullard Side Head is usable and fully efficient throughout the full actual range of the machine.

Send for Book MV-25 for full details of this and other features.

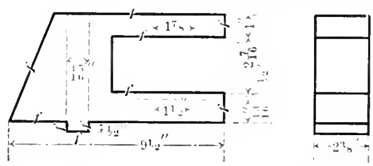
The Bullard Machine Tool Company

Bridgeport, Conn. **United States of America**

DOMESTIC AGENTS: Marshall & Huschart Mchy. Co., Chicago, Ill. The Motch & Merryweather Mchy. Co., Cleveland, Ohio. Seeger Machine Tool Co., Atlanta, Ga. Pacific Tool & Supply Co., San Francisco, Cal. C. T. Patterson Co., Ltd., New Orleans, La. The A. R. Williams Mchy. Co., Toronto, Ont. Williams & Wilson, Ltd., Montreal, P. Q. Prentiss Tool & Supply Co., New York, N. Y. Kemp Mchy. Co., Baltimore, Md. W. E. Shipley Mchy. Co., Philadelphia, Pa.
FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, England. Benson Bros., Sydney, Australia. Heinrich Dreyer, Berlin, Germany. Fenwick Freres & Co., Paris, France. Landre & Glinderman, Amsterdam, The Netherlands. Sam Lagerlofs, Stockholm, Sweden.



No Question Where This Job Belonged



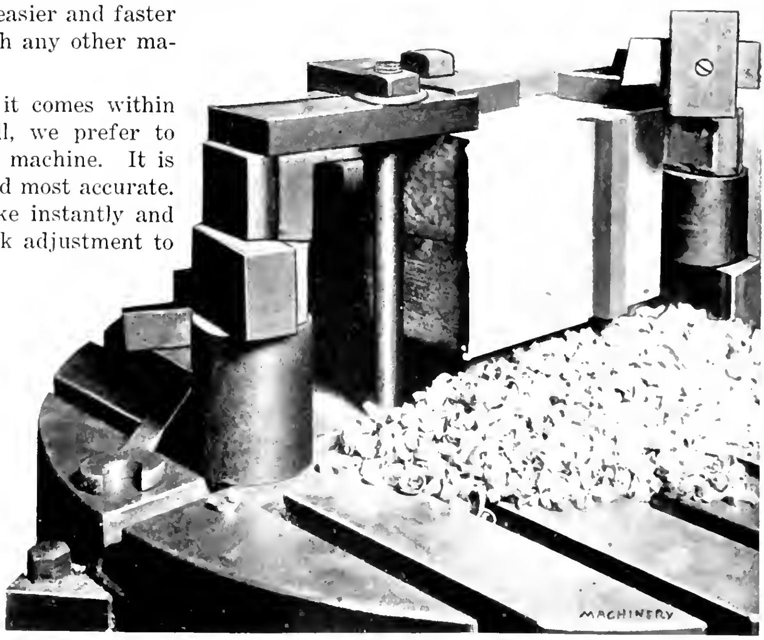
When this drawing for a hammered steel electric trolley jig was handed him, there was no question in the mind of the foreman for the Brown Hoisting Machinery Company (Cleveland, Ohio) where the job should be finished. He sent it to the Dill Slotter, where the tapered end, tongue and slotted section, 2⅞" wide by 5" long, were finished, two pieces at a time, easier and faster than was possible with any other machine or method.

He said: "Provided it comes within the range of the Dill, we prefer to take the work to this machine. It is fast, easy to set up and most accurate. We can stop the stroke instantly and we have a power quick adjustment to the circular table. It is an indispensable tool for our work."

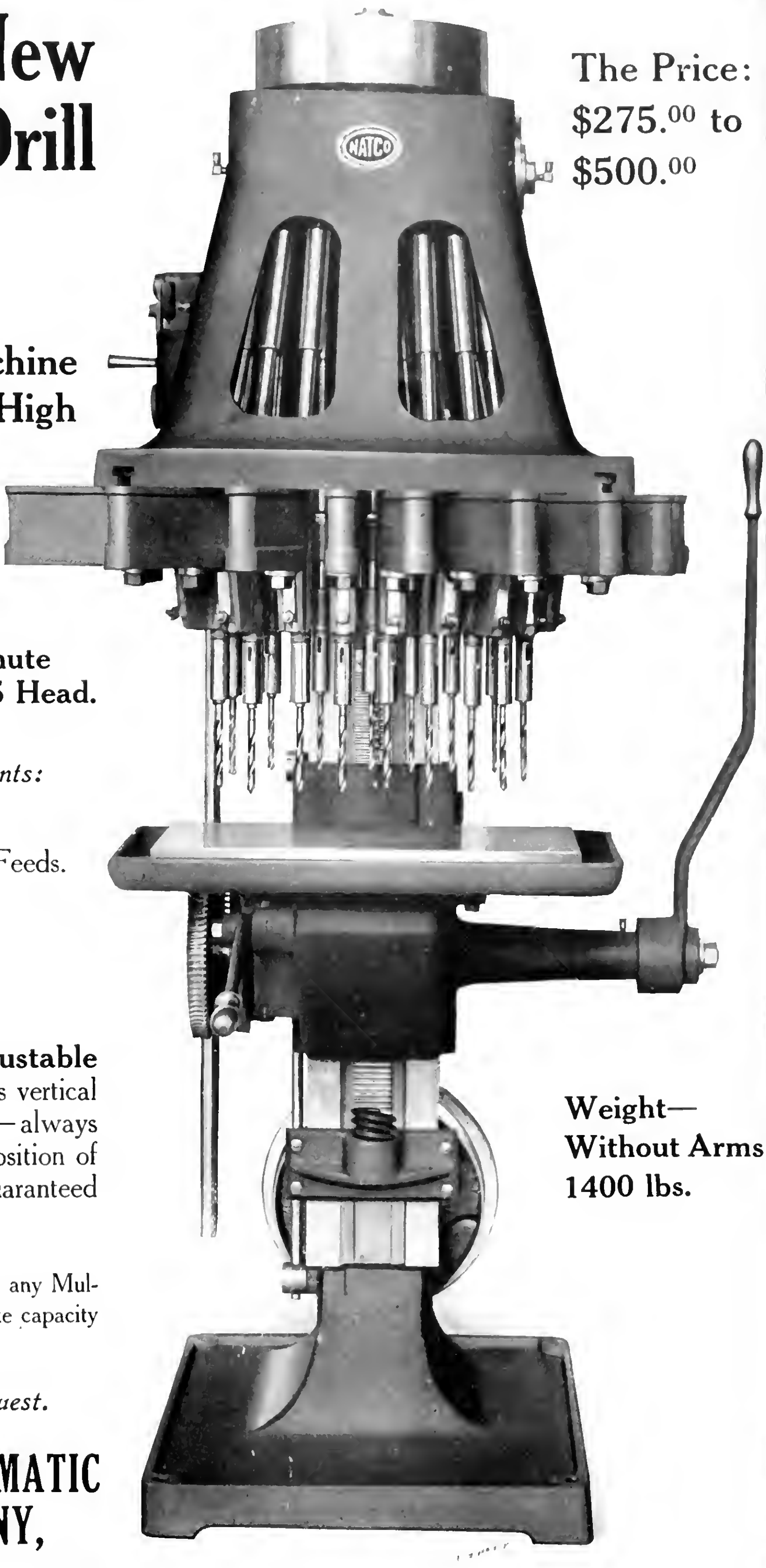
We'll gladly show you the many Dill Slotter advantages. May we?

The DILL SLOTTER PEOPLE

Kensington, Philadelphia, Pa.



Another New Multiple Drill



The Price:
$275.00 to
$500.00

A Powerful Machine that will drive High Speed Drills to best Advantage.

CAPACITY:

8½ x 12⅜ Drills at 5 inch Feed per minute in Cast Iron—9 x 15 Head.

Some of its Good Points:

Continuous Belt Drive.
Three Changes of Gear Feeds.
Pilot or Lever on Knee.
Automatic Drop Table.
Hyatt Roller Bearings.
All Gears Hardened.

A New Patented Adjustable Arm.—One nut controls vertical adjustment of spindles—always accessible regardless of position of Arms. Universal Joints guaranteed for 2 years.

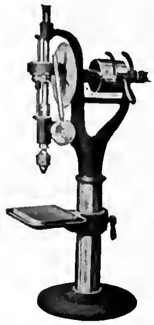
Weight— Without Arms 1400 lbs.

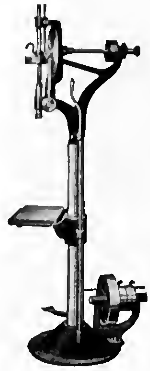
We invite a comparison with any Multiple Drill on the market of like capacity and price.

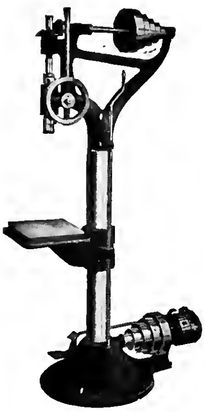
Further details on request.

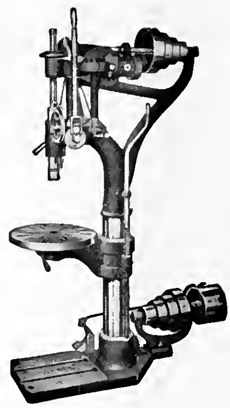
NATIONAL AUTOMATIC TOOL COMPANY,

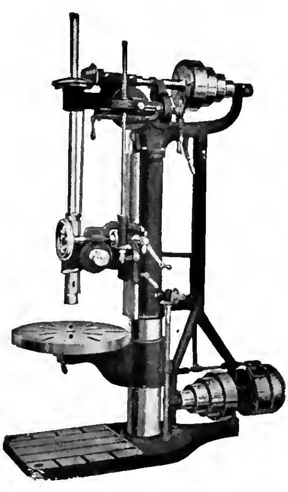
RICHMOND, INDIANA, U. S. A.

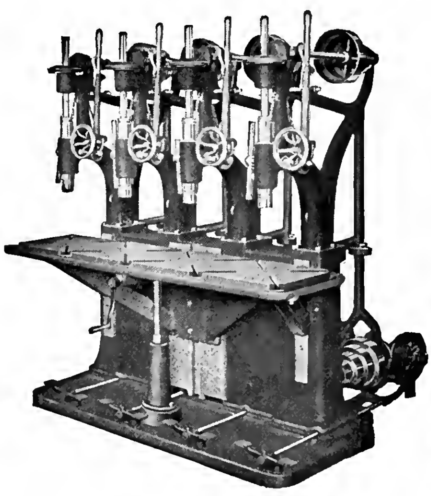










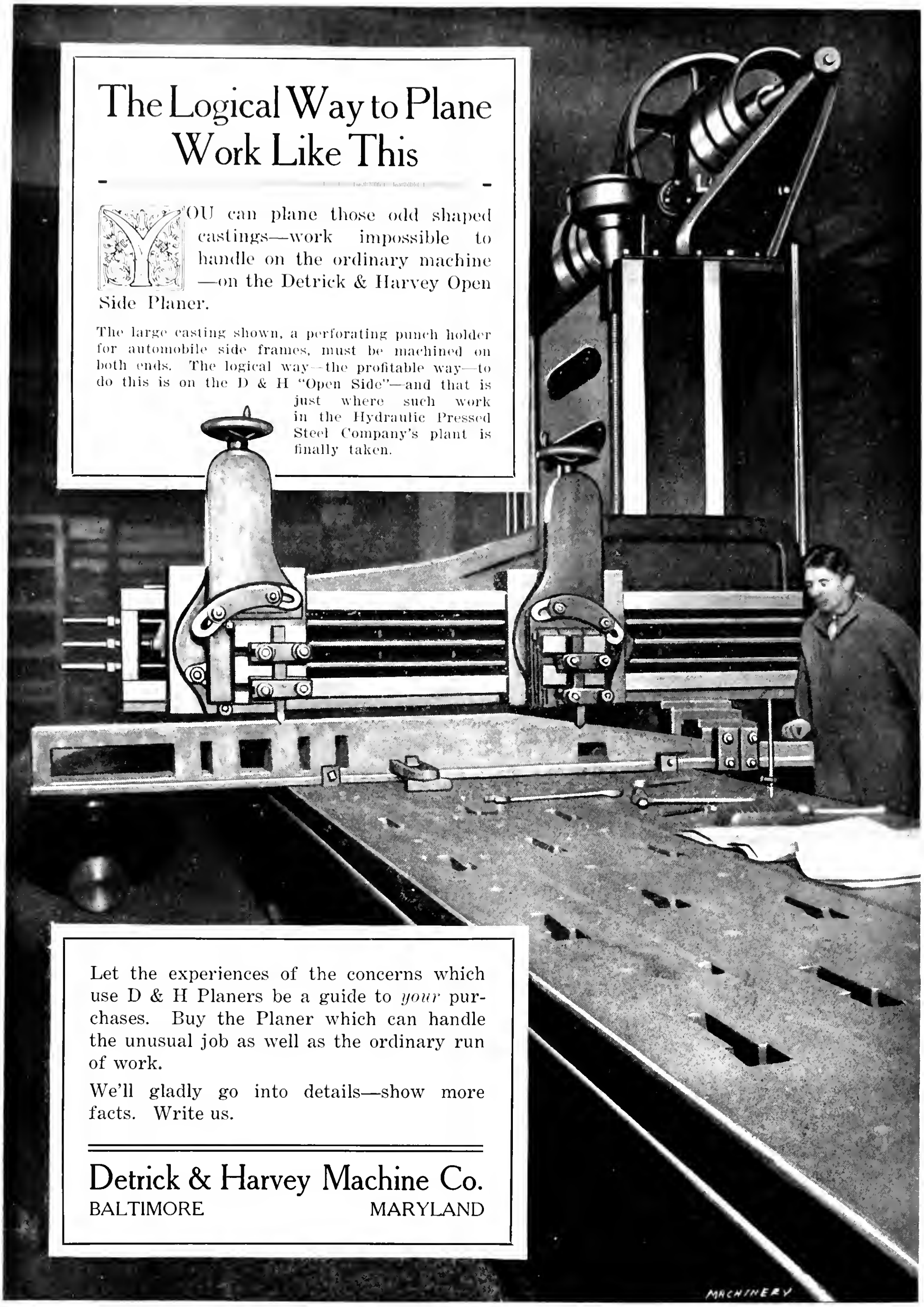


See pages 88-89

The Logical Way to Plane Work Like This

YOU can plane those odd shaped castings—work impossible to handle on the ordinary machine—on the Detrick & Harvey Open Side Planer.

The large casting shown, a perforating punch holder for automobile side frames, must be machined on both ends. The logical way—the profitable way—to do this is on the D & H "Open Side"—and that is just where such work in the Hydraulic Pressed Steel Company's plant is finally taken.



Let the experiences of the concerns which use D & H Planers be a guide to *your* purchases. Buy the Planer which can handle the unusual job as well as the ordinary run of work.

We'll gladly go into details—show more facts. Write us.

Detrick & Harvey Machine Co.
BALTIMORE MARYLAND

THE DETRICK & HARVEY OPEN SIDE PLANER

GEAR HOBBING

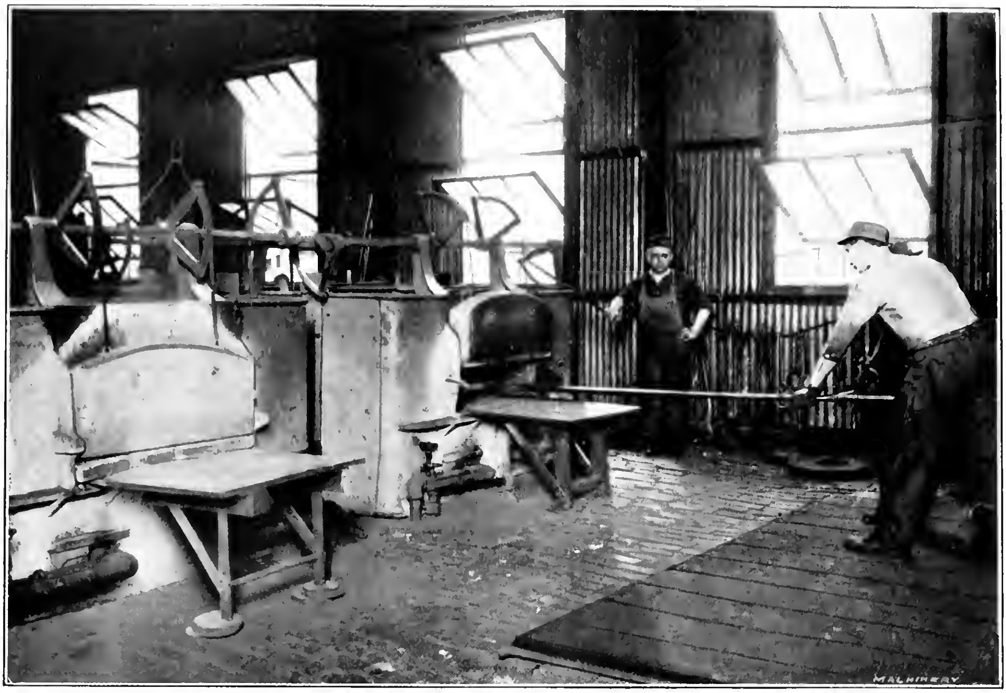
Tool and a Few Things it Makes Possible

When in operating position they present a true rack to the work. This rack is ground all over and any distortion in hardening is corrected, and being ground on the sides, the cutting edges of the tool generate without heating up the gears under operation. There is also this additional advantage—when worn out the tool may be returned and new racks inserted.

These hobs, with the rigid, powerful Lees-Bradner Gear Generating Machine, have set new standards of accuracy and production in automatically hobbing spur and spiral gears up to 14″ outside diameter. Worm gears up to 1″ C. P. and 14″ outside diameter and worms of any lead not over 1″ C. P., 8″ long and 8″ outside diameter can also be cut.

Let us send the Lees-Bradner booklets.

PANY, Cleveland, Ohio, U. S. A.



After You Have Turned It—What?

After you have turned up a difficult piece—a gear, a shaft, a universal joint—and your inspector has put the O. K. on it, what then? How about the heat treatment? Is it uncertain? Are there delays? Is there a loss in this department? Then it is high time you investigated

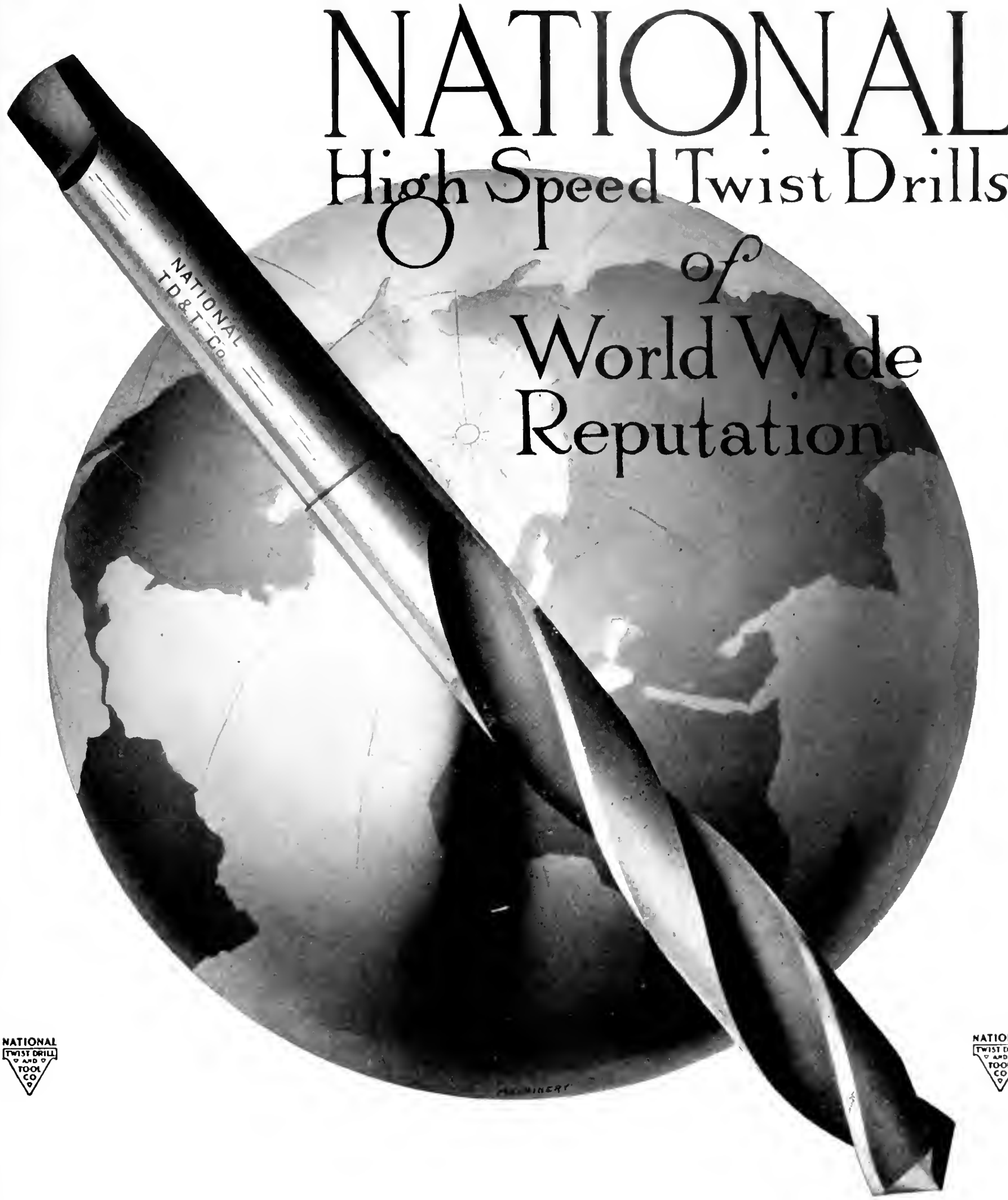
The Infuso Process

With new materials and new methods, perfected by specialists, "Infuso" makes easy results in heat treatments heretofore considered impossible. It reclaims materials scrapped by ordinary methods. It adds to the life of treated metals as much as 300 per cent in some cases. Intricate castings, or difficult heat treating, where only a part of the piece is hardened, we can treat by the "Infuso" Process—and guarantee results and minimum loss.

"Infuso" has accomplished such remarkable results for some manufacturers that they have closed up their expensive and uncertain heat-treating departments entirely. We give them the results they want—quicker, surer and cheaper.

Let us prove it on your samples. The booklet explains.

THE STEEL IMPROVEMENT COMPANY
CLEVELAND, OHIO, U. S. A.



NATIONAL TWIST DRILL AND TOOL CO

National Drills have an international reputation. They are used wherever there are machine shops. The final test, the service test, proves National Drills true to size, almost unbreakable in use and tempered to exactly the right degree.

National High Speed Twist Drills are more economical because they are more durable—the best reason in the world why you should use them.

Catalogue on request.

NATIONAL TWIST DRILL & TOOL COMPANY

DETROIT 120 White Street, NEW YORK, N. Y. OFFICES: 104 So. Jefferson Street, Chicago, ILL. MICHIGAN

operator received $2.75 per day; therefore, the comparative costs were:

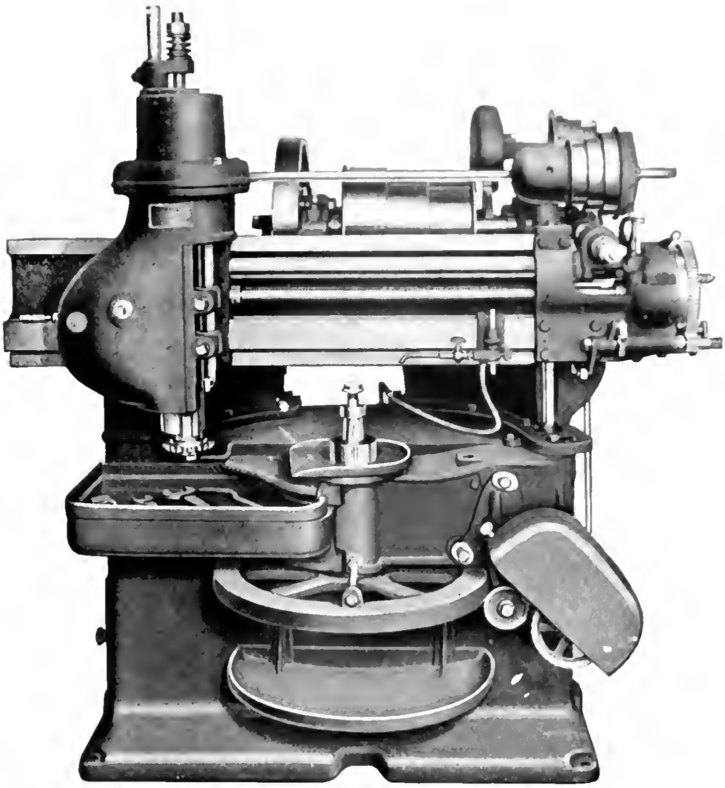
For 20 rotating gear cutters, 5 operators at $2.75......$13.75

For 14 Gear Shapers, 3 operators at $2.75 8.25

One operator could run four ordinary gear cutters while one operator could run five Gear Shapers.

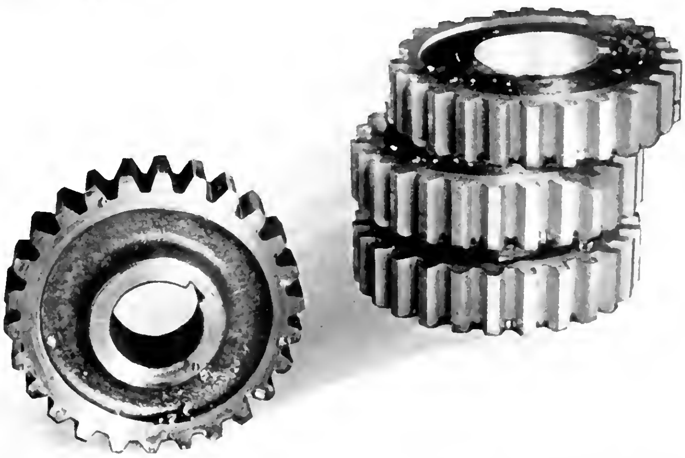
Now consider cutter costs. The rotary milling cutter costs $6.54 and cuts 300 gears before giving out. The Gear Shaper cutter costs $11.50 and cuts 600 gears before giving out.

Here are the figures for cutting a lot of 3000 gears:



Cost on ordinary gear cutters:—20 machines run by 5 operators for 3 days at $2.75	**$41.25**
10 cutters at $6.54	**65.40**
Total	**$106.65**
Average cost per gear	**.035**

Cost of cutting 3000 gears on the Gear Shaper:—14 machines run by 3 operators for 3 days	**$24.75**
5 Gear Shaper cutters at $11.50	**57.50**
Total	**$82.25**
Average Gear Shaper cost per gear	**.027**



And bear in mind that gears from the gear shaper were much better quality than those secured from the other types of machines. This concern now uses Gear Shapers exclusively for roughing and finishing transmission gears.

How do you do this work?

COMPANY, Springfield, Vermont

FOREIGN AGENTS:

Great Britain, Henry Kelley & Co., Manchester. Austria, White, Child & Beney, Vienna. Japan, Manning, Maxwell & Moore, Inc.

"I Bought These Three B & S Hammers Just After the Chicago World's Fair

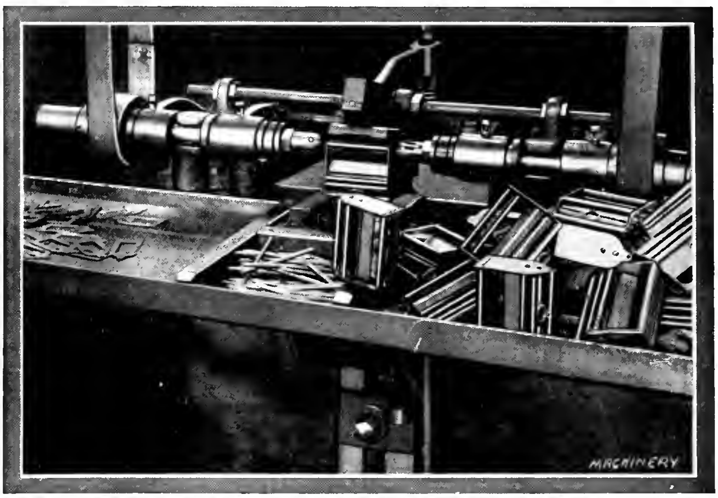
—I was making good money then for a youngster just out of his apprenticeship, and I bought the best tools I could get. I have put at least ten handles in the smallest hammer, and many in the others, too; but the hammers themselves are just as good as they were over twenty years ago, when I bought them."

G. O. Carlson, Die Sinker, Wethersfield, Conn., now runs a successful business of his own, and the longer he uses his Billings & Spencer Hammers the better satisfied he is with them.

This is the verdict of all users of B & S Tools. The longer you use them and the more of them you use, the better you'll like them. *May we send the catalogue?*

THE BILLINGS & SPENCER CO.
HARTFORD, CONN., U.S.A.

Riveting Both Sides at Once



This Grant Rivet Spinning Machine spins the heads on two rivets at opposite ends of the piece of work simultaneously. There's no reversing of the piece nor doing the job one head at a time—just a case of laying the work between the heads and putting your foot on the pedal. There are six 1-8 inch rivets in each one of these automatic stropping frames, and an unskilled operator heads them faster than they can be assembled by a girl.

There isn't a class of riveting where Grant machines won't fit, from work as large as agricultural implements, to as small as that of the clip cap on a fountain pen. Your work lies somewhere between these two extremes and we stand ready to demonstrate what a Grant machine will do with it. Costs nothing to have a few pieces riveted.

GRANT MANUFACTURING & MACHINE COMPANY
N. W. Station **BRIDGEPORT, CONNECTICUT, U. S. A.**

Thurlow Steel & Forging Co., Chester, Pa., has its plant in operation for manufacturing forgings, crankshafts, die blocks, bars, etc. The plant is equipped to produce forgings weighing from 1 to 10,000 pounds, the equipment including steam hammers and a 1000-ton forging press for heavy forgings and die work. Heat-treating furnaces have also been provided and a machine shop for roughing and finishing crankshafts, etc. The plant is under the management of John I. Rogers and Daniel C. Eagan.

Joseph T. Ryerson & Son, Chicago, Ill., announce the establishment of warehouses in St. Louis, Mo., for immediate service in their lines of finished steel to customers in the territory tributary to St. Louis. The plant, merchandise, equipment and good will of the W. G. Hagar Iron Co. have been taken over. The facilities of this plant will be immediately supplemented with complete modern warehouses and equipment for the handling and cutting of shapes, plates, reinforcing bars and similar heavy material.

Bertsch & Co., Cambridge City, Ind., builders of shears, punches, rolls, presses and special machinery for fabricating sheet metal, plates and structural steel, have erected new machine shop and foundry buildings. The foundry is of the monitor roof type having a fifteen-ton traveling crane in the center bay. The building is heated by hot air forced draft system. Fenestra steel window sash in the side walls and monitor admit a great volume of light. The machine shop is of the same general design, having large window area. The center bay is provided with a thirty-ton traveling crane and the building is heated and ventilated by the forced draft system.

Ansonia Mfg. Co., Ansonia, Conn., has purchased the Hampden Machine Screw Co. of Springfield, Mass., and the business and equipment will be moved to Ansonia immediately. Archibald R. Lemieux, who was secretary and manager of the Hampden Machine Screw Co., becomes general manager of the Ansonia Mfg. Co. The consolidation will enable the Ansonia Mfg. Co., maker of brass goods from sheet wire and rod, wind shields, pumps and auto accessories, to serve its customers better, generally.

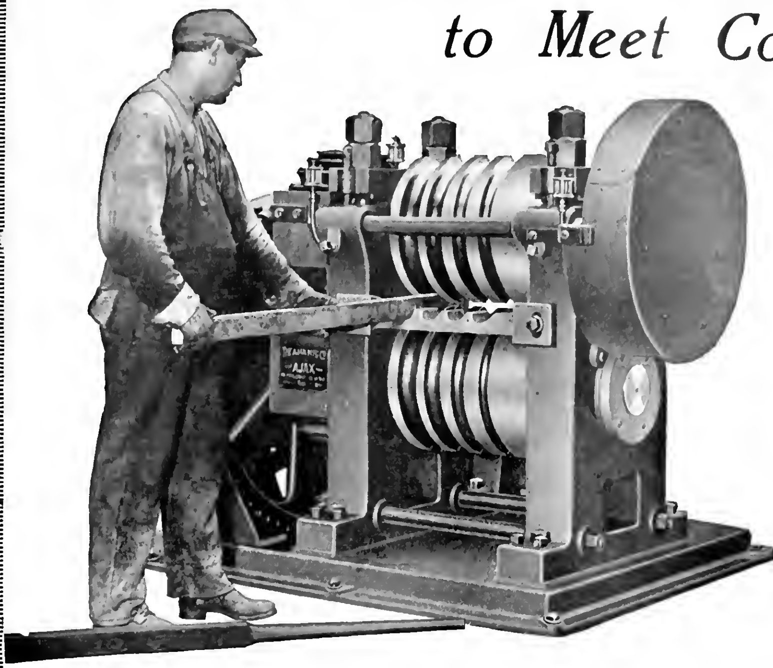
Keuffel & Esser Co., Hoboken, N. J., has moved its Chicago branch to the seven-story Keuffel & Esser Bldg., 516-520 S. Dearborn St. The company recently purchased this building and will occupy the greater part of it. It is situated near the "loop" half a block from an elevated station, mid-way between Van Buren and Harrison Sts., and near the important office buildings which house many of Keuffel & Esser's customers. A complete blueprint department has been installed, with much better facilities than that in the old location at 68 W. Madison St.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, is introducing a system for cooling and distributing drinking water known as the J-M system, which furnishes water at a temperature of 50 to 55 degrees F. Investigation made by Dr. Darlington, secretary of the welfare committee of the American Iron & Steel Institute, shows that water is most enjoyable at this temperature, having a stimulating action on the heart and relieving fatigue and exhaustion by equalizing the temperature of the body. The water is cooled by an A-S refrigerating machine and is then piped to bubbler fountains placed at convenient locations throughout the plant. A booklet describing the system in detail may be obtained on request.

Potter & Johnston Machine Co., Pawtucket, R. I., and the Windsor Machine Co., Windsor, Vt., have begun the erection of works at Tyseley, Birmingham, England, for the manufacture of Potter & Johnston automatic chucking machines, automatic center turning machines, automatic milling machines, automatic cutting-off machines, universal shaping machines and shaving machines, Gridley four-spindle automatic bar machines and automatic multiple-spindle drilling machines. All the foregoing machines are covered by British and foreign patents; and the establishment of the British works will enable the companies to better serve their ever-increasing number of European customers. In addition to the manufacture of the machines mentioned a specially organized toolmaking department for the prompt filling of orders for tools required by European customers will be established. The service of this department will avoid the delays caused in transport when shipped from American shops. The new works will be ready for occupancy next fall.

Billings & Spencer Co., Hartford, Conn., has bought the plant of the Columbia Motor Car Co. of Hartford, including 8¼ acres of ground. The purchase price was $350,000. The Billings & Spencer Co. has outgrown its present quarters, and the purchase of the Columbia factory will afford room for much needed expansion. The tract has a frontage of 221 feet on Laurel St. and 1024 feet on Park St. The land covered by buildings is 2.29 acres and the floor area of the building is 227,952 square feet. The plant is ideal for the manufacture of drop forgings, machinists' tools, wrenches, etc. The Billings & Spencer Co., which was organized in 1872, has grown steadily, and it turns out from 10,000 to 12,000 tons of steel forgings annually. It was founded by C. E. Billings and C. M. Spencer, who were the pioneer drop-forgers in Hartford. They were interested in the Roper Sporting Arms Co. of Amherst, Mass., maker of repeating shot guns, which concern was taken to Hartford in 1868. The newly acquired plant has excellent railroad facilities, a spur track from the N. Y., N. H. & H. R. R. running into the plant which will make the handling of heavy tonnage economical.

The Superintendent Found a Way to Meet Competition



Competition was sharp, prices were being cut and "the other fellow" was getting away with the business.

Then the superintendent saw an illustration in a trade paper that suggested something to him. He found that he could take a piece that had been laboriously tapered on the steam hammer, and produce it in less than a minute on

Ajax Taper Forging Rolls

(Trade Mark Registered)

He investigated this proposition at once and not only cut the cost on this important part of the product, but produced a forging free from hammer marks and defects which proved a valuable selling argument.

The cost of maintaining and repairing hammers, and the frequent delay in operations has also been done away with in this plant.

Even if you are not worried by competition it will pay you to investigate this method of producing the tapered pieces you use in your product.

If in doubt as to what can be done, consult the Ajax Engineers. Their advice is free and *they have to make good* on their estimates.

Here are some of the pieces successfully produced by this method:

Automobile Truck Axles.
Trolley Poles.
Drag Bars (for implements).
Seat Springs.
Wedges.
Brake Shoe Keys.
Tong Jaws.
Track Wrenches.
Brake Levers.
Ship Liners.
Gun Barrels.
Pliers.
Tubing.
Carriage and Wagon Axles.
Body Irons.
Bailey Body Loops.

The Ajax Manufacturing Company

Chicago Office
621 Marquette Bldg.

Cleveland, Ohio

New York Office
1369 Hudson Terminal

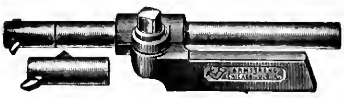
THERE'S AN

ARMSTRONG BORING TOOL

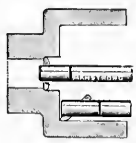
TO MEET YOUR REQUIREMENTS

Forged Boring Tools are expensive—inefficient. They are wasteful of time and tool steel and very expensive to maintain, especially if high speed steel is used—ARMSTRONG BORING TOOLS use high speed steel efficiently and economically, and are made in a range of sizes suitable for all classes of work, light or heavy.

Armstrong Boring Tools require no forging or tempering and very little grinding. They are always ready for use, are very stiff and will bore close up to a shoulder or bottom. One Armstrong Boring Tool will take the place of a dozen forged boring tools. Made in seven sizes.



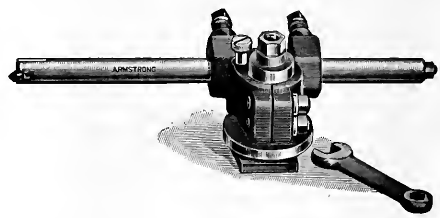
This cut shows Double Ended Cutter roughing out cored hole; also angle cutter boring and facing end.



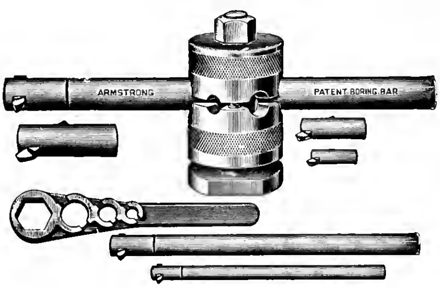
Showing Tool Cutting an internal thread

Armstrong Adjustable Boring Tool

This tool combines Convenience, Adjustability and Rigidity to a remarkable degree and is well adapted to a very wide range of work. The holder is easily adjustable to different heights and will hold bars of various diameters. The bars are made from high carbon steel seamless tubing of heavy gauge and are extremely stiff. The cutter can be adjusted and solidly fixed at various angles for Boring, Facing or Turning. Made in four sizes.



Armstrong 3-Bar Boring Tool

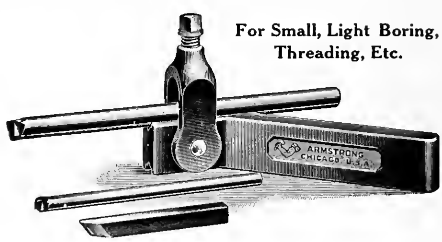


The many points of advantage of this lathe attachment will be appreciated by practical machinists. A slight turn of one nut releases or fastens both bar and holder. Bars can be changed as needed almost instantly, thus allowing the operator to use the stiffest bar possible for each job, with the result that speeds and feeds can be increased and time saved. Made in four sizes.

Armstrong Boring Tool Holder

This tool will be found very handy in the Tool Room or in Boring work of small internal diameter, Threading, Brass Turning, etc. The boring bars furnished are made from the best tool steel properly hardened, tempered and ground ready for use. The holder is reversible, and can be used for turning either right or left hand. Made in four sizes.

For Small, Light Boring, Threading, Etc.



Catalog A-12 sent upon request

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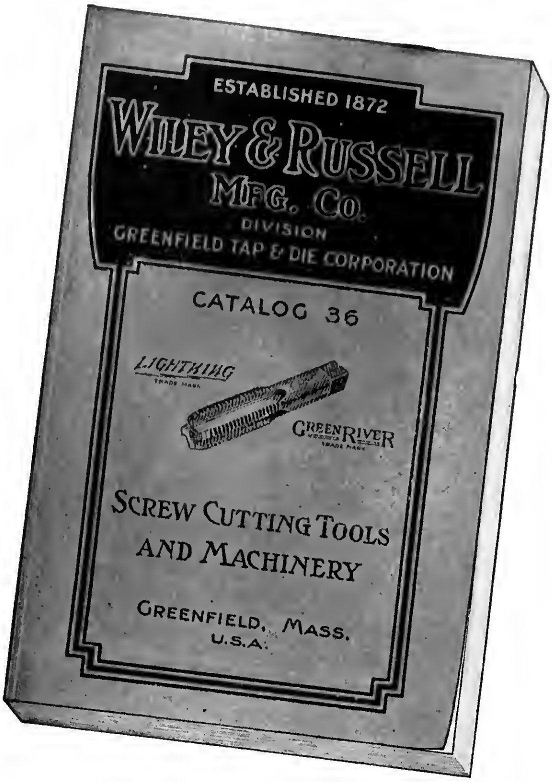

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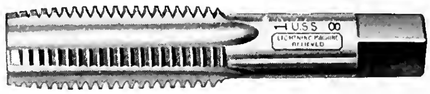
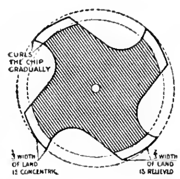
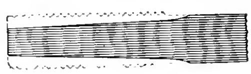


1. A cutting edge that gradually curls and finally breaks the chips



2. A relief built into each tooth
3. A flute stronger toward the shank than at the point



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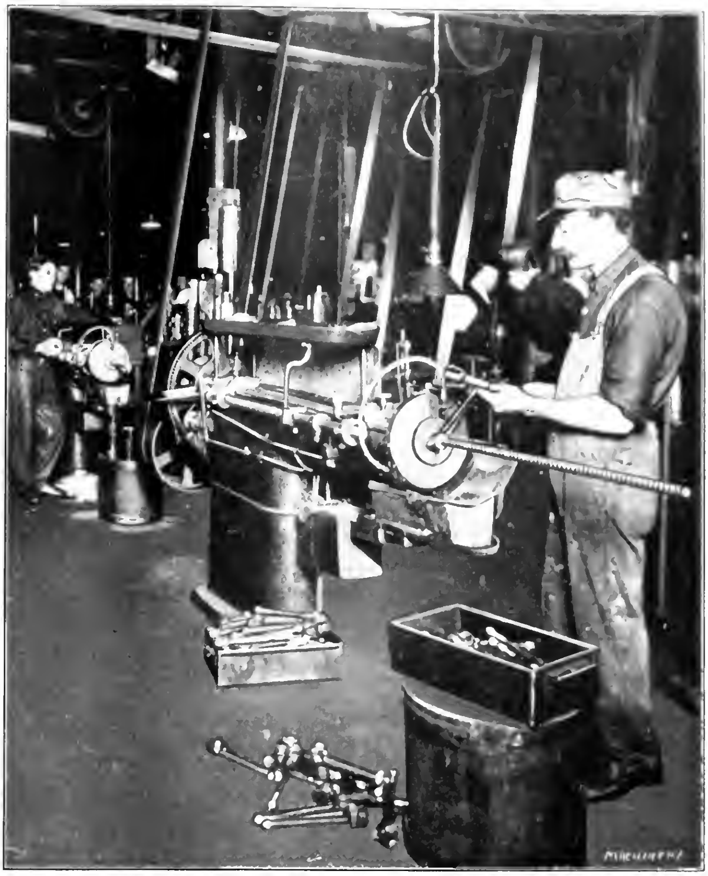
The Original Lapointe Broaching Machine and the Automobile Parts Manufacturer



A great field for the broaching machine is in the manufacture of automobile parts—and the great machine for making these parts is the Original Lapointe Broaching Machine. This is the machine which made the economical production of some automobile fittings possible—square holes, for example, in change speed gears, steering cranks, etc.

The first machine in the above illustration is in operation on steering cranks. A square hole 15-16" across the flats, 1 1-8" across the corners by 1 3-16" long is broached through this drop-forged steel crank. The machine further down the line is broaching four splines in chrome nickel steel sliding gears. These splines are 0.383" wide by 3-16" deep and 2 3-8" long.

There are many other examples; but these are sufficient to show the efficiency of the Lapointe Machine on either square, round or splined hole work. Automobile parts are broached on this machine at the rate of from 20 to 40 pieces per hour according to conditions.

Let us tell you more about the possibilities of broaching.

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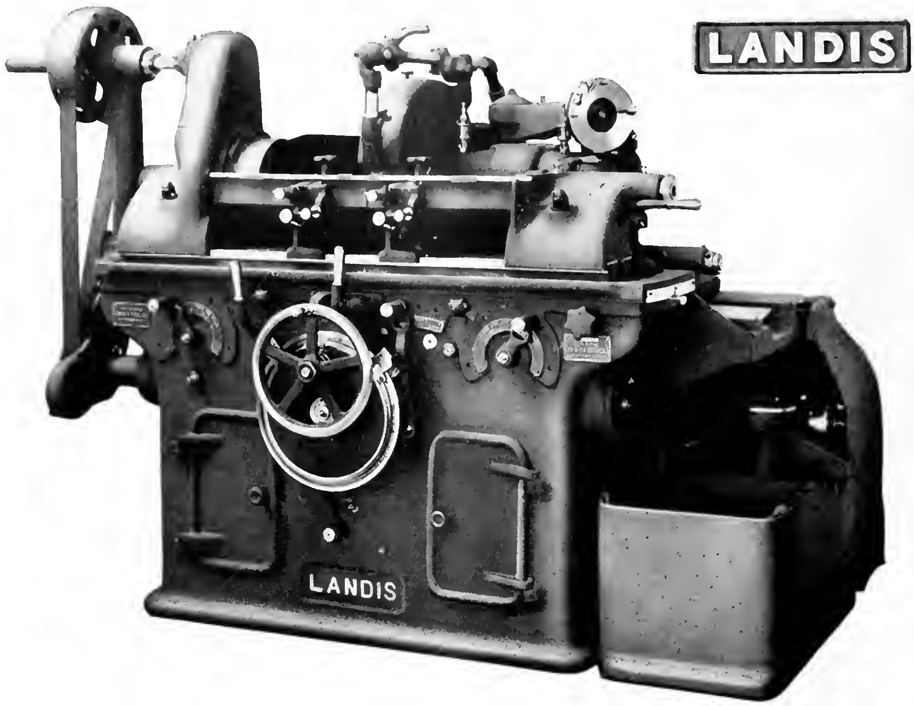
Important Development i



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One of Twelve

NORTON GRINDING MACHINES

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Willys-Garford Plant

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There are reasons for Norton Grinding Machine superiority. The principle of carrying the work past a fixed grinding point is right. The method of driving the wheel and the proportion and design of the carriage are carefully worked out to support this principle. Norton Grinding Machines are built with convenience of operation constantly in mind. They are accurate and convenient and rapid work producers. They carry large, heavy wheels which remove stock quickly.

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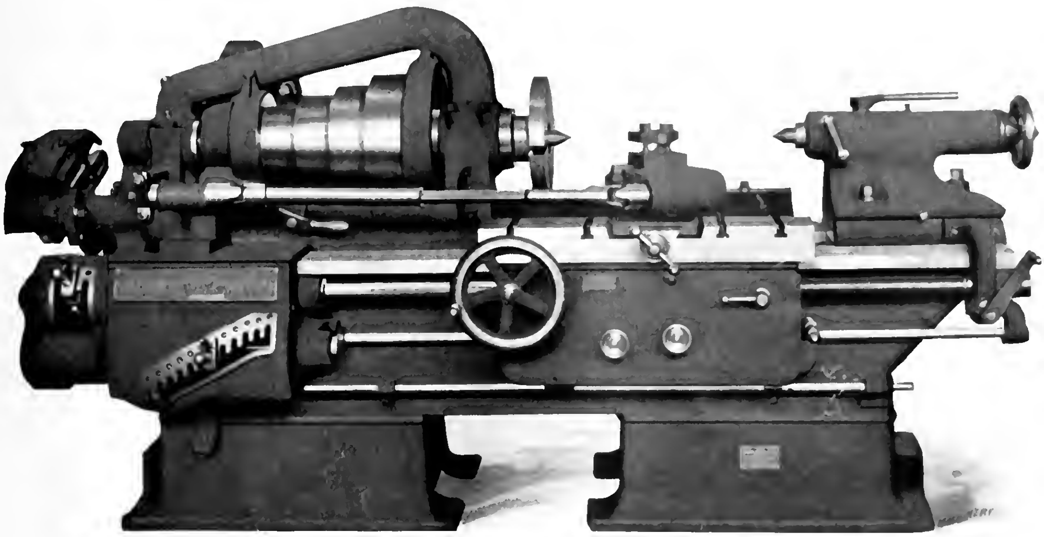

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The relieving attachment is capable of handling any work which will swing over cross slide. It will relieve either straight or spirally fluted work, formed cutters, hollow mills, right- and left-hand taps, etc.

Toolmakers are realizing more and more the value of relieved teeth in special hobs, formed cutters and taps such as they have been in the habit of making themselves, but have not been able to accomplish these results before on the larger sizes of work. This 24″ lathe meets this need in a very satisfactory manner.

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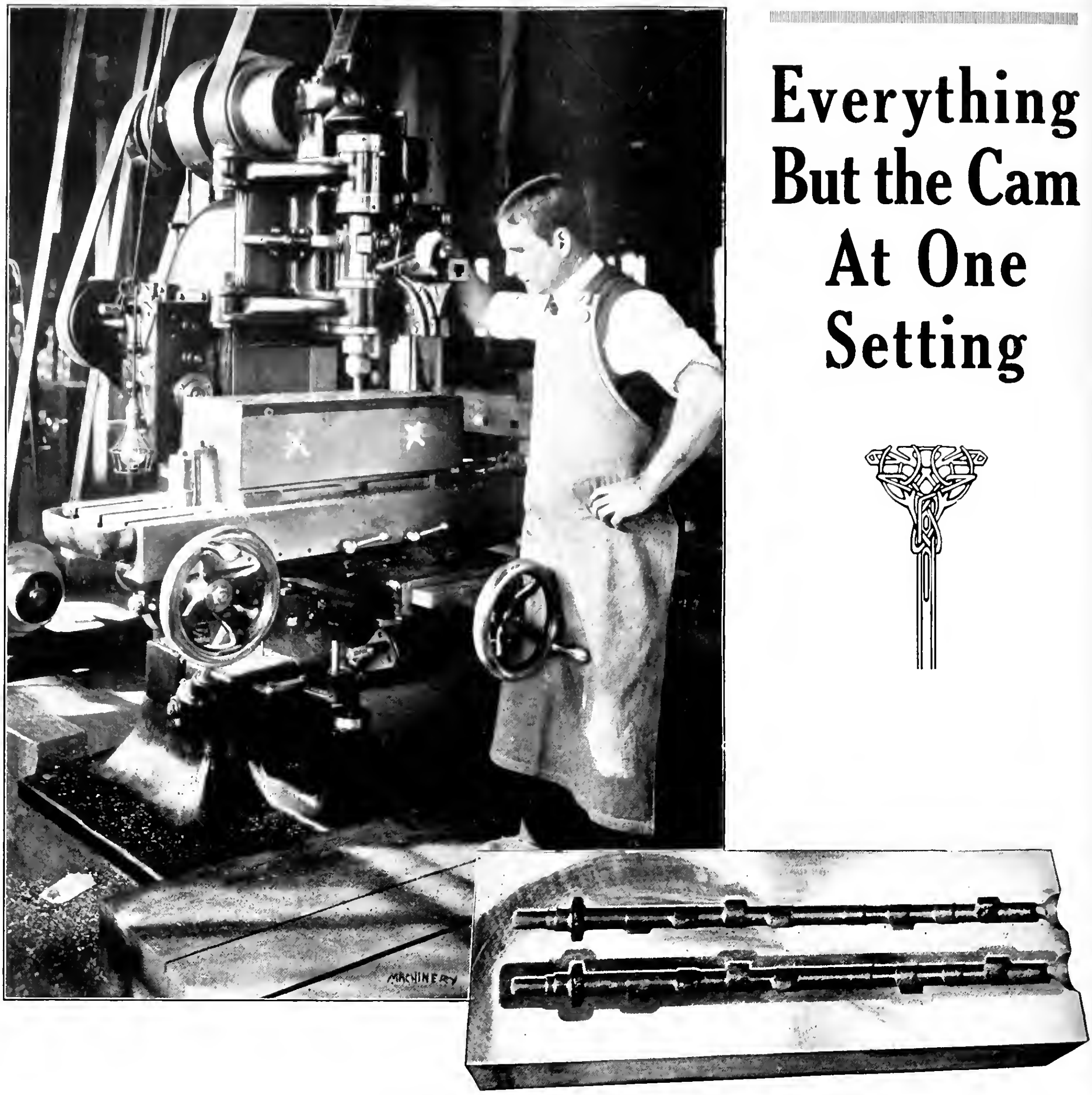

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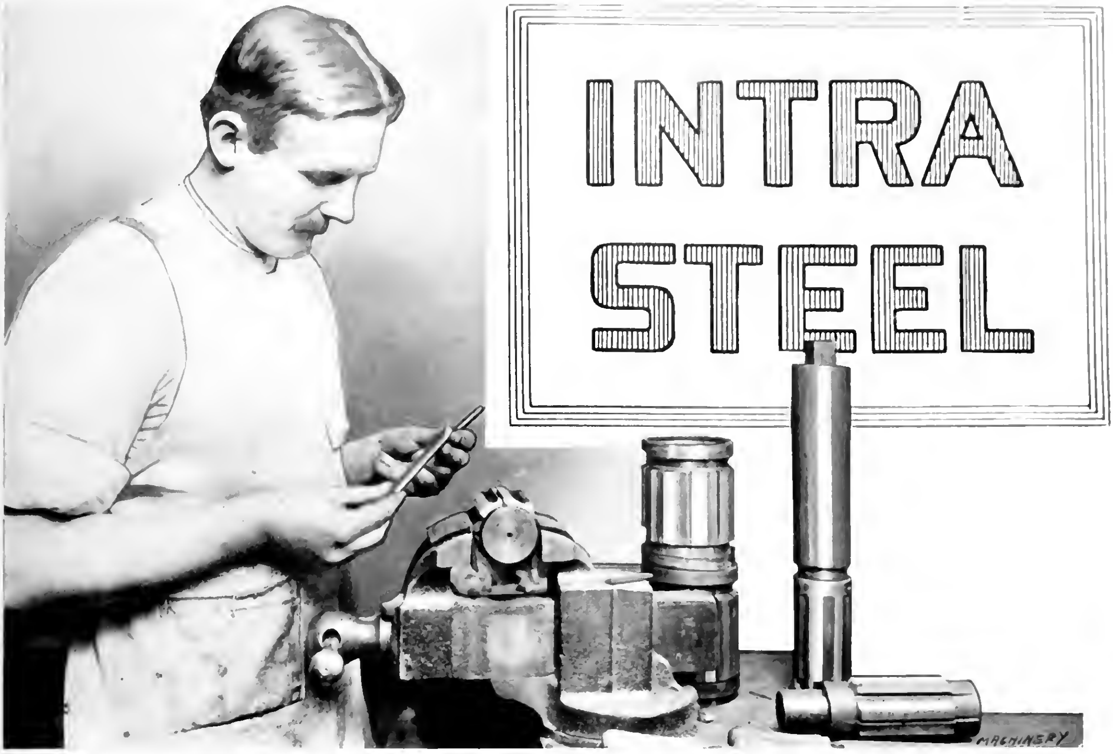
JACKSON MACHINE TOOL COMPANY

JACKSON, MICHIGAN, U. S. A.



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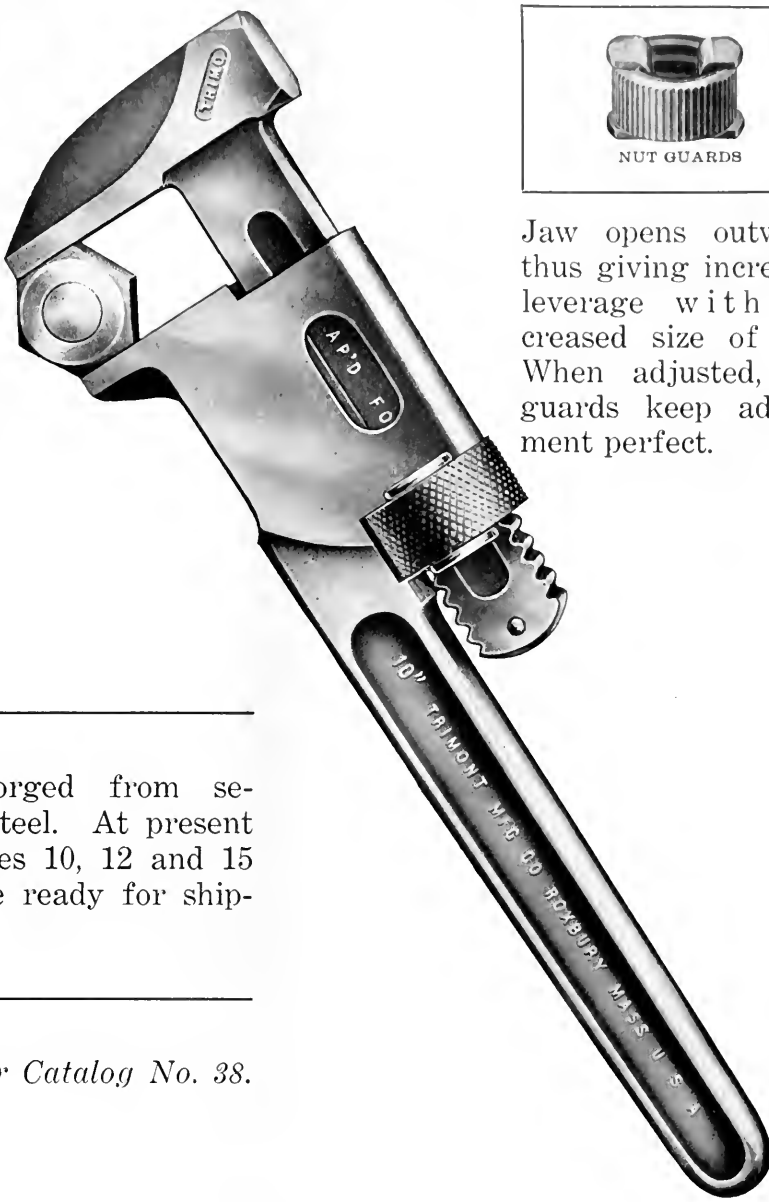
Jaw opens outward, thus giving increased leverage with increased size of nut. When adjusted, nut guards keep adjustment perfect.



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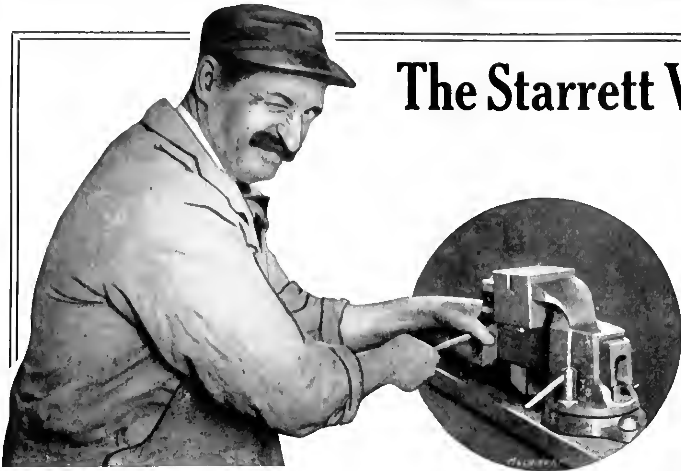
55 to 71 Amory Street **Roxbury (Boston), Mass., U. S. A.**

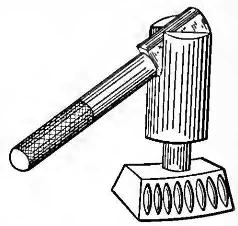
The Starrett Vise "Stays Put"



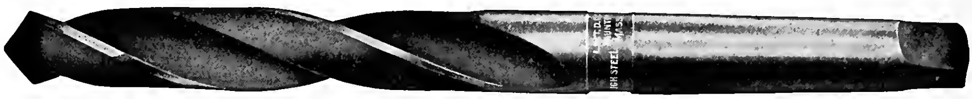
The new Starrett Vise with swiveled base is entirely new. Two faults are usually accredited to swivel base vises. The pin type always has backlash; the clamping bolt type has a tendency to slip. We use the clamping bolt scheme—but note the clamping bolt we use. The corrugated edges pull up in the corresponding corrugations at base of the vise; all other clamping bolts are smooth instead of corrugated.

Your strongest men cannot budge the Starrett Vise from a clamped position. Here is one of our "big fellows" trying to, but he couldn't stir it.

We make this swivel vise with that new style handle which is so popular—adjustable—any position when you need it; out of the way when you don't. *Let us send you more vise details.*



ATHOL MACHINE CO., Athol, Mass.



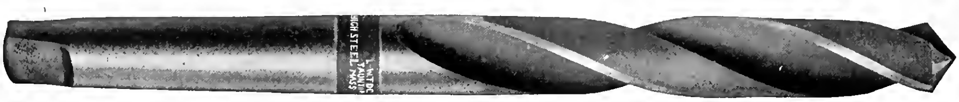
AN HONEST DRILL

like an honest man, is a good friend and a good servant.

Lincoln-Williams Twist Drills

never disappoint the user — they meet requirements from the standpoint of adaptability and they stand high speeds and heavy service. The best Vanadium Steel is used in Lincoln-Williams Tools, and they are made by a special process that insures toughness, good temper and long-wearing cutting edges.

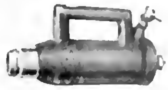
Styles and sizes for your needs today and tomorrow. Catalog for list.



Lincoln-Williams Twist Drill Company
TAUNTON, MASS., U. S. A.

"Little David," Scaler.

"Little David" Calker.



Holder-On.

"Little David" Riveter.

"Little David" with Safety Retainer.

PNEUMATIC TOOLS

FOR THE

Boiler Maker—Machinist—Foundryman—Iron Worker

"Crown" Floor Rammer.

"Crown" Bench Rammer.

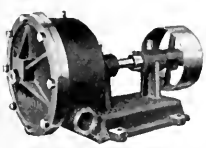
The Ingersoll-Rand pneumatic tool line is the most extensive offered the trade, and covers all the requirements of the railroad shop, the boiler shop, machine shop, foundry and iron work.

It comprises such well-known tools as the "Little David" Drills, Calkers, Riveters and Chippers, "Imperial" Hoists and "Crown" Rammers.

In the pneumatic tool field the trade names, "Little David," "Imperial" and "Crown," are recognized as representative of the very best practice. They stand for an efficiency and economy of operation unapproached by others.

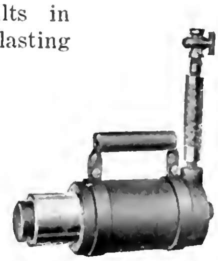
In designing these tools, such factors as ease of operation, large work capacity and adaptability, low maintenance and air consumption have been so well provided for, that many plants, including some of the very largest, have standardized on them.

They are built as well as it is possible to do so. Metals of quality are used throughout; wearing parts are of hardened and ground special alloy steels, and special oil treatment of metals results in a product of exceptional lasting qualities.



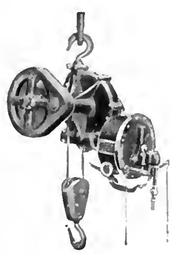
"Imperial" Motor.

SEND FOR BOOKLET 698
containing full information

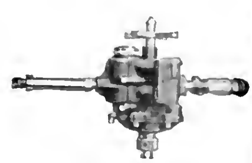


"Little David" Jam Riveter.

"Little David" Wood Boring Drill.



"Imperial" Air Hoist.



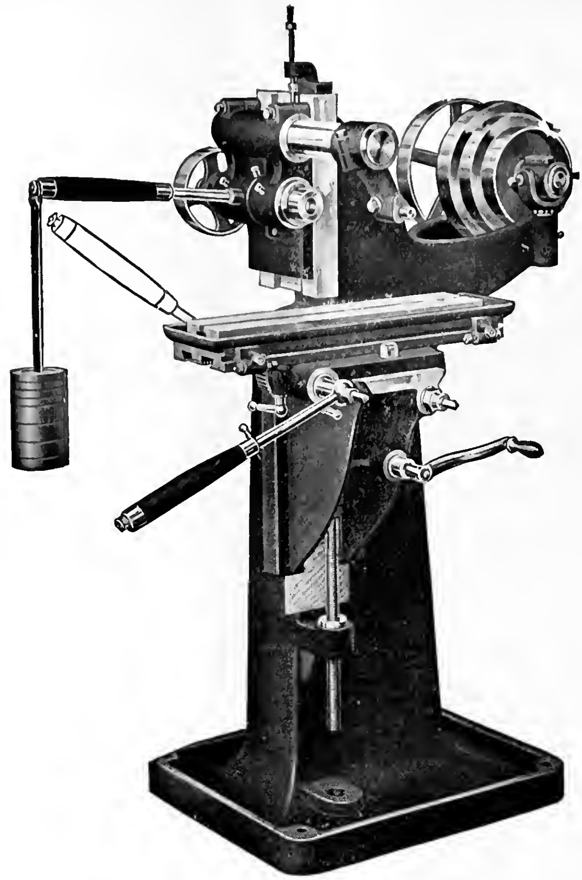
"Little David" Drill.

INGERSOLL-RAND COMPANY

NEW YORK — Offices the World Over — LONDON

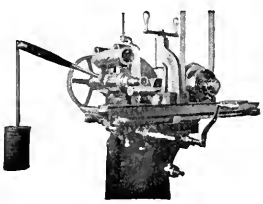
Air Compressors — Air Lift Pumping

6 PT

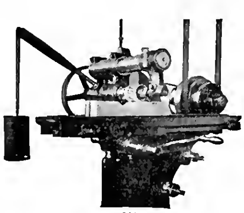


THE "WHITNEY" HAND AND WEIGHT (FEED) MILLING MACHINE

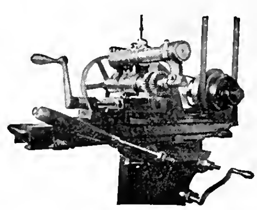
For Cam Cutting, Gear Cutting, Key-seating, Profiling, Slotting, Slabbing, etc., this machine is the handiest and most adaptable on the market.



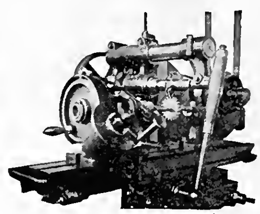
Keyseating



Profiling

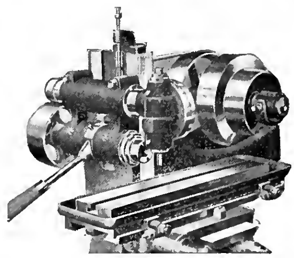


Straddle Milling



Sprocket or Gear Cutting

No machine shop or toolroom is complete without a "Whitney" Milling Machine. Its wide range of work will pay for itself in a short time.



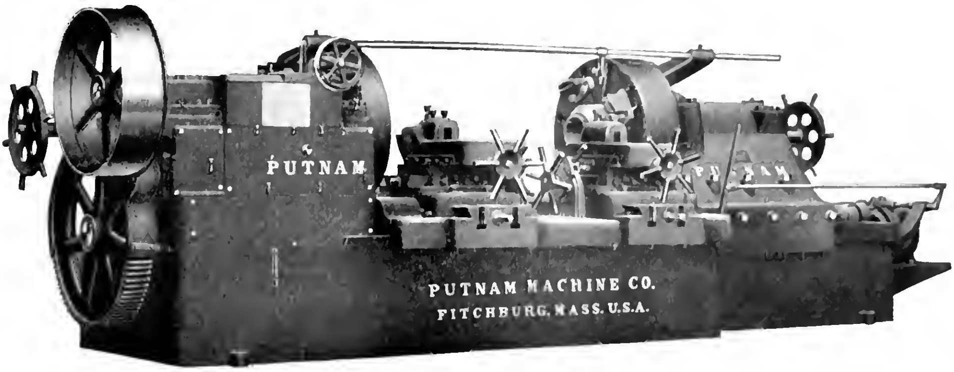
This Universal High Speed Milling Attachment permits the use of end mills and makes the machine desirable for die sinking, profiling, drilling and all classes of light milling where small cutters and high speeds are necessary.

THE WHITNEY MFG. CO., Hartford, Conn.

Manufacturers of High Grade Driving Chains, Keys and Cutters for
The Woodruff System of Keying, Hand (feed) Milling Machines.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London. Fenwick Freres & Co., Paris. F. G. Kretschmer & Co., Frankfurt, a/M., Germany.

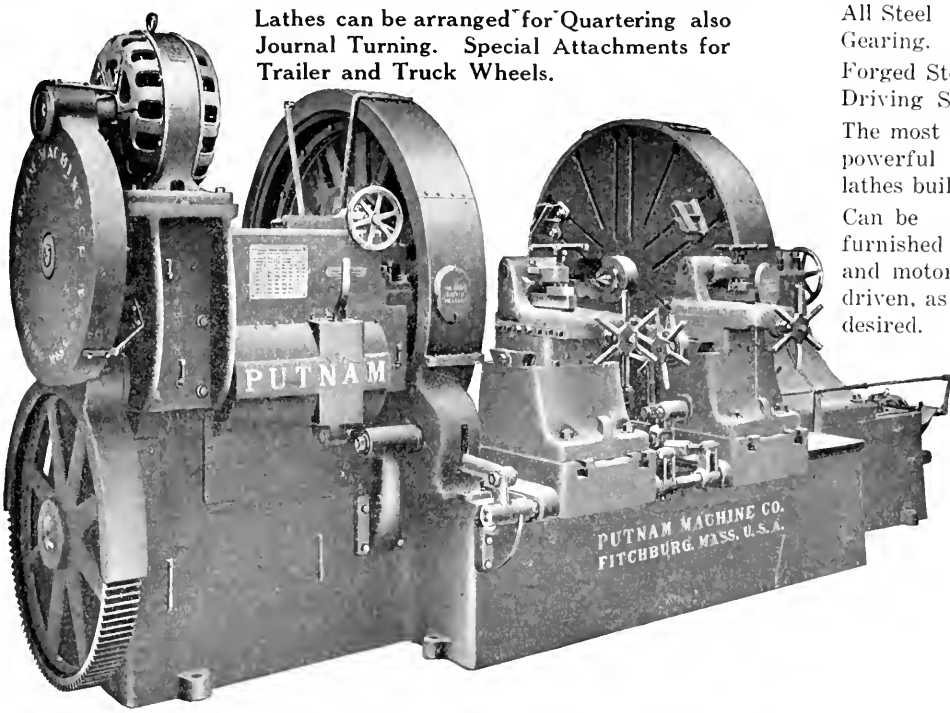
PUTNAM
Latest Pattern 42" Coach Wheel Lathe



All Steel Gearing. Heaviest and strongest built. Belt or motor driven, as desired. Combination Tool Holder. Putnam Driving Dogs. Automatic Tailstock Binding Device. Calipering Device.

PUTNAM
Latest Pattern 79", 85", 90" Driving Wheel Lathes

Lathes can be arranged for Quartering also Journal Turning. Special Attachments for Trailer and Truck Wheels.



All Steel Gearing.

Forged Steel Driving Shaft.

The most powerful lathes built.

Can be furnished belt and motor driven, as desired.

MANNING, MAXWELL & MOORE, Inc.

119 WEST 40TH STREET, NEW YORK

Machine Shop and Foundry Equipment of Every Description

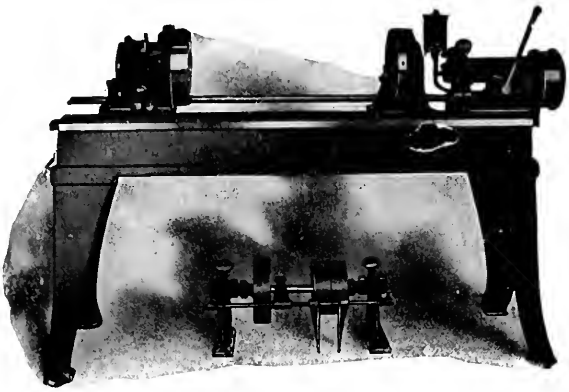
BRANCH OFFICES

Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Mexico City, Mexico, Milwaukee, New Haven, Philadelphia, Pittsburgh, St. Louis, San Francisco, Yokohama, Japan

THE WHITON

REVOLVING CENTERING MACHINE

FOR ACCURATELY CENTERING FINISHED SHAFTS



The cut shows new **Revolving Centering Machine**—a large size of the well known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

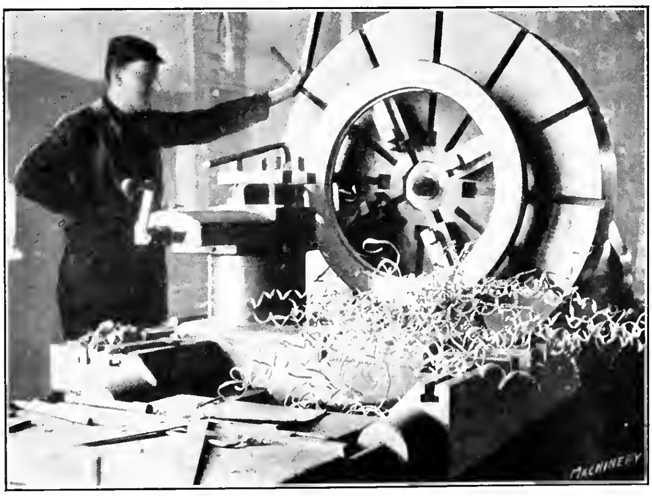
Constructed same as the smaller machine and embodies all the special features.

Circulars and prices sent upon application.

THE D. E. WHITON MACHINE COMPANY

NEW LONDON **CONNECTICUT, U. S. A.**

Tire Molds Turned on a "New Haven" are Accurate



New Haven Lathes are used in the shops of J. E. Thropp & Sons, Trenton, N. J., for turning steel tire molds, which are made from very stringy, tough, fifty-point carbon steel. The finished work must be accurate, perfectly smooth, free from chatter marks or rough cutting—that's why the "New Haven" is preferred. The proof of "New Haven" service in this shop lies in the fact that it is only five years since the first *New Haven Lathe* was installed and now there are *seven*, running twenty-three and one-half out of every twenty-four hours.

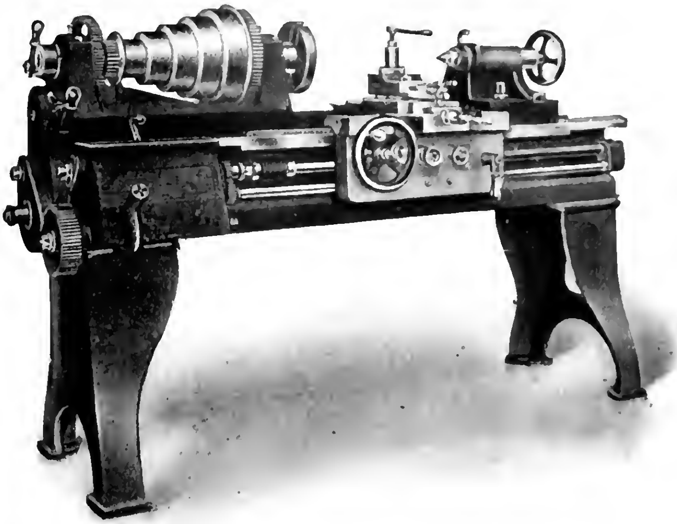
If your work requires a heavy duty, accurate, durable lathe, investigate the New Haven. Catalogue on request.

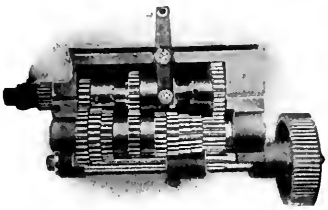
NEW HAVEN MFG. COMPANY, New Haven, Conn.

The Flather Quick Change Gear Lathe

Latest and Best.
Strong and Simple.
Least number
of Gears.
Greatest number of
Threads and Feeds.

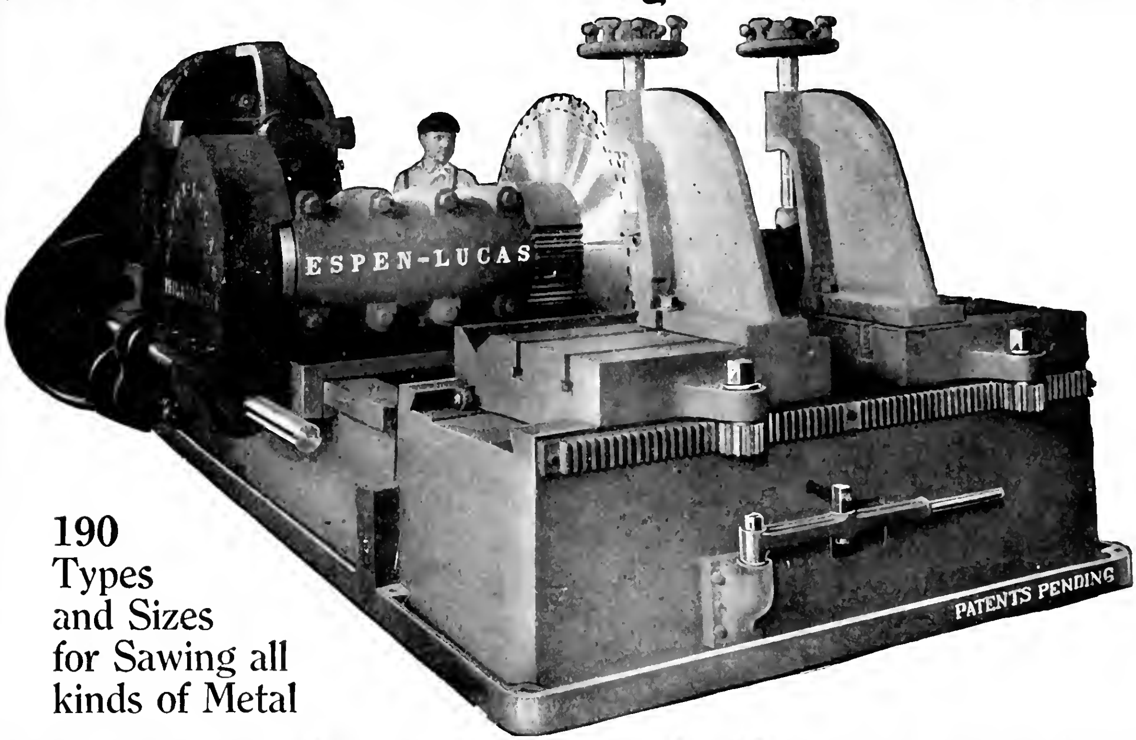
Send for descriptive circular.





Flather & Company, Incorporated, **Nashua, N. H.**

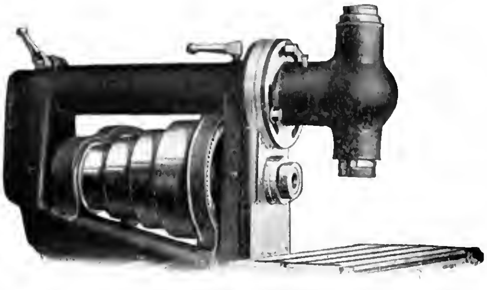
This is the Fastest Cold Sawing Machine in the World



190
Types
and Sizes
for Sawing all
kinds of Metal

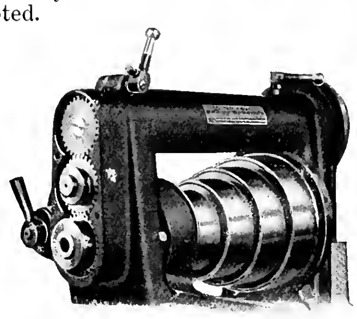
THE ESPEN-LUCAS MACHINE WORKS, Front and Girard Avenues PHILADELPHIA, PA.

Attachments



Vertical Attachment

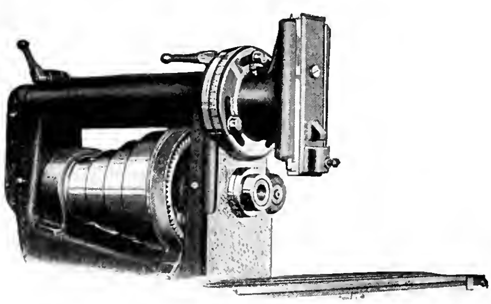
Adding a good attachment to a good machine is a step forward every time. We make *Rockford Universal Milling Machines* as good as they can be made and the attachments the same way. There is an attachment for Vertical milling that appeals where work is varied, where time is limited and where only accurate, fast machine work is accepted.



Rear view showing geared drive for attachments

There is a Slotting Attachment which widens the range, making the milling machine into a first-class Slotter in short order. With these facilities many jobs can be accomplished on the "Rockford" at one setting of the piece, which would ordinarily require several different operations.

If this outline appeals to you, send for more solid "Rockford" facts.



Slotting Attachment

Rockford Milling Machine Co.

ROCKFORD, ILL., U. S. A.

Cutting for Fun or Profit?

How does the work you send to the Shaper department come through? Is there profit in it? Are results perfectly satisfactory?

No matter how hard you are to please, the design, workmanship and general construction of "Kelly" Shapers will appeal to you at once, as will the quality and quantity of "Kelly" output. We have paid special attention to accuracy, believing that a shaper should, above all, be accurate and *stay* accurate.

"Kelly" Crank Shapers do not chatter on the cutting stroke, and planing to an exact line on heavy cuts is made possible by table supports which prevent sagging.

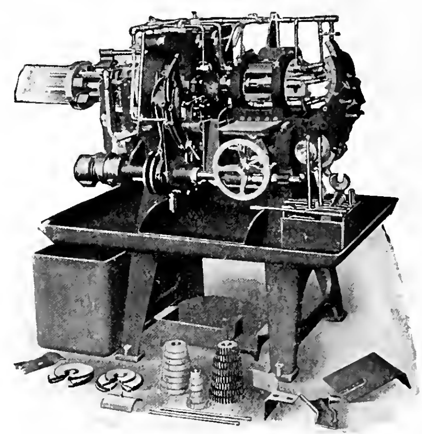
Ask for circular when you write.

The R. A. Kelly Company

XENIA, OHIO

A Matter of Screws

If you are one of the increasing number of manufacturers who takes pride in building up to a high efficiency standpoint, in stopping the leaks and increasing profits, it's time to take up the *Screw* question. Do you make them or buy them? A *Davenport Multiple Spindle Automatic Screw Machine* leaves no doubt about the *best* way. If you don't believe it, ask those who use them.



Complete specifications and details on request. Write now.

DAVENPORT MACHINE TOOL CO.

NEW BEDFORD MASSACHUSETTS

AGENTS: Motch & Merryweather Machinery Co., Cleveland, Cincinnati, Detroit and Pittsburgh. F. G. Kretschmer & Co., Frankfurt, Germany, and Wien IX/2 Michelbeurnstrasse, 1A. Charles Churchill & Co., Ltd., London, Manchester, Birmingham, Newcastle-on-Tyne and Glasgow.

CYLINDRICAL STEEL GRINDING — ALOXITE WHEEL

THERE is joy on the job when the grinding wheel is right—when it is cutting fast, free, clean, without filling up or losing its shape, giving just the finish you want, turning out more work at a greater profit.

There isn't any one wheel that will do all your grinding—the secret real grinding ability, of getting out the most and the best work in the least time is to get

GRINDING ALUMINUM CASTING
CARBORUNDUM WHEEL

The Right Wheel in the Right Place

¶Our Service Department is ready and willing to lend its years of experience to help you get this wheel.

¶*If you are grinding brass, bronze, cast iron, or aluminum—CARBORUNDUM.*

¶*If you are grinding steel of any kind—reamers, cutters, drills, malleables—ALOXITE.*

The Carborundum Company
Niagara Falls, N. Y.
New York Chicago Boston Philadelphia
Pittsburgh Cleveland Cincinnati
Grand Rapids Milwaukee
London, Eng.

Alundum
TRADE MARK REGISTERED

Crystolon
TRADE MARK REGISTERED

NORTON
TRADE MARK REGISTERED

Experience

and

Science

¶ Experience is a vital factor in determining the correct wheel to meet existing conditions—or in correcting the conditions. Correct conditions mean greater profits.

Science has been the vital factor in the development of Norton Alundum and Norton Crystolon and in the perfecting of the manufacturing processes that are largely responsible for the quality of

produce

Norton Grinding Wheels

Results

Results that take the form of larger production—lower operating cost—better finish—constitute the substance of reports upon the performance of Norton wheels from foundries and machine shops everywhere.

If you have a grinding problem there is abundant reason why you should inquire if Norton experience can aid in its solution.

You have only to write

Norton Company

Worcester, Mass., U.S.A.

New York Store
151 Chambers Street

Chicago Store
11 North Jefferson Street

Electric Furnace Plants
Niagara Falls, N.Y.; Chippawa, Ont., Can.

686

A New Bryant Chucking Grinder—Phenomenally Fast

THIS is the new Bryant Chucking Grinder in action—a machine we furnished the Brown-Lipe-Chapin Company, Syracuse, N. Y. We have claimed it was fast—here is an example which shows just what we mean by fast.

The work is high carbon steel side bevel gears for differentials. Dimensions of hole, $1\frac{1}{4}''$ by $2''$. Production, 400 in nine hours.

Phenomenal? Yes.

If you are grinding work within the range of this new Bryant machine, we'll show you production possibilities which you probably won't believe—till we prove them. This sounds big. It is big—the biggest thing in the grinding field today.

You should know all about it. Will you write?

BRYANT CHUCKING GRINDER COMPANY
SPRINGFIELD VERMONT, U. S. A.

Builders of One, Two and Three Spindle Chucking Grinders

EUROPEAN AGENTS: Germany, Holland, Belgium, Switzerland, Italy and Austria-Hungary, M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany. Great Britain, James R. Kelly & Co., Ltd., 3 Bridge End, Leeds, England. Russia, Schuchardt & Schutte, St. Petersburg, Russia.

AMERICAN GRINDING WHEELS

What we are Doing in Other Shops

Still more instances in which AMERICAN wheels have proved more efficient than other wheels. Seventy-five per cent of our new business is gained through competitive tests. These are but a few of them. Note the wide range of operations, sizes, grains and grades. No other wheel manufacturer can offer you such complete service as we can.

Corundum Wheels
Carbolite Wheels
Emery Wheels

Processes:

VITRIFIED
SILICATE
ELASTIC

For Every Grinding Operation.

BOLT AND NUT WORKS:—$\frac{7}{8}$ x $\frac{1}{4}$ x $\frac{1}{4}$" No. 5860 grade K Corundum wheels for dry grinding teeth of high-speed milling cutters on Brown & Sharpe cutter grinder.

SCREW FACTORY:—6" Dish wheels, No. 5860 grade $1\frac{1}{4}$ W for dry grinding sides of small high-speed steel slotting saws on Norton Tool and Cutter grinder.

STREET RAILWAY SYSTEM:—10 x 2 x 1" No. 24 grade Q Emery wheels for hand dry grinding, with swing frame grinder, of street railway rails (grinding out corrugations, grinding off welded joints, etc).

AUTOMOBILE MANUFACTURE:—18 x 6 x 8" No. 5824 combination grade M Corundum wheels for automatic, wet, cylindrical grinding, of hardened drive shafts, on Landis grinders.

GENERAL MACHINE SHOP:—20 x 4 1/2 x 5 15/16" No. 361 grade R Carbolite wheel for general rough machine shop work, principally snagging cast-iron castings.

TOOL GRINDING:—24 x $2\frac{3}{4}$" Special Corundum wheel No. 2824 grade 3 for automatic grinding, wet, of high-speed steel and high carbon tool steel tools on Sellers No. 1 grinder, in structural steel plant.

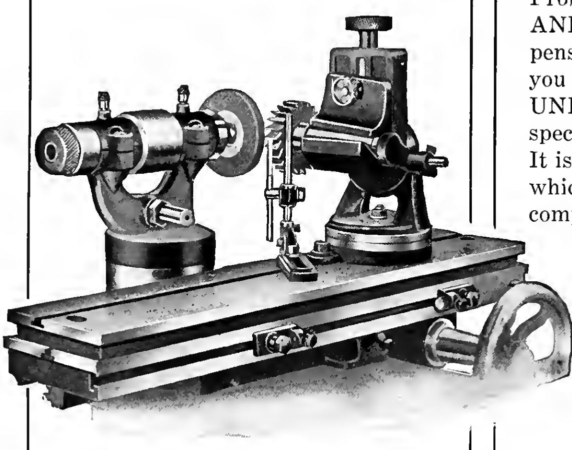
The names of the users cited above will be given on request, and we extend to you the same proposition made to them—we will send wheels for test on your own work, on the basis that unless they are *more* efficient and economical than those you are now using, there is no charge to you. *Write today—no time like the present.*

AMERICAN EMERY WHEEL WORKS

PROVIDENCE, RHODE ISLAND, U. S. A.

Buck & Hickman, Ltd., London, Sheffield, Birmingham, Manchester, Glasgow; R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland; R. S. Stokvis & Fils, Paris, France, and Brussels, Belgium; F. G. Kretschmer & Co., Frankfurt, a/M., Germany; Heinrich Dreyer, Berlin, Germany; Hans Schulze, Vienna, Austria; Kann & Heller, Budapest, Hungary; A. B. V. Lowener, Stockholm, Sweden; V. Lowener, Copenhagen, Denmark; V. Lowener's Maskinforretning, Sverre Mohn, Christiania, Norway; Takata & Co., Tokio, Japan; Societa Italiana de Fries & Co., Milan, Italy; La Maquinaria Anglo-Americana, R. D'Aulignac, Barcelona, Spain; Bevan & Edwards Pty., Ltd., Melbourne, Australia; O. R. San Galli, St. Petersburg, Russia. Murphy & Charles, Inc., Valparaiso, Chile (for Chile, Peru and Bolivia).

Greenfield



All Kinds of Tool Sharpening and Special Grinding.

Are You Getting Out Something New?

Probably you have a lot of SPECIAL TOOL AND JIG WORK to do. Such work is expensive, but if you have proper equipment you can keep the cost down wonderfully. OUR UNIVERSAL GRINDER handles all kinds of special grinding in a most economical fashion. It is furnished with a large line of Attachments which are simple and easy to use; there are no complicated adjustments to be made.

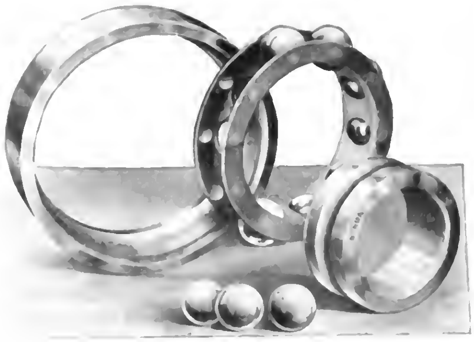
This Grinder will handle all the tool sharpening and special grinding of most shops and is very inexpensive considering its great usefulness.

We have a catalog showing each of these Attachments set up on the machine and ready for a grinding job; it might be very interesting to you; send and get it.

Greenfield Machine Co.

Greenfield, Mass., U. S. A.

The Causes and the Meaning of Noise in Ball Bearings



As you well know, Neighbor, noise in a machine is usually a danger signal. In bearings, it indicates the presence of looseness and friction that shouldn't be there. And friction, you know, means wear.

In ball bearings—which are supposed to be almost frictionless—noise is a sure sign of trouble a-brewing. Stop that noise at once—or you'll soon have to get a new bearing.

Noise results from vibration. Vibration comes—in a ball bearing—from looseness of component parts; from too much play; from imperfectly finished races; from imperfect balls; from sliding friction where rolling friction is supposed to be; from loose mounting of the bearing; and from other causes. Look out for all these—they're dangerous.

The fit of the bearing in the housing and upon the shaft is also of importance in the reduction of noise. Tight fits—rigid mounting of both races—eliminate looseness. Your question is—rigid mounting, or floating mounting?

Then, there are many types of ball retainers or cages that, in the very nature of things, are bound to create noisy conditions. Study the cage proposition and you'll know why—you'll know that a noisy bearing is a wearing, inefficient bearing.

Finally, the way a bearing is put together—the fit of the parts—their dimensional accuracy or otherwise—the way it is, or must be, mounted and assembled—the way the parts are retained (all points of design and workmanship)—determine whether that bearing is going to be noisy or to run quietly.

Consider now, Neighbor, the "**NORMA**" Ball Bearing from this standpoint of noise or silence.

In the "**NORMA**" Bearing it is almost impossible (except under misuse and abuse) to create conditions where sliding friction exists—Point One for "**NORMA**" Silence.

"**NORMA**" ball races must be rigidly mounted, outer race held tightly in the housing and inner race held without any chance of movement on the shaft. This eliminates all chance for vibration between bearing races and machine parts—Point Two for "**NORMA**" Silence.

"**NORMA**" ball cages yieldingly hold the balls at the extremities of the axis of ball rotation with a light elastic pressure and with a very small contact surface. Friction between balls and cage is minimized and vibration here absolutely prohibited—Point Three for "**NORMA**" Silence.

The parts of "**NORMA**" Bearings are uniformly made to the highest degree of dimensional precision. This means absolutely correct relations of those parts within the bearing— perfect freedom of movement without the narrow excess of freedom which permits vibration, or chattering—Point Four for "**NORMA**" Silence.

And then, the materials used in "**NORMA**" Bearings are so carefully selected in the light of bearing requirements, and so carefully treated, as to give maximum resistance to every wearing tendency which might destroy the perfect relation of parts—Point Five for "**NORMA**" Silence.

Now, Neighbor—let's get right down to brass tacks.

You want your bearings to last. They never will, if they're noisy.

You probably want them to run at high speed. They can't—for very long—if they're noisy.

You want them to run true, and keep alignment and adjustment. They can't, if they're loose—for that means they're noisy; which, in turn, means they're wearing.

What's the answer? Use "**NORMA**" Silent-Running, High-Precision Ball Bearings. Our Engineering Department is anxious to show you how.

THE NORMA COMPANY OF AMERICA

1790 Broadway New York

"NORMA"

Ball, Roller, Thrust and Combination Bearings

that Every Machine Designer Should Know

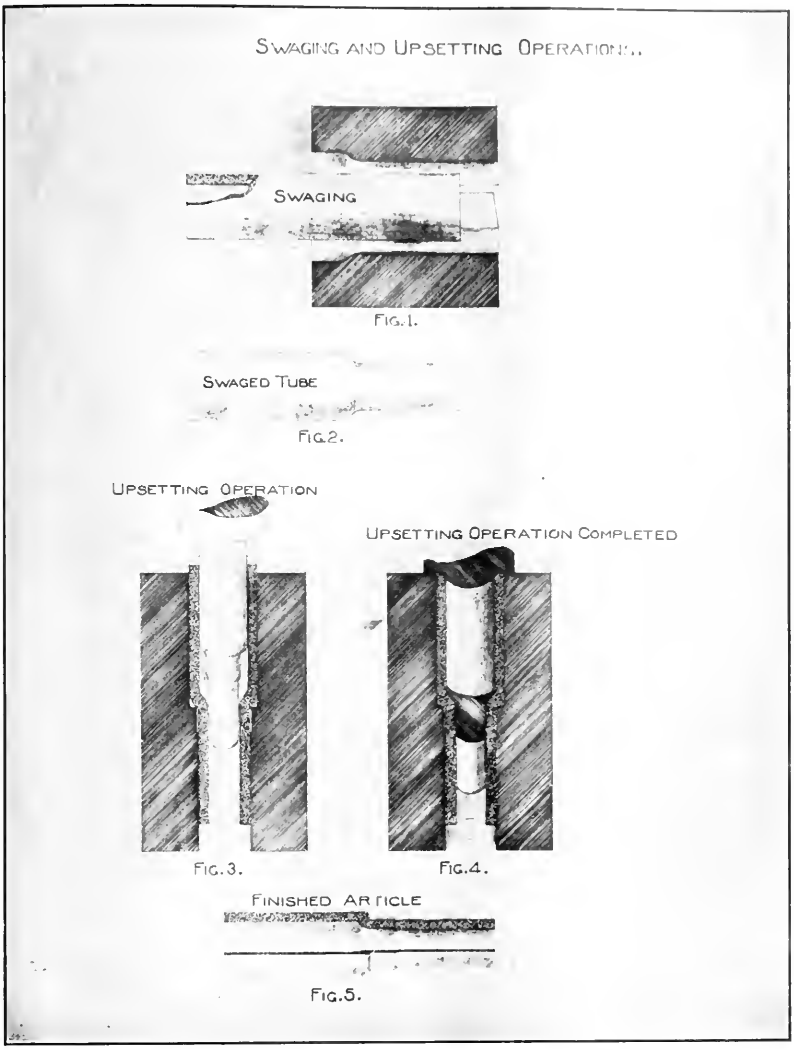


PLATE NO. 4

¶ Figure 7 (Plate 2) shows another hammering or swaging operation in a set of dies, in which the ball is rounded up so as to conform to the shape required in the finished article, figure 8 (Plate 2).

¶ Plate No. 4 shows another variation of upsetting and swaging. Here, however, the operations are reversed. The swaging, or reducing of the diameter of a portion of the tube, is done before the upsetting. The tube has three different diameters, which have to be produced with different wall thicknesses, and the most economical method of producing intricate articles is always adopted. The swaging operation, with the subsequent operation of upsetting, brings out in sharp contours the shape required in the finished article.

¶ As previously indicated, this series is designed particularly for the busy man—the illustrations suggesting (at a glance perhaps) new possibilities for Shelby Seamless Steel Tubing in machine design.

¶ Next month the operation of the spinning machine will be illustrated, and also the flow of metal during the spinning operation.

*No. 1—Facts About Shelby Seamless Steel Tubing that Every Machine Designer Should Know. (Published May, pages 152-153.)
No. 2—Mechanical Manipulations of Shelby Seamless Steel Tubing. (Published June, pages 110-111.)
No. 3—Mechanical Manipulations of Shelby Seamless Steel Tubing—Flanging. (Published July, pages 166-167.)
No. 4—Mechanical Manipulations of Shelby Seamless Steel Tubing—Forging. (Published August, pages 146-147.)

For the convenience of customers desiring immediate delivery, stocks of Shelby Seamless Steel Tubing are kept in many

large cities; the location of stock nearest to any specified point will be given on request.

PITTSBURGH, PA.

PACIFIC COAST REPRESENTATIVES:
U. S. Steel Products Co., San Francisco, Los Angeles, Portland, Seattle.
EXPORT REPRESENTATIVES:
U. S. Steel Products Co., New York City.

COUPON

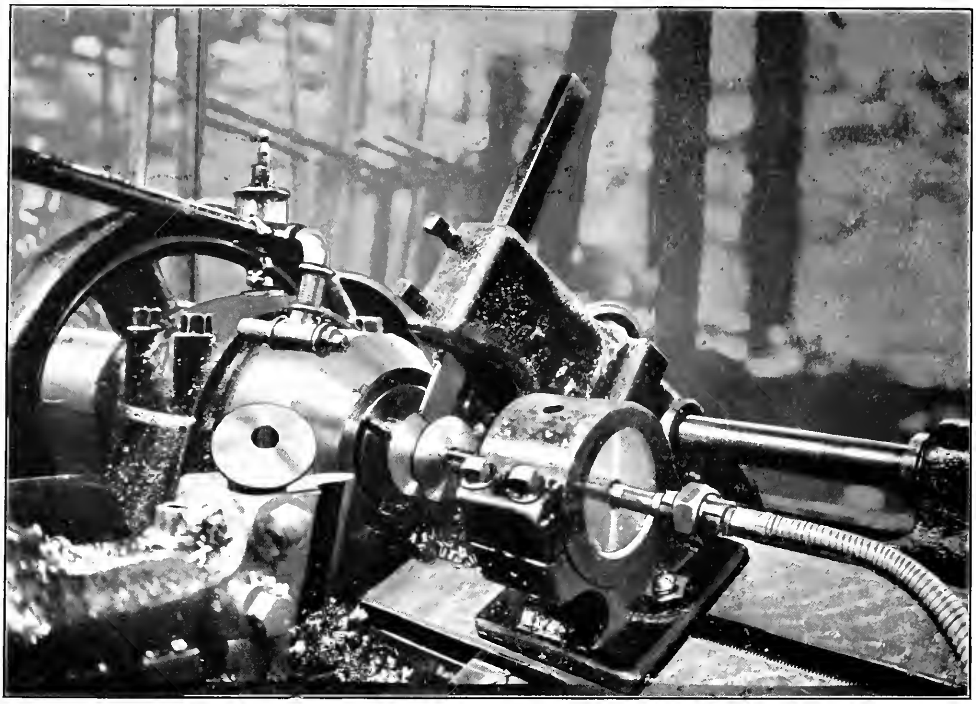
NATIONAL TUBE COMPANY, 1802 Frick Bldg., Pittsburgh, Pa.
Gentlemen:—I am interested in Shelby Seamless Tubing for use as follows: ....

N. B. If possible send a sketch or drawing of the purpose or purposes you have in mind.

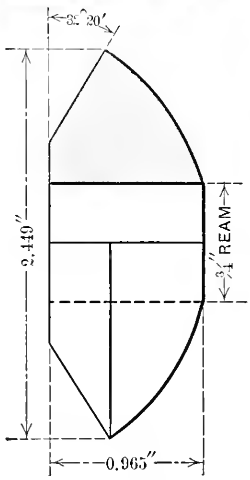
Name..
Street Address..
City..
State..
With what concern identified..

MACHINERY, August, '14

GRID AUTOM



Machining Gear Blanks on the Single Spindle Gridley Automatic



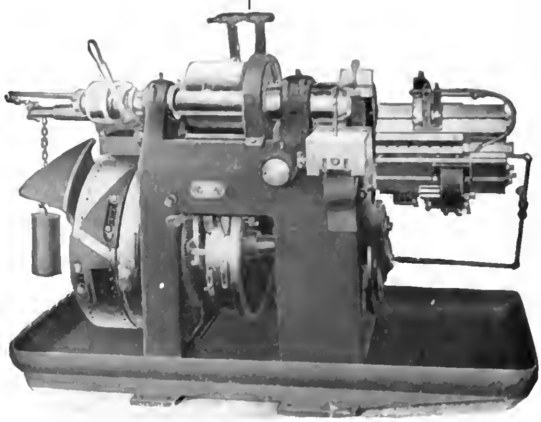
The bevel pinion shown is one of the many good jobs turned by the Warner Gear Company on Gridley Single Spindle Automatics. This gear blank is made from a 2½″ bar of 0.35 per cent carbon steel to the dimensions shown, at the rate of 157 in 10½ hours. The operations on the gear blank are as follows: Stop, spot, drill, form, ream and cut-off, and the work must be accurate in all respects. For those screw machine jobs where accuracy is absolutely necessary you need a Gridley Automatic.

WINDSOR MACHINE COMPANY,

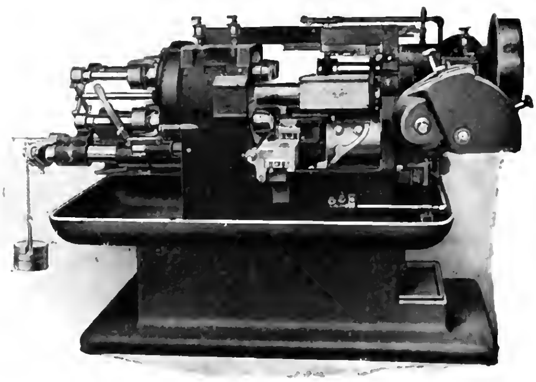
OFFICES AND REPRESENTATIVES: Western Sales Offices, 1229 McCormick Building, Chicago, Ill. Modern Machinery & Engineering Co., 1410 C. P. R. Building, Toronto, for Canada. Windsor Machinery Company, 68-Avenue de la Grande Armee, Paris, J. Ryan, Manager, for Great Britain, France, Belgium and Switzerland. Craven Bros., Ltd., Manchester, England, Great Britain and Colonies.

LEY
ATICS

The Single Spindle Gridley Automatic is built for handling a large range of work accurately. There are three sizes for handling bars up to 2¼″, 3¼″ and 4¼″ in diameter respectively. The design of the turret permits the doubling up of the tools, one behind the other, on certain work, thus affording a means for performing several operations from one turret—a great advantage where the work is long or where many different operations are to be performed. The design of this turret eliminates all overhang of the cutting tools, thus making it possible to take heavy cuts without chatter and loss of accuracy. It is adaptable to accurate work, but not at the expense of time, because the rigid machine is backed by rigidly supported tools.



Single and Multiple Spindle Gridley Automatics



The Multiple Spindle Gridley Automatic has not the range of the Single Spindle; but it is a greater producer, holding four bars of stock in the spindle carrying cylinder, which revolves step by step, bringing each spindle with its bar successively into alignment with each tool—a construction which makes for enormous outputs.

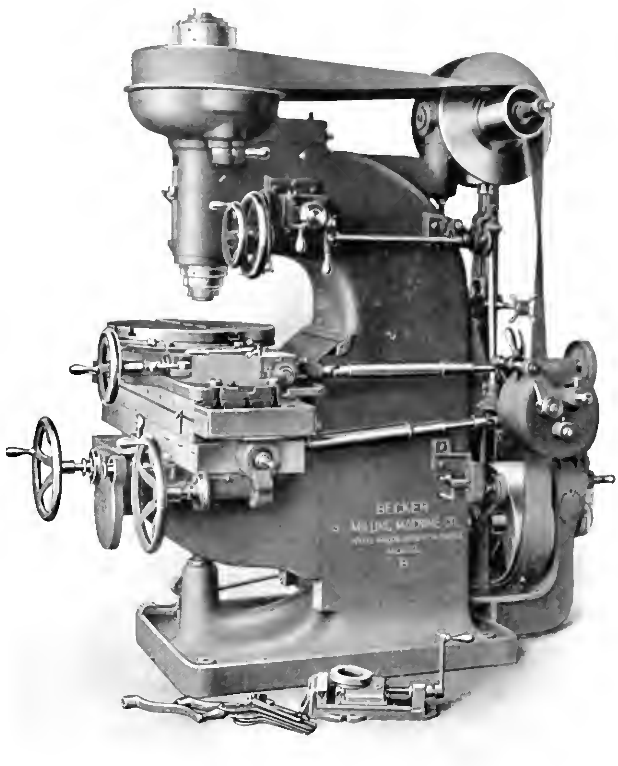
Send for complete descriptive matter on these three machines.

WINDSOR, VERMONT, U. S. A.

Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland. M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany, Austria-Hungary, Italy, Norway, Sweden. Schlmunck & Company, Moscow, Russia, for Russia. F. G. Kretschmer & Co., Frankfurt-on-Main, Germany, for the Balkan States.

The Becker Model "B"

Made Chips Fly on This —— Job ——



THE production rate on this job is startling. It shows the great power behind the cutting tool on the Becker Milling Machine.

A Novo Superior Steel Inserted Tooth Milling Cutter was placed at a 20-degree angle, feed started at .250″ per revolution and gradually increased to .321″ at which speed the table moved at 20½″ a minute, removing 45 cubic inches of cast iron in one minute or .75″ per second. The back gear ratio was 5 to 1, the cutter diameter 6½″ with a periphery speed of 125″ and a spindle speed of 64 R. P. M. Such an arrangement produced a cut 6″ wide and ⅜″ in depth.

You, no doubt, have similar milling which could be done quicker, better and more economically on a Becker Model "B" than on any other machine. Write for full particulars.

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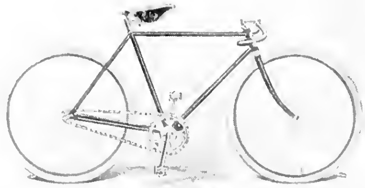

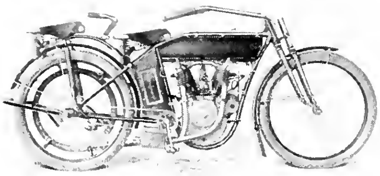

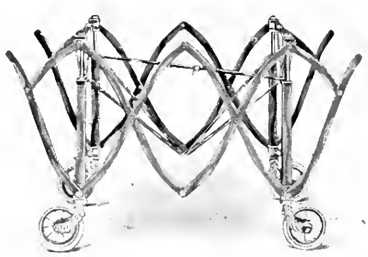

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STANWELD STEEL TUBING

More Stanweld Steel Tubing is used in vehicle-construction than any other make. It is used by the world's largest manufacturer of go-carts; by the world's largest manufacturer of bicycles; by the world's largest manufacturer of motorcycles; by the world's largest manufacturer of automobiles.

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Our facilities are practically unlimited, and we think you'll find our costs surprisingly low.

Send a letter or post-card today.

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Edgewater Park CLEVELAND

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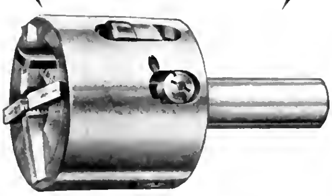

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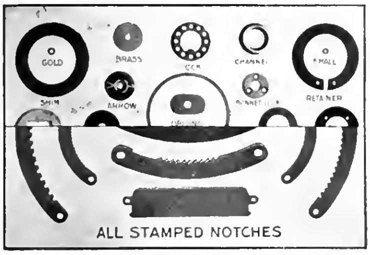

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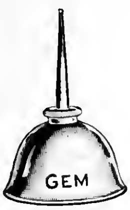
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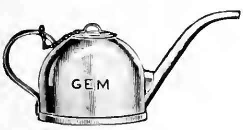
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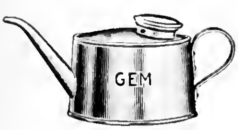
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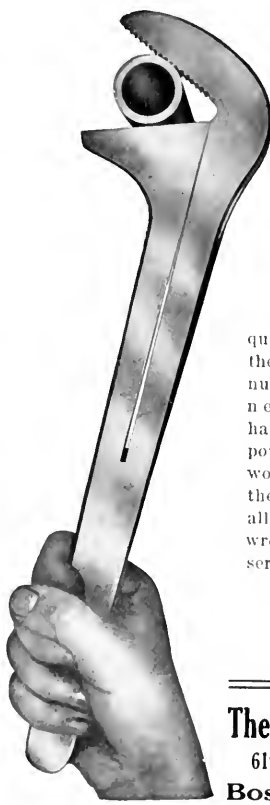

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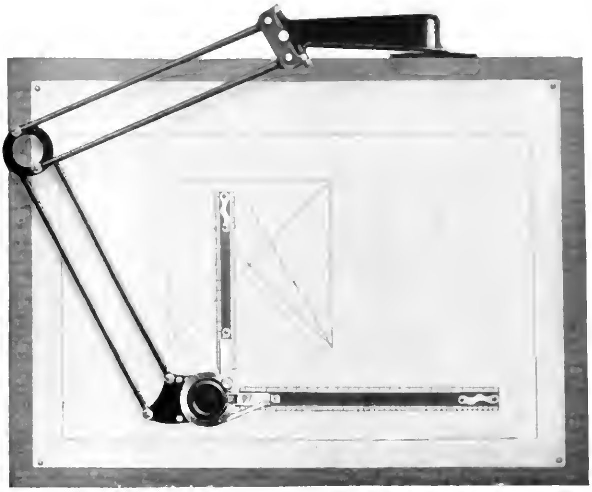

Universal Drafting Machine Company

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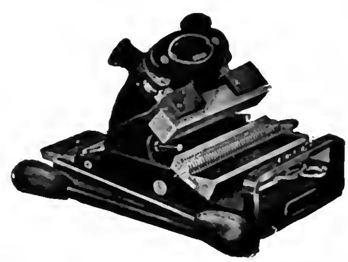

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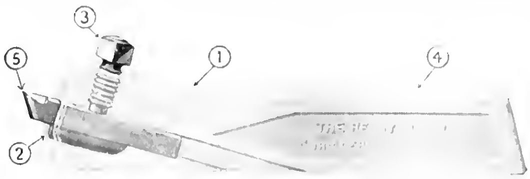

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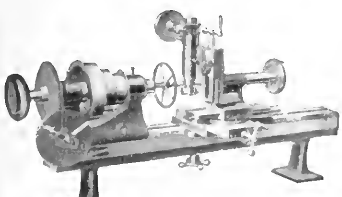

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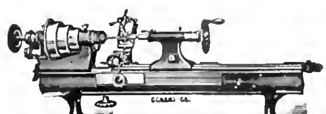

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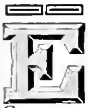

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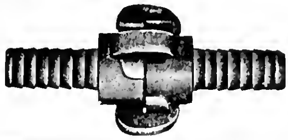

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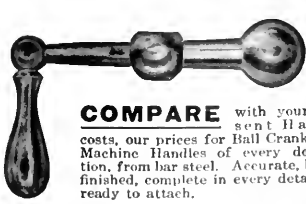

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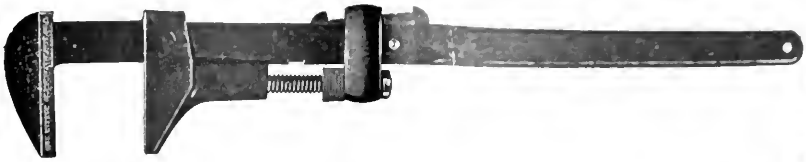
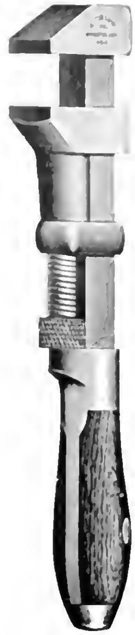

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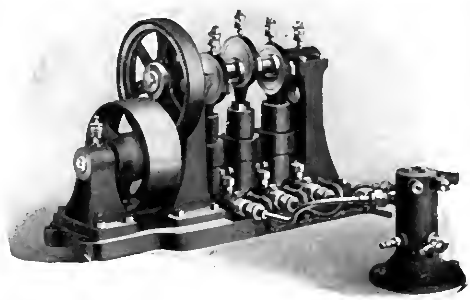

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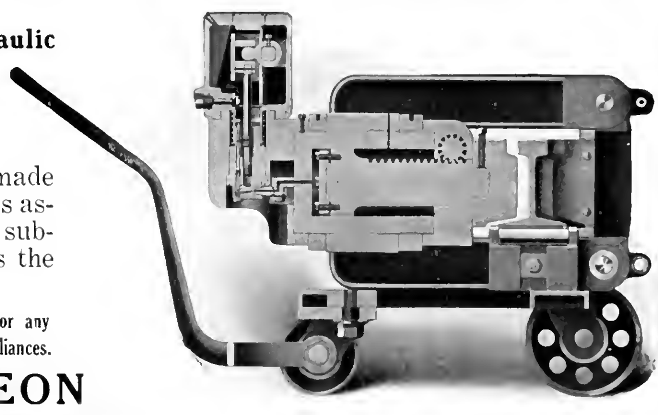

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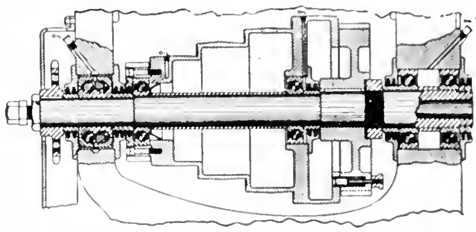


In this application of New Departure ball bearings, the front end of the spindle is supported by two New Departure Single Row bearings of heavy series, the outer races of which float so that they take only radial loads. The rear end of the spindle is mounted on New Departure Double Row bearing so clamped that it takes all thrust on the spindle and carries the radial loads as well. The pulley cone, mounted on a Single Row ball bearing, turns with minimum friction when the back gears are thrown in on heavy cuts.

New Departure Ball Bearings

in Milling Machine Head

Ball Bearings can be as successfully applied to milling machinery as they have been to drilling appliances. The use of ball bearings in machines of this type reduces power consumption and increases production capacity. In the example shown above, New Departure Double Row or combined radial and thrust ball bearings are used to excellent advantage.

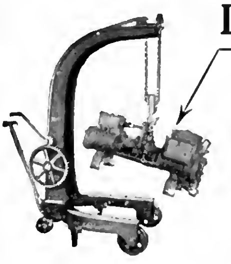
Other applications of New Departure ball bearings to machine tools are shown in data sheets which will be mailed free to manufacturers, purchasing agents, mechanical engineers, master mechanics, etc., writing on the letterhead of their firm.

The New Departure Mfg. Co.

BRISTOL, CONNECTICUT

WESTERN BRANCH: 1016-17 Ford Building, Detroit, Michigan

It Would Require Six Men to Lift this Casting



Can you afford to take six men away from their regular work just to carry some heavy casting to a machine? Not when a Canton Portable Crane and one man can do the work, not an experienced, high-priced man at that.

Canton Floor Cranes are well built, simple to operate and they sure can lift. Prices are reasonable. Ask for Booklet E-10, when writing.

THE CANTON FOUNDRY & MACHINE CO.

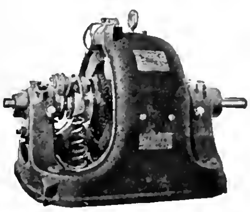
CANTON, OHIO, U. S. A.

John Has Never Scrapped a Westinghouse Motor

"IT'S OLD, BUT IT'S STILL ON THE JOB."

"JOHN," said the manager to the superintendent, "that's a pretty old motor we have there. I got it when we started business fifteen years ago."

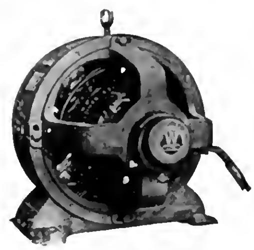
"It's old," replied John, "but it is still on the job and is good for several more years. That's what I like about Westinghouse motors. They're not only good when you get them, but they stay good. Why, as long as I've been here I've never scrapped a Westinghouse motor.



The old Westinghouse Type M Motor which has an international reputation for reliability and good service.

"And these modern Westinghouse motors we have here with their rolled steel frames and sparkless commutation are better in every way than the old types. I expect your children's children can come here and find these motors still working."

Westinghouse motors are built for long life. Every detail of the design is the result of years of experience in motor building. The use of the highest grade of materials, expert workmanship, rigid inspection and thorough tests before shipment, insure the purchaser receiving apparatus of greatest reliability.



The modern Westinghouse type SK commutating pole motor.

Westinghouse Electric & Mfg. Co.

East Pittsburgh, Pa.

Atlanta, Ga.	Cleveland, Ohio	Knoxville, Tenn.	Portland, Ore.
Baltimore, Md.	Columbus, Ohio	Louisville, Ky.	Rochester, N. Y.
Birmingham, Ala.	Dallas, Tex.	Los Angeles, Cal.	St. Louis, Mo.
Boston, Mass.	Dayton, Ohio	Memphis, Tenn.	Salt Lake City Utah
Bluefield, W. Va.	Denver, Colo.	Milwaukee, Wis.	San Francisco, Cal.
Buffalo, N. Y.	Detroit, Mich.	Minneapolis, Minn.	Seattle, Wash.
Butte, Mont.	El Paso, Tex.	New Orleans, La.	Spokane, Wash.
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Charlotte, N. C.	Indianapolis, Ind.	Omaha, Neb.	Tacoma, Wash.
Chicago, Ill.	Joplin, Mo.	Philadelphia, Pa.	Toledo, Ohio
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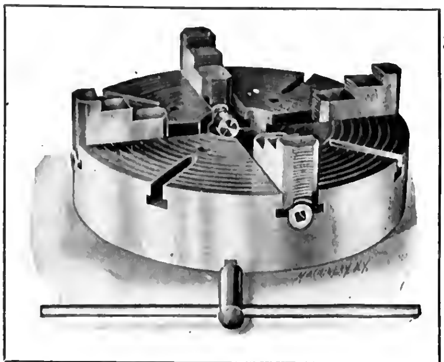
W WESTINGHOUSE ELECTRIC



Horton Heavy Duty Chucks

For Extra Strength
Extra Gripping Power
Extra Capacity

These chucks have been redesigned, strengthened, improved in every way to meet the demands of modern manufacturing and high-speed steels. They are adapted for railroad work, unusually heavy turning — exacting service of all descriptions.

Let us send circulars of the Horton All-Steel Chucks or catalogue which covers the whole Horton line.

THE E. HORTON & SON CO., WINDSOR LOCKS, CONNECTICUT, U.S.A.

THE IMPORTANCE OF GOOD CHUCKS

SWEETLAND

Send for the booklet "Chucking for Profit" and the new catalogue of Sweetland Lathe Chucks.

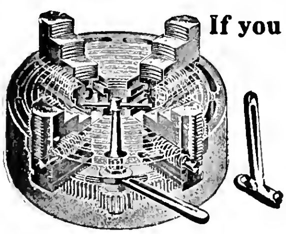
Buy chucks which are safe, which save chucking time and which assure positive accuracy—buy

Sweetland Chucks

The new "Liability" laws make safety appliances essential on all machines. Sweetland Chucks won't slip, shift nor dislodge the work, and there are no projections to catch and tear hands or clothing. They are quickly adjustable to work of differing shapes and requirements, have great gripping power, are easily applied and controlled, and their accuracy cannot be questioned. Sweetland Chucks can be counted on for excellent service under all conditions.

THE HOGGSON & PETTIS MANUFACTURING CO.
NEW HAVEN, CONNECTICUT

If you want the best Lathe or Drill Chucks—buy Westcott's



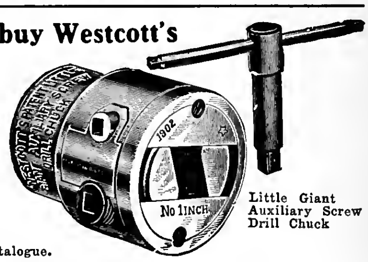
Spur Geared Scroll Combination Lathe Chuck

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

**Strongest Grip Greatest Capacity
Great Durability and Accuracy**

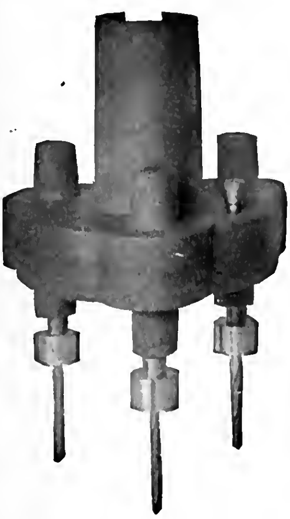
WESTCOTT CHUCK CO., Oneida, N. Y., U. S. A.

Ask for English, French, Spanish or German catalogue.



Little Giant Auxiliary Screw Drill Chuck

DRILLERS
UPRIGHT GANG SPECIAL
Hoefer Mfg. Co.
FREEPORT ILL USA
FOR ALL PURPOSES



Unexcelled for Special Work

Hoefer Auxiliary Drill Head

As a time and labor saver on special drilling jobs, the "Hoefer" is unsurpassed—drills all the holes at once and saves resetting work.

Hoefer Auxiliary Drill Heads can be made to fit any layout. Hardened chrome-nickel steel gears and high-grade heavy-duty ball thrust bearings, enclosed in a dust- and dirt-proof casing, provide a positive, smooth drive with a minimum amount of loss by friction.

We will show you conclusively that a Hoefer Head can greatly reduce the production cost of many jobs if you'll let us. How about it?

Estimates cheerfully furnished.

Hoefer Mf'g. Co.

FREEPORT, ILLINOIS, U. S. A.

Auxiliary Head Agents:

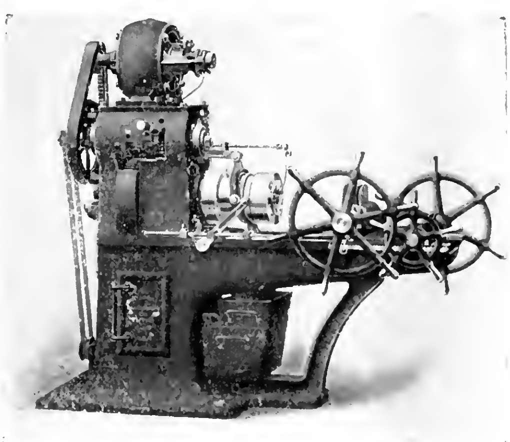
J. R. STONE TOOL & SUPPLY COMPANY

24 Goebel Building, Detroit

DRILLERS
Hoefer Mfg. Co.
FOR ALL PURPOSES

The National Bolt Cutter

always cuts perfect threads—uniform in diameter and accurate in pitch, no matter what class of threading, what quality of material, or what variation is encountered in diameter or hardness of the stock.



The National Die Head has a positive lock that makes it as rigid as a solid die, and insures the same high degree of accuracy in cutting. Once set for size, the National Die Head retains that size until changed by the operator. This eliminates constant gauging and frequent adjustments on the Head, hence eliminates this element of waste time by the operator, and insures greater output.

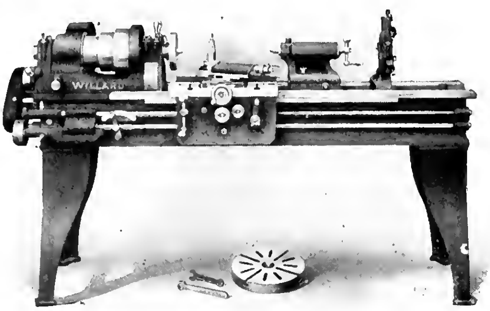
Leading Railways and Industrials are using National Bolt Cutters, and many shops are installing National Die Heads on other types of Threaders to secure bigger output and greater accuracy.

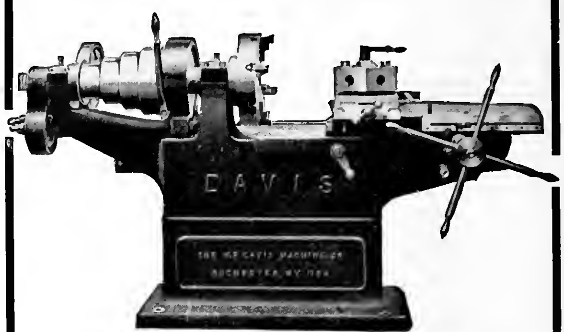
National Bolt Cutters are built in sizes of $\frac{3}{4}$ to 6 inch capacity, single, double, triple and quadruple spindle, belt or direct motor drive.

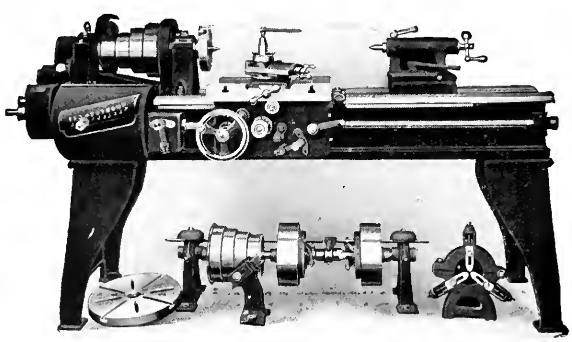
Ask for Bulletins Nos. 10 and 20 on National Bolt Cutters, and let us assist you in eliminating your threading difficulties.

THE NATIONAL MACHINERY CO., Tiffin, Ohio, U. S. A.

ORIGINATORS OF MODERN BOLT, NUT AND FORGING MACHINERY


WILLARD


DAVIS



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"AMERICANS"

Safety
Efficiency
Economy

Send for particulars

Stocked and Sold by Dealers

In sizes from 3" to 66" diameter
Larger sizes on application

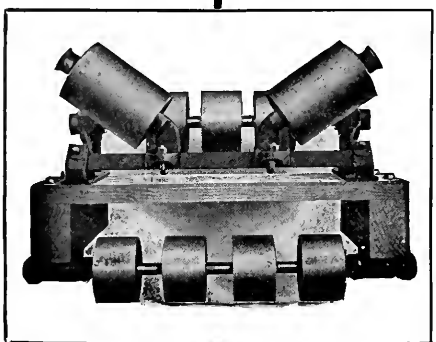
Safety—Beaded Edged Rim.
Efficiency—Correct Crown and Grooved Face.
Economy—Arms that cut the air.

MADE BY

PHILADELPHIA
CHICAGO

THE AMERICAN PULLEY CO.

NEW YORK
BOSTON

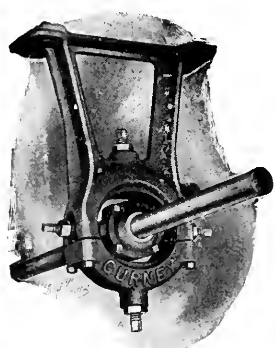


Improved Belt Conveyers

We manufacture Improved Belt Conveyers of several styles, troughing the belt or running it flat, as conditions may warrant. These conveyers are economical of power, simple in design, capable of running 24 hours per day, and require little time or attention from any one. There's no harm in writing us. *Send for Catalogue No. 38.*

H. W. Caldwell & Son Co. Western Ave. 17th-18th St. Chicago

New York: Fulton Bldg., Hudson Terminal, 50 Church St.



GURNEY BALL BEARINGS

ARE SPECIALLY DESIGNED FOR HIGH SPEED

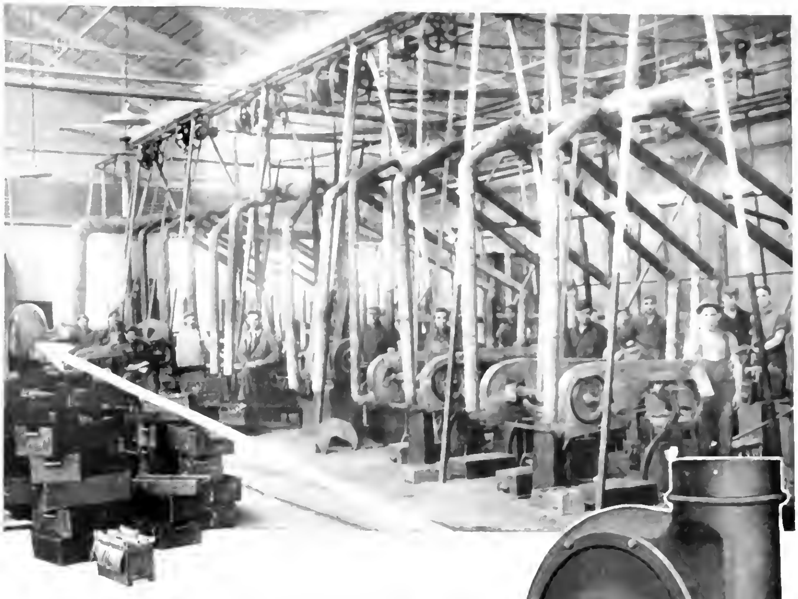
Our RADIO-THRUST BEARING carries either Radial or Thrust load or both. A self-contained Thrust Bearing with radial capacity. Two bearings at the cost of one.

BALL BEARING SHAFT HANGERS

Gurney Ball Bearing Co.

JAMESTOWN, N. Y.

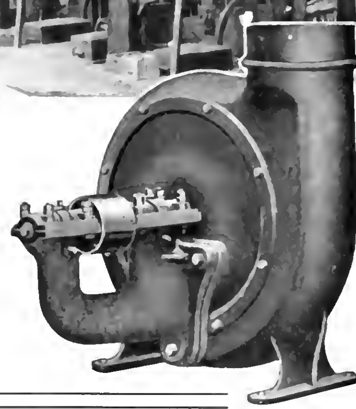
A Thirty H. P. "Buffalo" Blower Makes This A Clean Grinding Shop



This is what the B Volume Exhauster is doing in the grinding room of the Utica Drop Forge & Tool Company's Plant. You can't afford to install any exhaust system until you have investigated the "Buffalo." It is unequaled in its adaptability to your needs, in its efficiency and in its ability to render you superior service. We are backed in these claims by the unsolicited testimonials of hundreds of users.

These blowers have permanently air-tight shells. No center division for leakage of air. The fan and shaft are removable with ease and despatch through the opening made by removing either one of the side plates, and without completely dismantling the blower.

"Buffalo" Blowers and Exhausters have a service record that proves them without an equal in effectiveness, smooth running, long service and economical operation. All types for all conditions. *Catalog 256-51 contains complete information.*



BUFFALO FORGE COMPANY, Buffalo, N.Y.

Manufacturers: Forges, Blowers, Heating, Ventilating and Drying Apparatus. Branch Offices in Principal Cities.

Cut Down the Working Time

on grinding, boring, drilling, polishing and similar work. A Stow Flexible Shaft equipment enables you to do it; can be easily set up in any part of the shop and driven from the line shafting.

STOW FLEXIBLE SHAFTS

permit tools to run in any position; power goes through any number of curves; quick, convenient, efficient. Every day some job shows up where these handy outfits will cut shop costs—cut deeply.

Catalog on request.

STOW FLEXIBLE SHAFT CO.

26th and Callowhill Streets
PHILADELPHIA, PA.
U. S. A.

A powerful suction or a high pressure can easily be secured with

LEIMAN BROS. ROTARY POSITIVE HIGH PRESSURE **BLOWERS** and **VACUUM PUMPS**

because they take up their own wear. This is important when used with automatic machinery. It means long life and efficient service. It means the right machine in the right place—all blowers look very much alike outside. Therefore, like a book, the inside should be investigated thoroughly before purchasing. All parts are large and strong and there are only a very few of them. Here you have efficiency, simplicity, economy, noiselessness all in one machine. Users everywhere are the leaders in the business world—that means something. Quality is what they demand. It will pay you to investigate the subject of these pumps before purchasing any machine. That is how we secure our orders—the result of quality of service which the machine has already given to users.

Get Catalog No. 16 for blowers or No. 17 for vacuum pumps

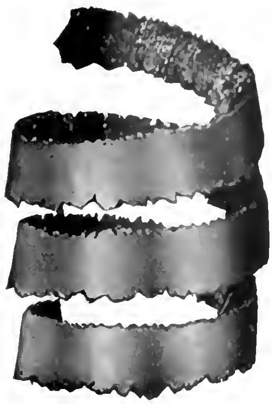
LEIMAN BROS., 62E. John Street NEW YORK

Outfits for cutting and polishing gem stones and quartz specimens; for rolling copper, brass, gold, etc.; for turning, drilling, sand blasting, polishing dust collecting, and complete equipment for trade and vocational schools.

JESSOP'S "ARK" HIGH SPEED STEEL

Has an Unexcelled Record. ARK. **Note the Following Facts.**

In turning 100 railway car wheel tires, Jessop's "Ark" High Speed Steel has the record of losing less steel, due to grinding, than any other make.



The actual amount of steel ground off the tool in turning 100 wheels was 3 ounces. This is an unrivalled performance in steel economy.

We have a large stock of Carbon Tool Steel and High Speed Steel. Write for Catalogue.

WM. JESSOP & SONS, Incorporated

91 JOHN STREET, NEW YORK, N. Y.

Boston Warehouse: 163 High Street

Branch Warehouses throughout the United States

Specialists in Hot and Cold Rolled Strips, Wire, Etc.

Annealed, Hardened, Black, Blued or Polished—Any Section or Size

STEEL STRIPS *for* Pens, Safety Razors, Rules, Measuring Tapes, Clock and Watch Springs, Band Saws, Slitting Saws, Cartridge Clips, Feeler Gauges and Camera Shutter Steel, etc.

SECTIONAL STOCK *for* Razors, Surgical Instruments, Cutlery, Chain Links, Springs, Piston Rings, Adding and Registering Machine Parts, etc.

STEEL WIRE *for* Springs, Sewing Machine and Hosiery Needles, Watch and Clock Axles, Music Wire, Hackle Pins and Wire Rods, etc.

DRILL ROD—both Carbon and High Speed.

Our Mills, viz:—Samuel Fox & Co., Ltd., Sheffield, England, have specialized in cold rolling and drawing for 60 years and are leaders in this sort of work.

Write us at once for our Mill Catalogue, or, better still, let us figure on some of your requirements.

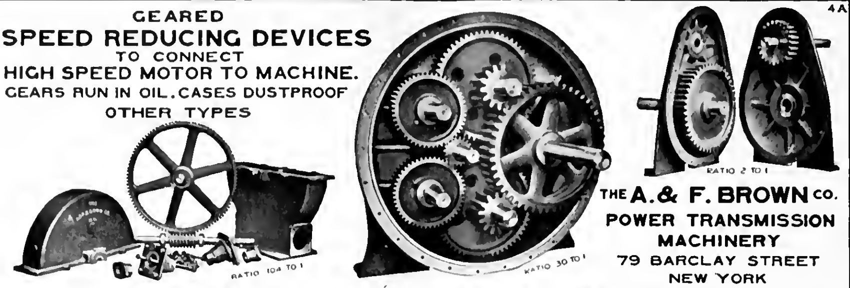
THE MUIR-DAVIDSON STEEL CO.

44 CLIFF STREET Sole Agents for the United States and Canada. NEW YORK, N.Y.

GEARS 3" TO 18' FOR MOTOR, MACHINE, ROLLING MILL OR WATER POWER PLANTS. **GEARS**

SPUR
BEVEL
WORM
ANGLE
SPIRAL
MORTISE

GEARED
SPEED REDUCING DEVICES
TO CONNECT
HIGH SPEED MOTOR TO MACHINE.
GEARS RUN IN OIL. CASES DUSTPROOF
OTHER TYPES



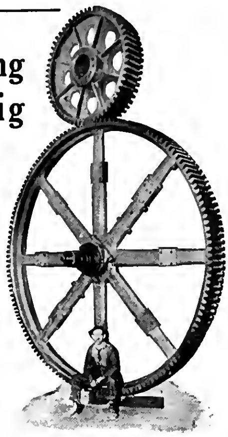
THE **A. & F. BROWN** CO.
POWER TRANSMISSION
MACHINERY
79 BARCLAY STREET
NEW YORK

SPECIAL MACHINERY BUILT TO PLANS AND SPECIFICATIONS

CAST IRON
STEEL
SEMI-STEEL
BRONZE
RAWHIDE
FIBER

GEARS CUT PLANED HOBBED MACHINE MOLDED FORGED **GEARS**

No Gear Making Job is Too Big for Our Modern Plant



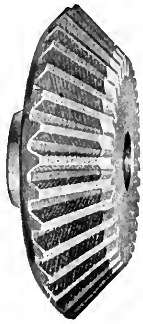
Neither is there any gear-cutting order too small to gain our careful, painstaking attention.

Look at this pair of gears. "Some size, eh," yet accurately cut right here in our plant and delivered to the purchaser on time.

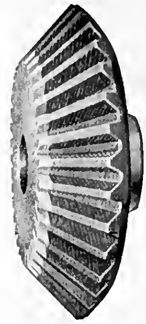
We know how—that's proven. Now we want you to profit by our service. Try it.

The Earle Gear & Machine Company
Stenton and Wyoming Aves. Philadelphia, Pa.

"PEERLESS"



No other name fits our Rawhide Pinions as well. We have given the best materials to expert workmen and the result has been "Peerless."



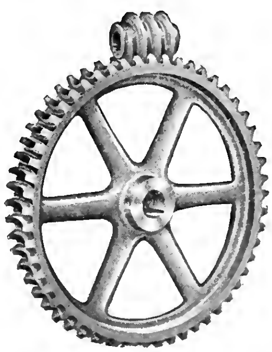
Rawhide Pinions

Twenty years of experience in the making of these gears speaks well for our ability to satisfy. We have made every effort to please and have been well rewarded by repeat orders. If you use "Peerless" now, how about some more? If not—start right—order Peerless Rawhide Pinions. We also make cut metal gears.

Better write today for details.

THE HORSBURGH & SCOTT CO.
CLEVELAND, OHIO, U. S. A.

POOLE GEARS



Machine Molded or Cut

SPUR, BEVEL AND ANGLE GEARS

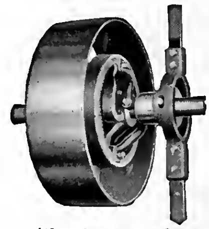
MORTISE, INTERNAL AND WORM GEARS

Our facilities range from the smallest to a gear 50 ft. in diameter.

BUILDERS OF HEAVY MACHINERY

POOLE ENGINEERING & MACHINE COMPANY
BALTIMORE MARYLAND

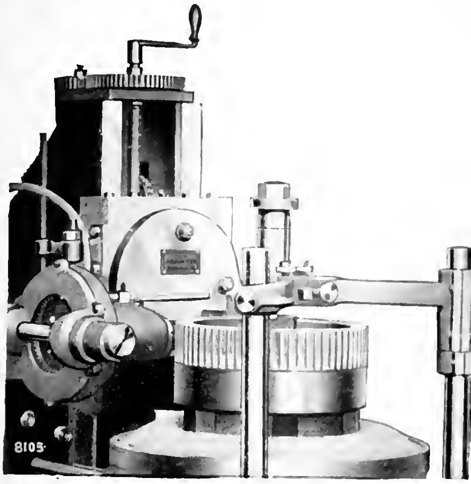
Clutches



Get a fresh grip on things. Install Edgemont Friction Clutches on your shafting and note the difference. They are practically self-contained, need no oil, are burn proof and can be repaired if necessary without removal from shaft.

Catalogue "E" sent on request.

The Edgemont Machine Company
2700 National Avenue DAYTON, OHIO, U. S. A.

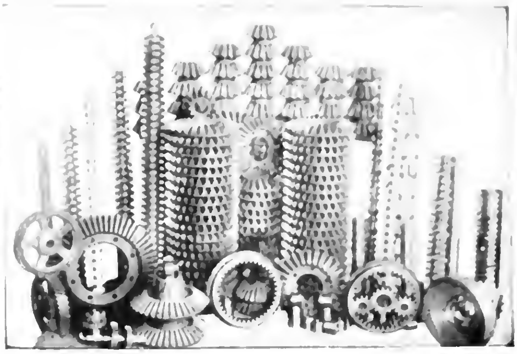


In Cutting a Sixty-Tooth Gear

on an old-style Automatic Gear Cutter the cutter head stops, backs up, the blank indexes and a new cut is started sixty times. On a Farwell Gear Hobber this happens just ONCE for each gear or arbor full of gears, no matter how many teeth there are. This is one reason for our big outputs.

Write about it today.

The Adams Co., 972 Market Street Dubuque, Ia., U. S. A.



Products of the Foote Plant

The exclusive production of gears of all kinds is our business. We cut them accurately, follow specifications to the letter, and no gear-cutting problem is too difficult for Foote Service to handle.

"Gear Problems F. X." and other literature will be mailed at your request. Send for it today.

The Largest Gear Makers in the West.

Foote Bros. Gear & M. Co.
210-220 N. Carpenter Street, Chicago, Ill.

Fawcus Machine Company

PITTSBURG, PA.

Gears of all descriptions to 24 feet diameter. Heavy machinery designed and furnished for all purposes.

Works: Ford City and Pittsburg, Pa.

Main Office - - - - - - - - Pittsburg, Pa

Oxy-Acetylene Welding and Cutting Apparatus

OXY-ACETYLENE WELDING DAVIS APPARATUS DAVIS-BOURNONVILLE CO. N.Y.

Highest efficiency in results and greatest economy in operation. High pressure, positive mixture torches. Complete outfits for greatest requirements.

Write for new catalog No. 97.
Full information, illustrations, etc., on request.

DAVIS-BOURNONVILLE CO., 30 Church Street, New York

HINDLEY WORM GEARS

Safe, Silent and Efficient

Our experience covers a period of over half a century. Our Gears cut theoretically correct on special machines. Let us assist in designing your next Worm Drive.

Our Engineering Department is at your service.

HINDLEY GEAR COMPANY
1105 Frankford Ave. PHILADELPHIA, PA.

LARGE GEARS

FOR

Sugar Mills—Brass Mills
Presses—Rolling Mills
Bridges

Cast Iron,
Cast Steel, Bronze

Cut or Machine Molded

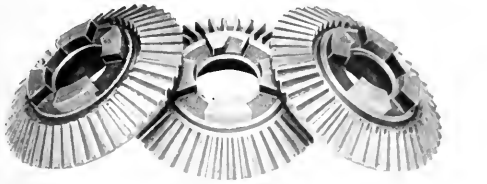
TAYLOR-WILSON MFG. CO.
1000 Thomson Avenue
McKees Rocks, Pa.

GEARISMS

Published by the Philadelphia Gear Works
1120 Vine Street, Philadelphia, Pa.

VOL. II AUGUST, 1914 No. 10

DEVOTED *to the* INTERESTS *of* GEAR USERS EVERYWHERE
Edited by the Little Gear Man



At the Top

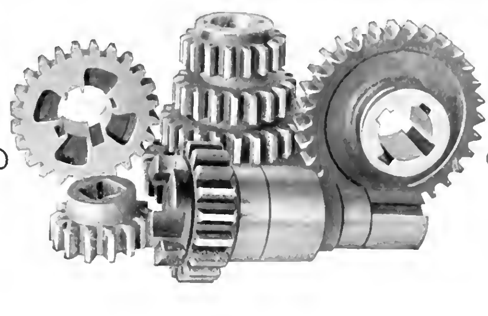
MOUNTAIN climbing is similar to building a reputation in the business world. There are many obstacles to overcome; it takes lots of determination and there are times when it seems as though the top were as far away as when you started; but once it is reached the reward is ample for all your efforts. After years of climbing, the Philadelphia Gear Company is able to say:—"There are none above us in point of service."

Let us handle your next gear cutting order and you'll see why we are "at the top" in our particular line.

Conditions Which Govern Gear Design

The gear designer bases his choice of materials and dimensions on the considerations of strength, durability, smoothness of action, noiselessness and cost. Gearing cannot be perfect in all these respects, as some of them are mutually hostile. Cost, for example, must be sacrificed if gain is to be made in other directions. The designer must compromise—rely upon judgment and experience in determining the relative importance of various requirements. Strength, however, must be the prime consideration, for if the teeth of a gear are not strong enough to transmit the power required, they will break, and all other advantages are lost. Durability is usually sufficient if strength is sufficient, though high-speed gearing may wear out before it breaks. Smoothness of action is coincident with high efficiency and silent running, and this latter is largely a matter of selection of materials, provided the teeth are formed to the correct tooth curves.

Our Engineering Department is at your service—use it.



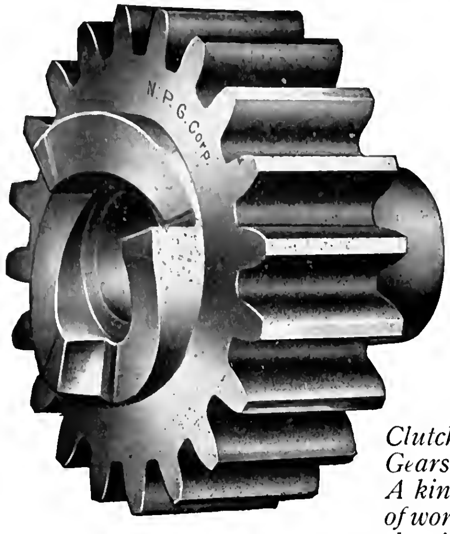
Are you acquainted with the following facts about our SPECIAL HARDENED AND TREATED STEEL GEARS?

BOSTON
BEST
BEST TREATMENTS
BEST MATERIAL
BRAND OF

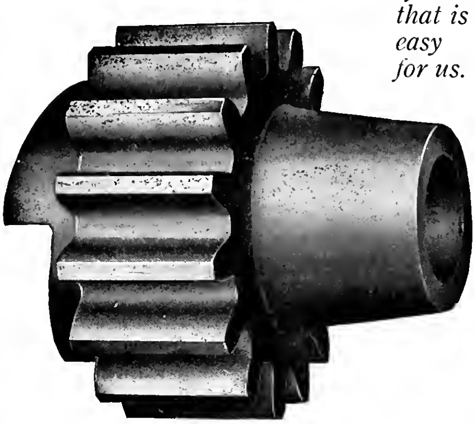
GEAR
GEAR
GREATEST STRENGTH
GREATEST TENACITY
GEARS THAT

WORKS
WORKMANSHIP
WARPAGE LESS
WONDERFUL TOUGHNESS
WEAR

NORFOLK DOWNS, (QUINCY), MASS.



Clutch Gears. A kind of work that is easy for us.



"Any Old Gear" WON'T DO Everywhere, but New Process Gears and Pinions WILL

You get more than mere material and machine work when you buy New Process Gears and Pinions. You get correct tooth design, right machining methods, judicious selection of metal and the careful finish essential to permanently satisfactory service.

One order would prove to you that New Process Gears and Pinions are reasonable in price and genuinely good.

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N.P.R.H. Co. REG U S PAT OFF

YOU CAN'T PUT YOUR GEAR WORK INTO BETTER HANDS

NEW PROCESS GEAR CORPORATION

SYRACUSE, N. Y.

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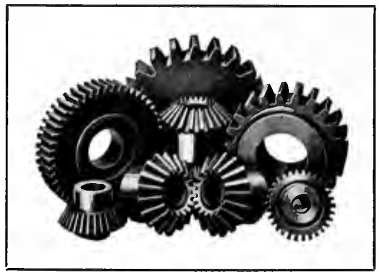


Nuttall Small Cut Gears

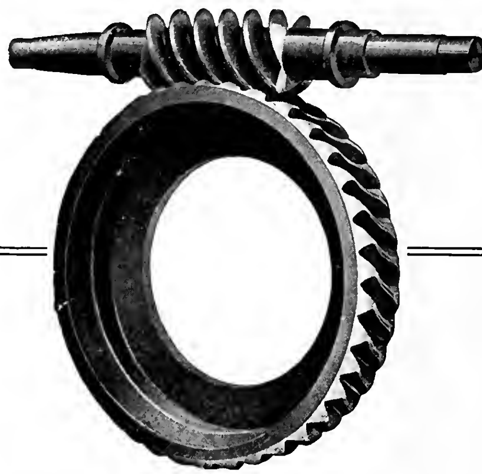
Our plant is not only equipped to cut the largest gears built, but also those of the smaller sizes.

Gear Cutting has been our business for more than a quarter of a century. We can furnish gears to your specification.

Address Dept. K.

Nuttall — Pittsburgh

World's Largest Gear Works



Cleveland Worms

are being successfully used by many for automobile and heavy stationary drives. Information gladly given.

Why Experiment with Experimenters?

The Cleveland Worm & Gear Co.

988-992 E. 67th St., Cleveland, Ohio, U.S.A.

Wherever a Leather Belt Can be Operated to Advantage

a Gilbert Wood Split Pulley can be used successfully. Style A, illustrated, is built for extra heavy service—main drives, trip-hammers, dynamos, etc. We guarantee

STYLE A

GILBERT WOOD SPLIT PULLEYS

for the work specified—no matter how severe the requirements. Being much lighter than either solid or split iron or steel pulleys, less expensive shafting and hangers may be used with equally satisfactory results. Less weight on the bearing reduces frictional loss in power, and the hard maple wood rim assures perfect belt contact and allows the pulley to run with absolute safety, at from two to three times the speed of the best iron pulleys.

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SAGINAW, W. S. MICHIGAN

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Arguto
NON-METALLIC
TRADE MARK

Oilless Bearings
lengthen the life of your machinery

Increase the efficiency of your factory or shop and cut down expense with Arguto Oilless Bearings.

They are made of wood, chemically treated, require no oil or other lubrication—and they outwear the best bronze metal. Moreover, Arguto Oilless Bearings

- save cost of oil
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- last for years

They are adapted for loose-pulleys, countershafts, and confectioners', electrical, harvesting, insulating, paper-box, printing, shoe, spinning, textile, weaving, and winding machinery.

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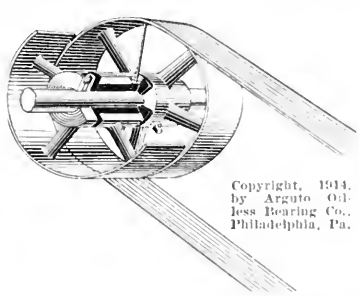

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"CAPITAL" NEW WATER HARDENING HIGH-SPEED STEEL "CAPITAL"

KEEN EDGE, LASTS 5 TO 8 TIMES ORDINARY HIGH SPEED

DRAWN FLATS, key steel or tool steel from stock. Shapes of any kind to order. Largest assortment of bright material—strips, sheets, bars and wire.

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"HERE, THERE AND EVERYWHERE"

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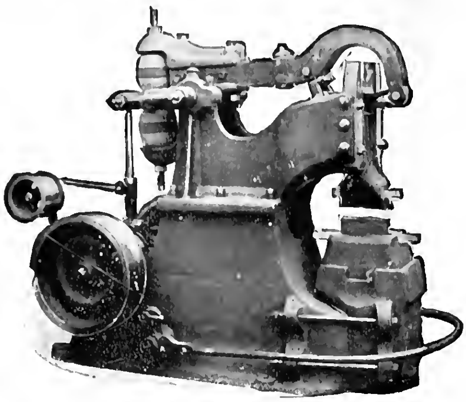
Send for Our Booklet "CLUTCHES AS APPLIED IN MACHINE BUILDING"

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN.



Bradley Upright Hammers

Are made with heads weighing 15 to 500 pounds. Each contains one-third to one-half more material than those of any other make of the same rating.

Their anvil blocks weigh nearly or quite double those of other hammers.

Their output is guaranteed 25 per cent greater than is possible with other hammers of same rating or no sale.

More Bradley Hammers are sold each year than all other power hammers combined.

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The Bradley Cushioned Helve Hammer — The Bradley Upright Helve Hammer
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Forges for Hard Coal or Coke

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FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Buck & Hickman, Whitechapel Road, London.

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Simple
Durable
Efficient
Economical

Adapted for every description of forging

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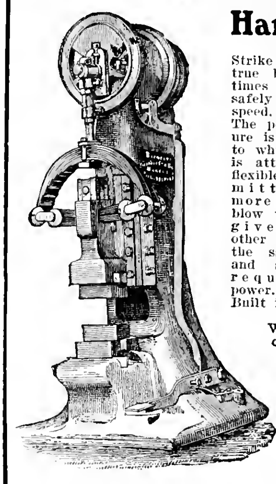
BAY STATE TAP & DIE COMPANY, Mansfield, Mass.

"Dead Stroke" Power Hammers



Strike a square, true blow at all times and can be safely run at high speed.
The peculiar feature is the spring, to which the ram is attached by a flexible belt, permitting a far more effective blow than can be given by any other hammer of the same weight and stroke, and requiring less power.
Built in 7 sizes.

Write for circulars.

MANUFACTURED BY

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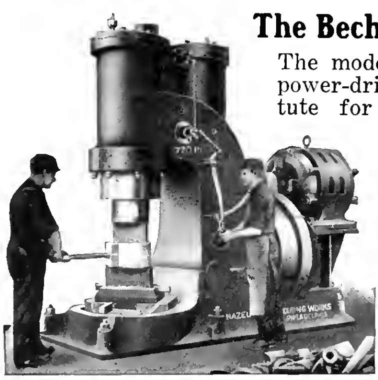
CHAMBERSBURG STEAM HAMMERS

"ALL SIZES FOR EVERY CLASS OF WORK"

Our hammers are double acting, have simple valve gear and give the operator perfect control. *Write us for details.*

CHAMBERSBURG ENGINEERING COMPANY, Chambersburg, Pa.
HYDRAULIC MACHINERY



The Beche Hammer

The modern, reliable power-driven substitute for the steam hammer.

Nazel Engineering and Machine Works
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Built in six sizes to work efficiently from 2" to 9" square. Belt or Motor Drive.

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Catalog furnished by

Vandyck Churchill Co.
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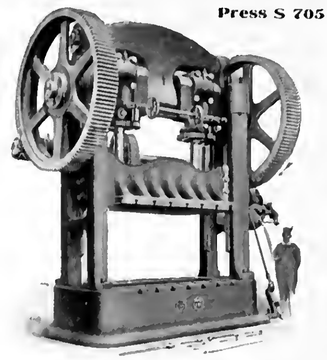

FOR SHEET METAL STAMPINGS

Single-action Press S 705 exerts 700 tons pressure and has an inside width of 124 inches. The cast iron columns are reinforced with four 6½-inch steel rods Weight, 154,000 pounds. Seven widths. Friction clutch. Similar presses exerting heavier and lighter pressures. Photographs and full information.

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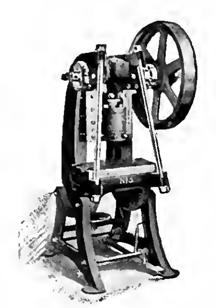
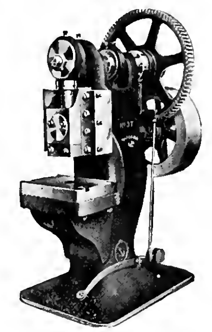

Inclinable Power Press


Geared Punching Press

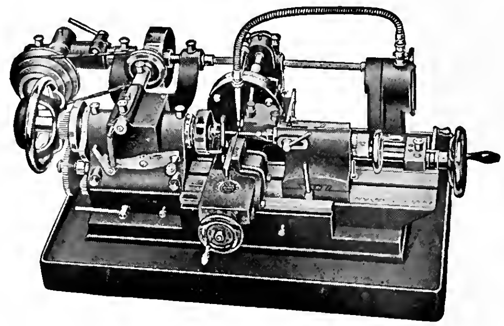
NIAGARA PRESSES

have extra large bearings, carefully scraped surfaces and solid forged and ground crankshafts. Design is simple and efficient. Solid construction and skilled workmanship add materially to the durability of these Presses. Give a Niagara Inclinable Power Press or Geared Punching Press the chance to "make good" in *your* shop. The service they are giving others will profit you. *Write for the catalogue.*

NIAGARA MACHINE & TOOL WORKS
BUFFALO, NEW YORK
MANUFACTURERS OF TOOLS FOR SHEET METALS

Consult a "Waltham" on Threading Problems

The Waltham Thread Milling Machine meets every requirement for accurate, fast thread milling. It is especially advantageous for small work. Every improvement has been made with the idea of strengthening the whole machine.



Write for particulars.

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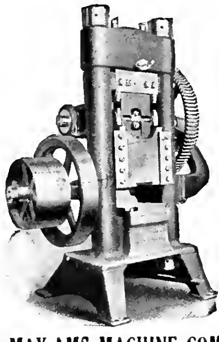
NEWTON STREET, WALTHAM, MASS.

Makers of Precision Bench Lathes and Machinery



Ams Power Presses

ECONOMY

We'll guarantee to furnish you with the right kind of Power Presses at right prices.

All machines are tested and pass rigid examination before leaving the factory, consequently we give the most liberal guarantee.

Standard dimensions in certain cases may be modified to meet special requirements. Any questions you would like to ask?

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CHARLES M. AMS, President.

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PRESS ATTACHMENTS—AUTOMATIC
METAL AND WIRE FORMING MACHINES
TUMBLERS—LARGE LINE
BURNISHING MACHINES—GRINDERS
SPECIAL MACHINES

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Talk To Us About Ball Bearings

You may have the right idea about placing ball bearings, but your experience may lack the practical touch. There's a lot about ball bearings that never gets into print. We are ready to give this information on any proposition you may have. Write us if it's only for our latest book on Ball Bearings.

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TRADE MARK
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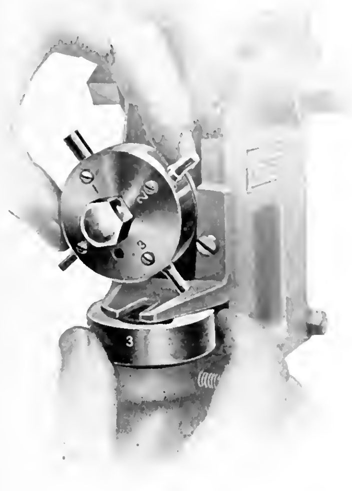
THE UNION Combined Punch, Shear and Rod Cutting Machine

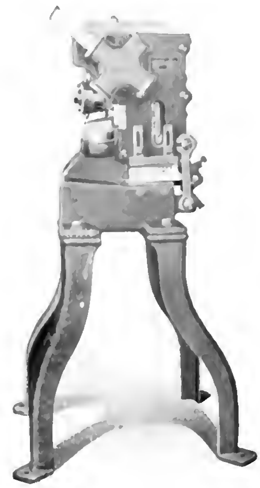


The Turret Punch and showing method of changing from one size to another

The TURRET PUNCH on this machine consists of *four different sizes of punches* and four corresponding dies. It is easily operated and always ready for work.

With this handy machine you can punch four sizes of holes, you can cut off rods, or shear off stock up to the capacity of the machine. It has also been used for cutting angles, channels, etc.

Let us show you how it can be adapted to your work.



No. 2 size mounted on legs

UNION MANUFACTURING COMPANY

New York Office:
26 Cortlandt Street

NEW BRITAIN, CONN., U. S. A.

W-S HYDRAULIC

COMPLETE HYDRAULIC EQUIPMENT

The illustration shows one of our complete hydraulic die press outfits. The press is connected to a motor driven four-plunger pump. The single operating lever shown beneath the gauge, controls the entire operation of the press. This is but one of the outfits we can furnish. We build all kinds and sizes of hydraulic machinery, and everything necessary to the complete installation, including pump, accumulators, intensifiers, valves, hydraulic pipe and fittings, and all sizes of leather packings of a quality unequaled by any other now on the market. **Write for catalogs.**

The Watson-Stillman Co.

ENGINEERS AND BUILDERS OF HYDRAULIC TOOLS

192 Fulton St. **New York**

Chicago: McCormick Bldg.

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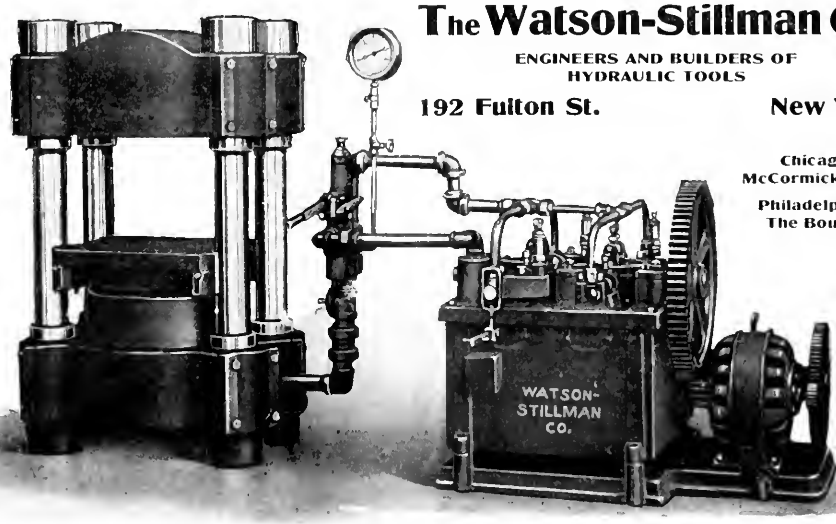

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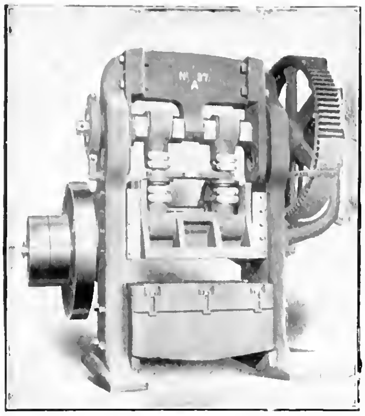
Whatever the business conditions, you can improve the condition of your business by installing



"TOLEDO" Presses

No. 97-A—A powerful "Toledo" 60" Double Crank Press designed for heavy cutting, gang perforating and forming light or heavy stamped steel parts, such as armature segments, steel wheels, floor registers, heater parts, automobile frames, etc.

Weight about 85,000 pounds.

Built single or double geared.

Presses and Dies for every requirement

The Toledo Machine & Tool Co.

Toledo, Ohio, U. S. A.

TWENTIETH CENTURY BALANCING TOOL

Always level and ready for use, no matter where or how you place it.

A practical tool for balancing pulleys, cones, armatures, polishing wheels, etc.; requiring no leveling or adjusting, it embodies great labor-saving features. No machine shop or polishing room can afford to be without this tool.

Made in four sizes to swing from 22" to 8-ft.

Write for descriptive circular.

MANUFACTURED BY

ROCKFORD TOOL COMPANY, Rockford, Ill.

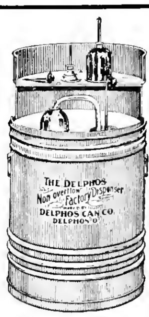
Storage Cans for Waste and Oil

The Delphos Oily Waste Can keeps oil-soaked waste out of harm's way and promotes order and cleanliness.

The Delphos Non-overflowing Oil Dispenser pumps any kind of oil, cannot overfill and is the quickest, cleanest and best method for filling the shop oil cans. Circulars on request.

For safety and economy use Delphos Cans.

DELPHOS MFG. CO., Delphos, Ohio, U. S. A.



NOT IN A TRUST

HAYES FILE COMPANY, Detroit, Michigan

Use our SPECIAL SOLDER-CUT File, for filing Solder

DIXON'S

Graphite Cup Grease

This line is made in a wide variety of grades—uniform as to quality, but differing in hardness for various classes of service.

Only the finest of mineral oils are used, with their lubricating qualities made more lasting and effective by the admixture of the right proportions of Dixon's fine flake graphite.

They never turn rancid or gum up—are not greatly affected by changes of temperature — the graphite veneer built up on the bearings may be depended upon to give perfect lubrication at all times and under all conditions.

Dixon's Graphite Greases need no special handling—they can be used in ordinary grease cups or in open bearings.

If you are not sure just what grade of Dixon's you need for your work, write us as to the service involved and we will recommend the proper grease—will send you a trial sample if you wish.

Send for Booklet No. 74 on "Graphite Cup Greases."

Made in JERSEY CITY, N. J., by the

Joseph Dixon Crucible Company

Established 1827

FLEXIBLE STEEL TUBING

CONTAINS NO PACKING

FOR SUPPLYING LUBRICANT TO MACHINE TOOL CUTTERS

SEND FOR DETAILS

WHEELOCK MFG. CO., WHEELOCK, VT.

PORTABLE TOOLS—*Cylinder Boring Bars, Flue Cleaners, etc.*

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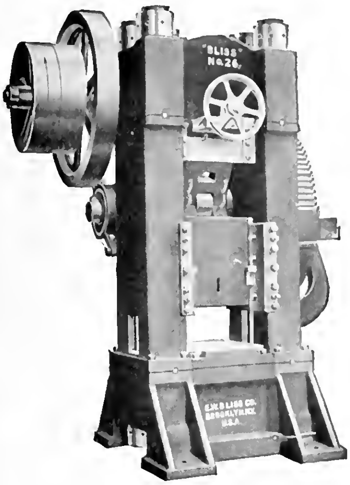
H. B. UNDERWOOD & COMPANY

1024 HAMILTON STREET - - - - - PHILADELPHIA, PA.

Bliss Knuckle Joint Embossing Presses

combine a massive, powerful construction with every facility for delicate adjustment.



"Bliss" No. 26
800 Tons Pressure

They have proved a high degree of economy in the embossing of steel, silver, britannia, brass, copper, aluminum, etc., in the manufacture of medals, coins, regalia, jewelry, watches, silverware, nameplates, etc.

The slides are actuated from above by means of powerful toggles made of tool steel, hardened and ground.

Easy, quick and accurate adjustments for pressure and die space are made by means of a tool steel wedge between punch holder and frame. Sometimes provided with automatic feeds, which greatly increase production.

Built in seven sizes, ranging from 100 to 1,500 tons pressure and from 7,000 to 110,000 pounds in weight.

Ask for detailed description.

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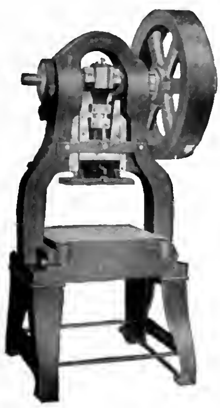
Representatives for Chicago and vicinity: Stiles-Morse Co., 565 West Washington Street, Chicago, Ill.

Offices in Europe: 100 Boulevard Victor Hugo, St. Ouen, Paris. Pocock Street, Blackfriars Road, London, S. E.

Swaine Arch Power Presses



are constructed just right for the rapid and accurate handling of a wide variety of sheet metal products. Particular attention is directed to the ample distance between the uprights and the large opening in the bed.

SWAINE PRESSES

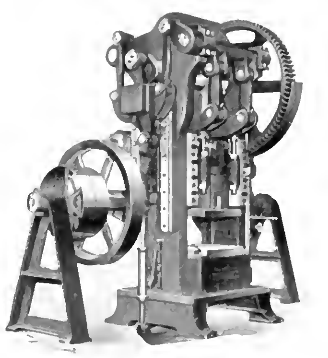
have provision made in their design for the use of many special attachments, including: Sunken Bolsters, Wiring Frames, Horn and Frame and similar fixtures that may be required. The Removable Front which permits the use of all these is a noteworthy feature.

Send for our 200 page Catalogue.

FRED. J. SWAINE MFG. CO.
7th and O'Fallon Sts. St. Louis, Mo.
LARGEST PRESS BUILDERS IN THE WEST

"CLEVELAND"
TOGGLE DRAWING PRESSES

Perfect dwell and perfect timing—"Cleveland" Toggle Presses are unusually heavy in their proportions, and are built in all sizes—both single and double crank, for the production of all classes of drawn sheet metal parts. They are equipped with automatic or hand operated multiple disc friction clutches. Yokes, rock shafts, cranks and links are steel castings. All pin bearings are bronze bushed.

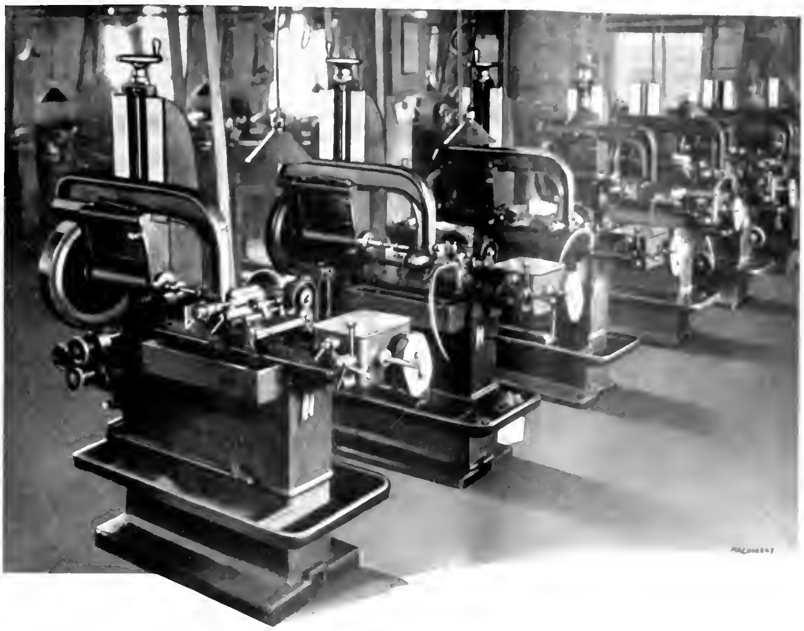


Patent Applied For.

We are prepared to furnish complete equipments of Presses, Shears and Dies for the production of large or small sheet metal articles of every description.

Send us your inquiries.

THE CLEVELAND MACHINE & MFG. CO.
4944 Hamilton Avenue
CLEVELAND OHIO, U. S. A.



This Installation 8 NEWARK GEAR CUTTERS

These 8 Newark Gear Cutting Machines were bought and installed one at a time by a big electrical manufacturing company all No. 2-A Machines all doing similar work all making good, or they wouldn't be there.

The 2-A is the "Baby" Newark Machine; capacity 24" x 8" x 8 D. P.; entirely automatic in operation; cuts spur gears only, including sprockets, ratchet wheels, circular saws and similar work; easily set up and as efficient, profitable and accurate a gear cutting machine within its range as you'll find.

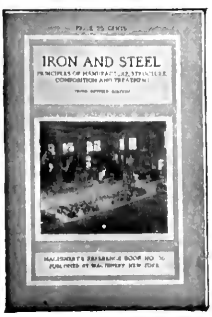
CATALOGUE SHOWS OTHER SIZES; THIS AND OTHER NEWARK TYPES

NEWARK GEAR CUTTING MACHINE CO., Newark, N. J.

CURTIS TURBINE FOR SALE

Turbine includes the following: 1 3000 Kw. General Electric, 4600 volt, three phase, four stage, 720 R. P. M. vertical turbine, including condenser base and tubes; 1 Laidlaw-Dunn-Gordon dry vacuum pump; 2 oil step bearing pumps; 1 motor-driven circulating pump; 1 Edwards steam-driven combination air and wet pump; 1 upper bearing; 1 middle bearing; 1 lower bearing, 2 or 3 step blocks; 1 atmospheric valve with connection to condenser; 1 exhaust head and as much galvanized iron piping for same as we can furnish; 1 extra valve casing, and floor plates around turbine. All apparatus in strictly first-class operating condition. Was removed from power plant to make room for an 8000 K. V. A. unit installed in its place. Can make immediate shipment and we will make a low price on quick sale.

THE EDISON ILLUMINATING COMPANY, Detroit, Mich.



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One of Machinery's Reference Books which graphically describes the process of manufacture of iron and steel, from the time the iron ore is mined until it is ready for market.

The book is written from a practical and interesting standpoint, tells its story in non-technical language, but covers the subject thoroughly.

Shop Arithmetic for the Machinist

Another "Reference" book that you need. Makes the use of formulas, and tables of sines and tangents easily understood without a knowledge of the higher mathematics.

25 Cents a Copy—Postpaid.

THE INDUSTRIAL PRESS, 140 LAFAYETTE STREET NEW YORK CITY

Machinery's Product Index

PERFECT RIVET HEADS ON SHUSTER RIVETERS

A Shuster Riveting Machine delivers a rotary blow, of just the right intensity, in just the right spot, every time. There's no work bent or broken in assembling when the Shuster Riveter is on the job.

That's one of the reasons why the Dayton Engineering Laboratories Company uses eight of these machines. Not only is output high class, but costs are low—and this is the best of reasons why you should investigate.

May we give you some of the facts? Ask for Catalogue R.

THE F. B. SHUSTER CO.
NEW HAVEN, CONNECTICUT

STRAIGHTENERS and CUTTERS for ROUND WIRE, SQUARES, HEXAGONS, Etc.

Hydraulic Accumulator with Pump and Tank

Constant Pressure with Valve Control

We furnish Accumulators in various sizes to suit constant and variable pressure systems.

BUILT BY

The Waterbury Farrel Foundry & Mch. Co.
Waterbury, Conn.

Western Office:
1012 Williamson Bldg.,
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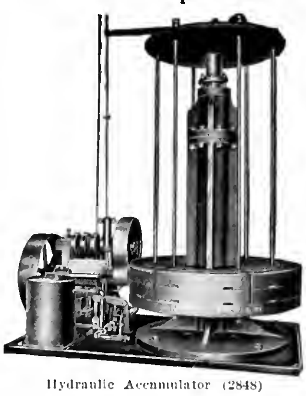


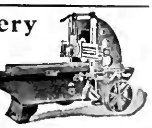
Hydraulic Accumulator (2848)

Automatic and Special Machinery

of all kinds designed and built. Inventions perfected. Builders of Variable Speed Iron Planers. Correspondence Solicited.

Engineers and Machinists.

THE W. A. WILSON MACHINE CO., Rochester, N. Y.



CINCINNATI LATHES

have none of the complicated mechanism that means endless repairs and short-lived efficiency. Years of actual service is the test behind every part. Every stud and shaft in our Double Wall Apron is supported at both ends to withstand any cut. Give us an opportunity to prove to you too the merits of our specialty.

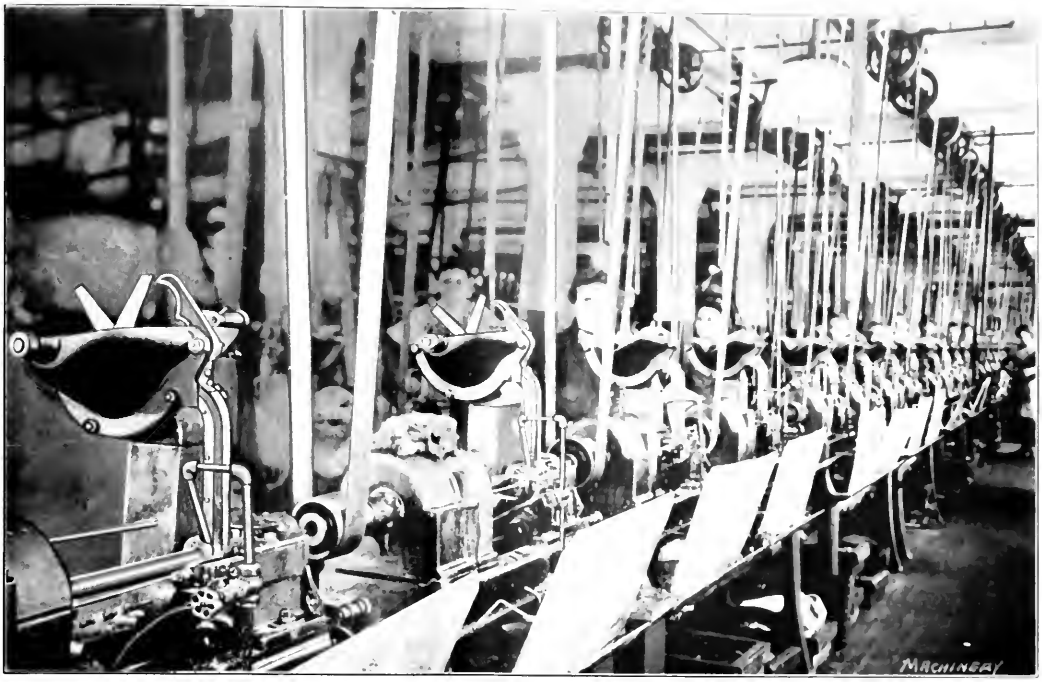
THE CINCINNATI LATHE & TOOL CO.
OAKLEY, CINCINNATI, OHIO, U. S. A.

Don't Waste Time Figuring

The index table tells at a glance just the right speed to run an "Albany" High Speed Drilling Machine. The micrometer depth gauge tells when the hole has been drilled deep enough, and the special friction drive is very practical. Prominent among "Albany" features are: "Rapidity of stopping and starting the spindle; speed with which drills and chuck can be changed, and closest accuracy when drilling to the correct depth.

Latest catalogue fully describes the machine. May we mail a copy?

Albany Hardware Specialty Mfg. Co.
ALBANY, WISCONSIN, U. S. A.



A Battery of Eighty "ACME" Semi-Automatic Nut Tappers

We furnished this battery of eighty Acme Semi-Automatic Nut Tappers to a large manufacturer in the Middle West, where these machines are used for tapping nuts from 1-2" down to 3-16". The photograph shows a row of machines at work on 1-4" and 3-8" stove and carriage bolt nuts, and a production of 30,000 1-4" nuts in ten hours is secured from each machine. Each operator attends to four machines, making the labor cost less than 1 1-2 cents per thousand.

Each machine has three spindles and three taps; but only one spindle and tap is in operation at a time. The nuts are automatically fed to the revolving tap from the bottom of a hopper and when the top shank is full the turret automatically indexes, bringing the next spindle and tap into action. The operator loosens the set-screw holding the shank and unloads the tapped nuts, then replaces the tap in the spindle. When the tap in operation is filled the turret again indexes, this sequence of operations being repeated continuously.

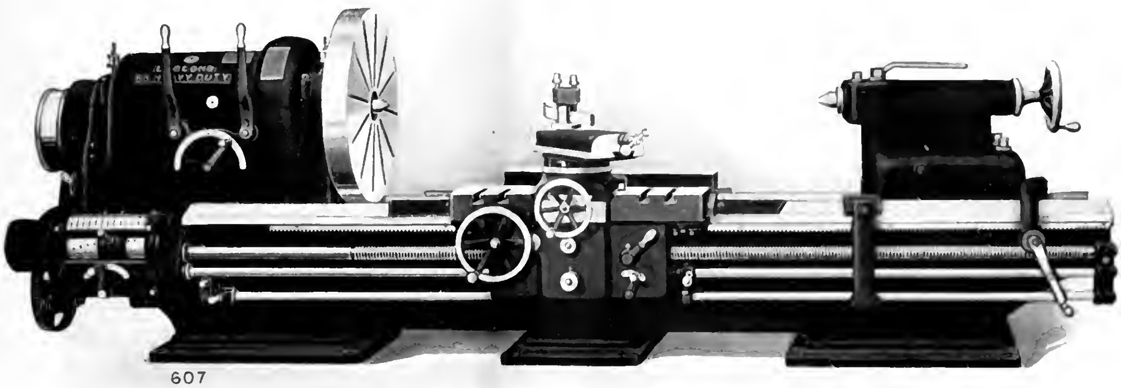
There is no backing taps out of the nuts the spindles are non-reversing, hence good threads are produced. All the operator does is keep the hopper filled and remove the taps when they become filled.

For the cheap manufacture of nuts with good threads these machines have no equal. Let us send circulars describing them in detail.

The Acme Machinery Company, Cleveland, Ohio

FOREIGN AGENTS: Alfred H. Schutte, Cologne, Brussels, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Vienna, Austria-Hungary and the Balkan States. C. W. Burton, Griffiths & Co., London

IT IS ONLY LOGICAL THAT LeBLOND HEAVY DUTY LATHES PRODUCE MORE WORK



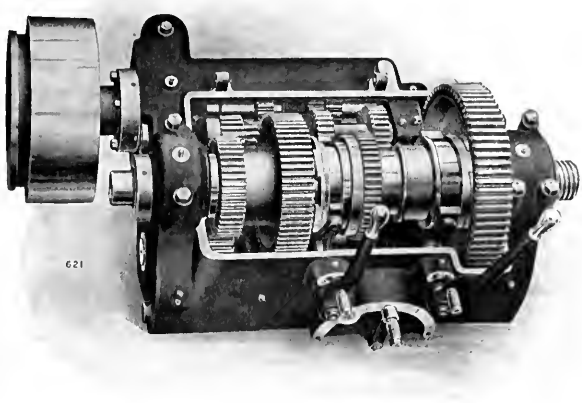
LeBLOND 30-INCH HEAVY-DUTY LATHE WITH SINGLE PULLEY DRIVE GEARED HEADSTOCK

They Produce More Work Because They Are Built For It

The powerful geared headstock, the single piece box section apron with only seven gears (all drop forged), the patent compensating vee bed section with twice the carriage bearing surface found on any other lathe of the same size, are factors—big factors—in determining production.

THE HEADSTOCK

The headstock is simply an automobile transmission in principle, carried out several steps and back geared to provide twelve changes of speed. The sliding gears and their mates, as well as the jaw clutches, are three and one-half per cent nickel steel, heat treated, with strengthened stub form teeth; in other words, practically indestructible. The shafts are short and rigidly supported, the driving power is tremendous—all that the modern tool steels can utilize. The changes are made instantly by the simple movement of three levers conveniently placed, while the spindle is started and stopped from the apron, introducing a new degree of convenience.

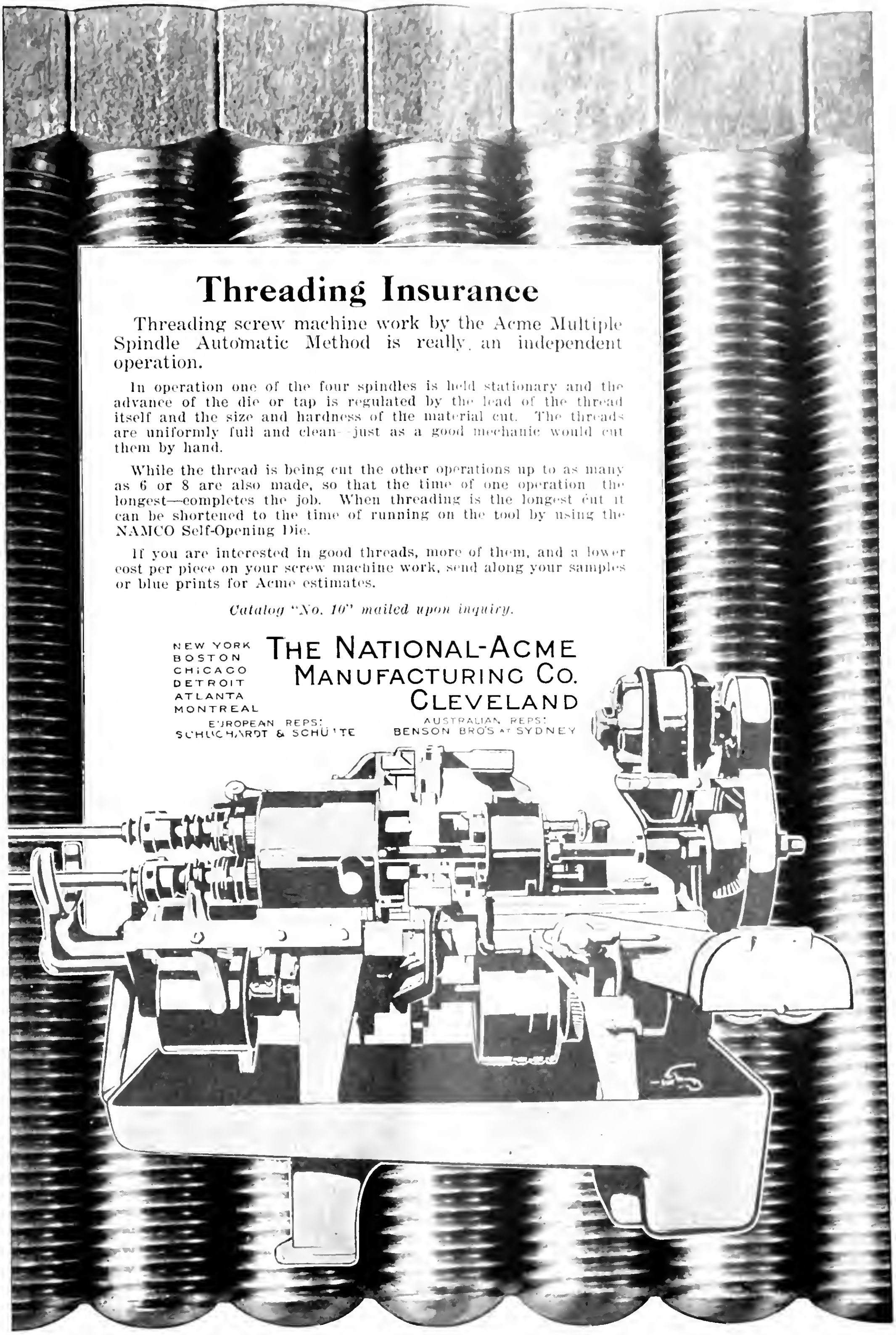


INTERIOR VIEW OF HEADSTOCK

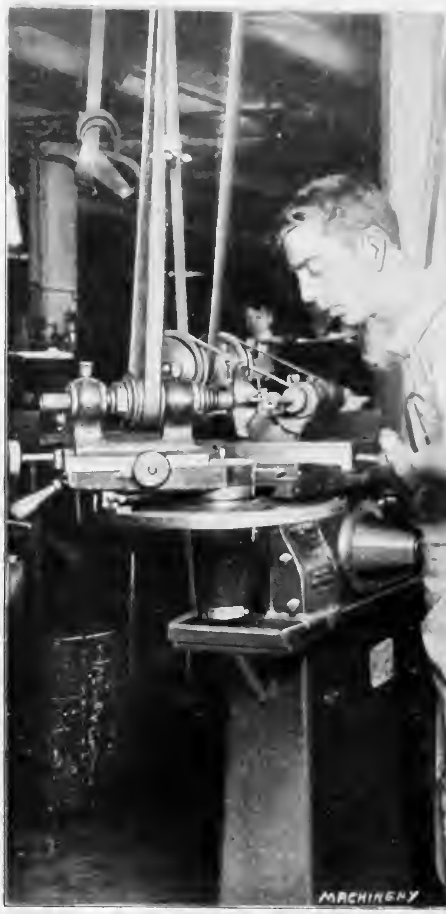
If you need a Lathe at all, you can't afford to overlook the LeBlond heavy duty.

THE R. K. LeBLOND MACHINE TOOL COMPANY, Cincinnati, Ohio

DOMESTIC AGENTS: Niles-Bement Pond Co., Birmingham, Ala., Boston, Mass.; Chicago, Ill.; New York, N. Y., Philadelphia, Pa. Pittsburgh, Pa.; St. Louis, Mo. Caldwell Machinery Co., Seattle, Wash.; Tacoma, Wash. Eccles & Smith Co., Los Angeles, Cal., Portland, Ore.; San Francisco, Cal. Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo. Cleveland Tool & Supply Co., Cleveland, O. J. L. Osgood, Buffalo, N. Y. E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind. Rumely Wachs Machinery Co., Chicago, Ill. F. E. Satterlee Co., Minneapolis, Minn. Oliver H. Van Horn, New Orleans, La. C. C. Wormer Co., Detroit, Mich.
FOREIGN AGENTS: Henri Benedictus, Antwerp, Belgium. Benson Bros., Melbourne, Australia, Sydney, Australia. J. F. Berndes & Co., Havana, Cuba. C. W. Burton, Griffiths & Co., London, Eng. Dodson Mfg. Co., Torreon, Coah., Mexico. The A. R. Williams Mchy. Co., Toronto, Ont., Montreal, Que., Winnipeg, Man., St. Johns, N. B. The General Supply Co., S. A., Mexico, D. F. Hallman Machinery Co., Vancouver, B. C. Alfred Herbert, Ltd., Milan, Italy. J. Lambercier & Cie., Geneva, Switzerland. Schuchardt & Schutte, Copenhagen, Denmark; Berlin, Germany; Paris, France; St. Petersburg, Russia; Stockholm, Sweden; Vienna, Austria; Budapest, Hungary; Prague, Austria; Tokio, Japan; Shanghai, China. Van Rietschoten & Houwens, Rotterdam, Netherlands. Western Machinery & Supply Co., Calgary, Alberta.


Threading Insurance
Threading screw machine work by the Acme Multiple Spindle Automatic Method is really an independent operation.
In operation one of the four spindles is held stationary and the advance of the die or tap is regulated by the lead of the thread itself and the size and hardness of the material cut. The threads are uniformly full and clean—just as a good mechanic would cut them by hand.
While the thread is being cut the other operations up to as many as 6 or 8 are also made, so that the time of one operation the longest—completes the job. When threading is the longest cut it can be shortened to the time of running on the tool by using the NAMCO Self-Opening Die.
If you are interested in good threads, more of them, and a lower cost per piece on your screw machine work, send along your samples or blue prints for Acme estimates.
Catalog "No. 10" mailed upon inquiry.
NEW YORK BOSTON CHICAGO DETROIT ATLANTA MONTREAL
THE NATIONAL-ACME MANUFACTURING CO. CLEVELAND
EUROPEAN REPS: SCHUCHARDT & SCHÜTTE
AUSTRALIAN REPS: BENSON BRO'S AT SYDNEY

Alphabetical Index of Advertisers



Rivett High Speed Internal Grinding

High speeds—productive speeds—are possible with the Rivett Internal Grinder because of the patented spindle construction. 10,000 to 30,000 revolutions per minute are obtainable on these machines without heating up the spindles, provided, of course, they have been properly oiled and adjusted. For such work as gages, automobile bearings, rollers for sewing machines and other small, accurate work these machines are without an equal.

In the Ford (Detroit) plant, Rivett Internal Grinders are used throughout the various departments. These machines fill an important place, especially in the tool-room. The photographs show one No. 3 and one No. 4 Rivett Internal Grinder, one being used on internal work and the other on tapered external work.

We guarantee Rivett Internal Grinders to grind a hole 0.010" in diameter as true and as easily as a larger hole can be ground. It matters not whether you want production or accuracy; Rivett Internal Grinders will give you both. Let us get together on your requirements.

RIVETT LATHE & GRINDER COMPANY

(Brighton District) BOSTON, MASS., U. S. A.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York City, Buffalo, Rochester and Syracuse, N. Y.; Boston, Mass.; Scranton, Pa. Motch & Merryweather Machinery Co., Cleveland and Cincinnati, Ohio; Detroit, Mich.; Pittsburgh, Pa. W. E. Shipley Machinery Co., Philadelphia, Pa. Marshall & Huschart Mchy. Co., Chicago, Ill. Pacific Tool & Supply Co., San Francisco, Cal.

FOREIGN AGENTS: For United Kingdom, Buck & Hickman, Ltd., 2 and 4 Whitechapel Road, London, E. C., 55 Station St., Birmingham, 3 Cross St., Manchester, and 27 Cadogan St., Glasgow, Scotland. For France, Belgium, Italy, Switzerland and Spain, Fenwick Freres & Co., 8 Rue de Rocroy, France. For Germany, Austria-Hungary, Holland, Luxemburg and the Balkan States, F. G. Kretschmer & Co., Frankfurt, a/M., Germany.

See our Ad. on Page 228

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